Proceedings of Learn X Design 2019: Insider Knowledge

Naz A.G.Z. Börekçi
Dalsu Özgen Koçyıldırım
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PROCEEDINGS

DRS LEARN X DESIGN 2019
insider knowledge

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# Table of Contents

Editorial ............................................................................................................................................................................ xv

Keynotes ............................................................................................................................................................................. xvii

Conference Tracks ........................................................................................................................................................... xxi

PhD Pit-Stop Track ........................................................................................................................................................... xxxv

## Part I. Conference Papers

### Section 1. Approaches and Attitudes

Reimagining the Future of Design Education: Nurturing Mindsets and Skillsets in Students
Gary Michael PRITCHARD, Lawrence ZEEGEN ........................................................................................................ 5

Transdisciplinary Knowledge: A Systemic Approach to Design Education
Pier Paolo PERUCCIO, Paola MENZARDI, Maurizio VRENNA ..................................................................................... 17

Metacognition in the Wild: Metacognitive Studies in Design Education
Juanita GONZALEZ TOBON, F. Andres TELLEZ BOHORQUEZ, Oscar Eugenio TAMAYO ALZATE ............................. 25

Exploring the Motives behind the Formations of Recently Established Industrial Design Programs in Turkey
Ilgım EROĞLU, Deniz EKMEKÇİOĞLU ......................................................................................................................... 37

Competency Domains for Systemic Design Education
Seda DUMAN, Şebnem TIMUR ÖĞÜT .............................................................................................................................. 47

Application of QFD and AHP in Curriculum Planning of Industrial Design Education
Xing-Min LIN, Chun-Heng HO, Lu-Ting XIA .................................................................................................................. 57

Qualities of Design Briefs for Studio Learning
Ricardo SOSA .................................................................................................................................................................... 69

Motivation Intended to Inform Design Teaching Practice
Ivan Mota SANTOS, Sebastiana L. de Bragança LANÁ ................................................................................................. 77

Interactive Imagery and Shared Mental Models in Design Learning
Gizem YAZICI, Fehmi DOĞAN ........................................................................................................................................... 89

Material Education in Design: From Literature Review to Rethinking
Ziyu ZHOU, Valentino ROGNOLI ..................................................................................................................................... 111

A UX Pedagogy on Multimodal Aspects of Emotions
Parisa MORADI, Amabel HUNTING, Ricardo SOSA ......................................................................................................... 121

Quantifying Design for User Experience Assignments: Using Rubrics as Assessment Tools
Armağan KARAHANOĞLU, Charlotte OUDE ALINK, Yekta BAKIRIOĞLU ................................................................. 131

UX Modelling in Design Education: Methods, Processes and Examples
Gülşen TÖRE YARGIN, Aslı GÜNAY, Sedef SÜNER-PLA-CERDÀ .................................................................................. 139

Teaching (with) Empathy and Creativity in Design
Ricardo SOSA .................................................................................................................................................................. 153

Representation and Context Based Studio Design Process: Articulating a City (Istanbul)
İpek AKPINAR, Canan GANIÇ ........................................................................................................................................ 161
Accelerating Students’ Capability in Design for Interaction
Bahar ŞENER, Owain PEDGLEY ................................................................. 171

Teaching the Critical Role of Designers in the Data Society: The DensityDesign Approach
Michele MAURI, Gabriele COLOMBO, Ángeles BRIONES, Paolo CIUCCARELLI ............................................................... 183

Transition from Basic Design to Product Design: A New Practical Basis
Dilek AKBULUT, Ebru GEDİK, Hatice KESDİ, Atakan BAŞ ............................ 197

Contemporary Art for Product Design Studio: Informed Conceptualism
Çiğdem KAYA PAZARBAŞI ............................................................................... 205

Motivational Factors for Participation in Industrial Design Competition
Bao-Yi ZHANG, Min-Yuan MA ........................................................................... 213

Participatory Design Methodology in Design Competition Practice
Lung-Chieh CHAO, Wen-Chih CHANG, Chien-Hsiung CHEN ........................................ 223

Section 2. Educational Milieu

Tacit Learning in an Extended Interior Design Studio
Aruna Venkatesh, Henry Ma ............................................................................. 237

Educating Designers in Virtual Space: A Description of Hybrid Studios
Andreas Ken LANIG .......................................................................................... 247

Virtual Learning Spaces: Designing Learning and Learning to Design
Ahu YOLAÇ ........................................................................................................... 257

OpenDesignStudio: Virtual Studio Development over a Decade
Nicole LOTZ, Derek JONES, Georgy HOLDEN ................................................. 267

The Evolution of the Design Studio: Hybrid Learning Spaces
Clive HILTON ...................................................................................................... 281

Dichotomous Tension: A Route for Self-Discovery in Architectural Pedagogy
Ramy BAKIR, Amr ABDEL KAWI ...................................................................... 291

The Outcomes of Collaborative Learning in Design Studio Courses
Dilek HOCAOĞLU, Salıha TÜRKMENOĞLU BERKAN ........................................ 303

An Ethnography of the Design Studio: Exploring Social Interactions and Performances in Studio Environment through Goffman’s Dramaturgical Approach
Süleyman Enes KARABULUT, Özge MERZALI ÇELİKOĞLU .................................. 313

Exploring the Ongoing Diversity Issues Embedded in Product Design
Gary UNDERWOOD, Franziska CONRAD .......................................................... 321

Industrial Design Students’ Reflections on Cross-Institutional and Distance Collaboration
Pınar KAYGAN, İrem DİLEK, Harun KAYGAN ..................................................... 331

How Inquiries into Craft Generate New Avenues for Multicultural Collaborations in Design
Bettina MINDER, Shilpa DAS, Praveen NAHAR, Karina KAINDL, Sabine JUNGINGER ............................................................... 339

Crossing the Finish Line Together: Collaborative Team Learning in Design Studios
Zhengping LIOW .................................................................................................. 347

Forget to Clean-Up When You’re Done
Milena RADZIKOWSKA, Stan RUECKER, Jennifer ROBERTS-SMITH .................... 361
Section 3. Tools and Methods

Nature as a Framework for Teaching Design
Inna ALESINA .................................................................................................................................................................. 387

A Study on the Visual Thinking in the Sketching of Product Design
Chun-Heng HO, Hang-Qing ZHANG ................................................................................................................................ 399

A New Approach in Design Learning: Childhood Pretense
Derya GÜRÇAN, Deniz LEBLEBİCİ BASAR ........................................................................................................................ 409

Making the Students of Interior Architecture Design Seating Furniture
Seçil ŞATIR ...................................................................................................................................................................... 419

Project Process Cards: A Self-Evaluation Tool for Design Studio
Mert TOSUN, Aydın ÖZTOPRAK, Ali Emre BERKMAN ..................................................................................................... 431

Using a Self-Reporting Tool to Capture Design Student’s Experience
Nur FINDIK ÖNAL, Bahar ŞENER ..................................................................................................................................... 439

Visualisation Method Toolkit: A Shared Vocabulary to Face Complexity
Chiara L. REMONDINO, Paolo TAMBORRINI, Wouter MEYS .......................................................................................... 453

When Rabbits Lead to Ideas: Inspiring Design by Retelling Stories through Metaphors
Özge MERZALI ÇELİKOĞLU ............................................................................................................................................. 461

Cast Away: A New Way to Read Value of Objects in the Context of a Movie
Hümanur BAĞLI .............................................................................................................................................................. 469

Translational Aspects of Basic Design Exercises
Michael RENNER, Sarah KLEIN ........................................................................................................................................ 477

Upside Down: A Flipped Design Thinking Course
Can GÜVENİR, Sevi MERTER, H. Hümanur BAĞLI ........................................................................................................... 487

Repurposing Online Videos for Exploratory Design Research
Gizem Hediye EREN, Fatma KORKUT ...................................................................................................................................... 499

An In-between Ludic Approach for UX Research: A Case Study
Martina SCIANNAMÈ, Davide SPALLAZZO, Mauro CECONELO ............................................................................................. 511

Rapid Development of Materials Experience through Active Learning
Owain PEDGLEY .............................................................................................................................................................. 521

Multi-Attribute Material Information Platform
Indji SELIM, Ana M. LAZAREVSKA, Tatjana KANDIKJAN, Sofija SIDORENKO ................................................................... 531

Educational Tools to Teach Design Students the Dynamic Behaviours of Smart Materials
Agnese PISELLI, Sara COLOMBO, Jenny FAUCHEU, David DELAFOSSE, Barbara DEL CURTO ........................................... 543

Nurturing Competence on Innovative Materials through New Media: The Case Study of Public Engagement of
MATto, The Material Library of Politecnico di Torino
Doriana DAL PALÙ, Valentina CORAGLIA, Beatrice LERMA, Claudia DE GIORGI ............................................................. 555
The NautICS Materials Workshop: Teaching and Learning Interactive, Connected and Smart Materials for Yacht Design
Stefano PARISI, Arianna BIONDA, Andrea RATTI, Valentina ROGNOLI................................................................. 565

Section 4. Making and Prototyping

Impossible Design: Fostering Creativity by Quick and Dirty Prototyping
Gabriela GOMEZ, Ricardo LOPEZ-LEON ................................................................. 581

Bundles of Spatial Ingredients: Designing Through the Prototype
Barbara Di PRETE, Fiamma Colette INVERNIZZI, Emilio LONARDO, Martina SCIANNAMÈ ........................................... 589

Why Design Students Need Application Programming Interfaces (APIs)
Mahshid FARZINFAR, Stanley RUECKER ........................................................................ 599

Game-Design-Driven Knowledge: When Prototypes Unpack and Reframe Conventions
Ilaria MARIANI, Davide SPALLAZZO ........................................................................... 607

Prototyping a New Economy
Gerry DERKSEN, Zhabiz SHAFIEYOUN, Stan RUECKER ............................................. 617

Teaching Wearables
Petra AHDE-DEAL, Mette LAIER HENRIKSEN .......................................................... 625

A Gestalt Approach to Teaching and Learning by Prototyping
Mauro CECONELLO, James POSTELL, Martina SCIANNAMÈ ........................................ 635

From Observing Beans to Serving the Elderly: Prototyping Medication Administration for the Elderly in Hong Kong
Brian Sze Hang KWOK .................................................................................................. 645

Progressive Prototyping for the Design of Spatial-Number Sense Tools
Ekta SURENDER, Koumudi PATIL ................................................................................ 655

An Exploratory Study for Provocative Prototypes: Creating Personas
Nagihan TUNA, Emre ÇAĞLAR ................................................................................... 671

Design for the Nonhuman
Aaron BRAKKE, Susan LIEPERT, Stan RUECKER ...................................................... 681

Using Cat-Centred Research to Learn the Design Thinking Process
Rachel SWITZKY, Rebecca SWEENEY ........................................................................ 693

Learning Fashion Outside Academia: From Sewing Circles to Maker Spaces
Gözde GÖNCÜ-BERK, Sasha WALLINGER ................................................................. 709

A Design Course for Craftspeople in Istanbul
Ashi Kiyak İNGİN, Aysenaz TOKER ........................................................................... 719

Education, Motivation, Maker Practice: The Case of Woodworking
Gökçe DENIZ, Dilek AKBULUT .................................................................................. 735

Rehashing Design through Evolutionary Computation
Miguel MONTIEL, Ricardo SOSA ................................................................................ 745

Computational Design Tools and Education: The Smartgeometry Case
Öykü ACICAN, Ipek GÜRSEL DİNO ............................................................................ 753

Mediating Cultural Values in a Multimedia Installation
Mauro CECONELLO, Davide SPALLAZZO ..................................................................... 761
Section 5. Social Contexts and Sustainability

Design Education for Rural Revitalization
Yi-ping CAO, Tie JI, Ming-fang ZHONG

Towards Community Centric Design in Cairo Informal Areas
Jomana G. ATTIAT, Alaa EL ANSSARY

Familiar Strangers: Enhancing Underground Travel Experience through Digital Screens
Güler AKDUMAN, Yumna MOHAMMED ALI

Learning Through Industry-University Collaboration: Observation of Product Innovation Cases Targeting Low-Income Communities
Hande İŞIK TOSUN

Facing a Phytosanitary Emergency through Transdisciplinary Approach of Systemic Design
Alessandra SAVINA, Pier Paolo PERUCCIO

Taking the Culture out of the Lab and Into the Office: A “Non-Lab” Approach to Public Service Transformation
Ryan HUM, Paul THIBAUDEAU

Intersemiotic Translation in Intercultural Communication Design
Shaima ELBARDAWIL

Behavioural Change for Efficient Usage of Electricity at Homes
Engin KAPKIN, Sharon JOINES

Self-Organization for Design Education: A Sustainable Flocking System
Nariman LOTFI

How Industrial Design Students Approach Service Design Projects
Deniz SAYAR

Integrating Repair into Product Design Education: Insights on Repair, Design and Sustainability
Nazlı ÖZKAN, Renee WEVER

Using Problem-Based Learning in Sustainable Design Education
Yasemin AFACAN

Asking the Industry Partners: Reflecting on the Value of Internships for Circular Design
Muireann McMAHON, Yekta BAKIRLIOĞLU

Studio-Sustain Urla-Barbaros: A Design Studio Course on Sustainability
Simge GÖKSOY, Aslı KIYAK İNGİN

Part II. PhD Pit-Stop Short Papers

An Inquiry into Architectural Space in Computational Design Practice
Kadir ÖZTÜRK

A Creative and Innovative Design Approach to a Traditional Cuisine - A Comparative Analysis of Turkish Cuisine (Developing A Conceptual Model of Culinary Design Thinking)
Sedef YÜCEL

How Does the Process of Industry 4.0 Change the Job of a Carpenter?
Wolfgang SCHWARZMANN
<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Products as Mediating Entities in a Connected World</td>
<td>953</td>
</tr>
<tr>
<td>Fazıl AKIN</td>
<td></td>
</tr>
<tr>
<td>A New Approach in Design Learning - Childhood Pretense</td>
<td>957</td>
</tr>
<tr>
<td>Derya GÜRCAN</td>
<td></td>
</tr>
<tr>
<td>Exploration of Interactive Data Visualization from the Design Perspective</td>
<td>961</td>
</tr>
<tr>
<td>Duygu BEYKAL İZ</td>
<td></td>
</tr>
<tr>
<td>Material Education in Design</td>
<td>965</td>
</tr>
<tr>
<td>Ziyu Zhou</td>
<td></td>
</tr>
<tr>
<td>An In-Depth Inquiry of Student Happiness in Spatial Design Education</td>
<td>969</td>
</tr>
<tr>
<td>Sıla Su YANAR</td>
<td></td>
</tr>
<tr>
<td>Self-Regulated Learning in Industrial Design Studio</td>
<td>973</td>
</tr>
<tr>
<td>Aysun ATEŞ AKDENİZ</td>
<td></td>
</tr>
<tr>
<td>An Evaluation of Interior Design Education Learning Outcomes in Turkey through the Contents of Design Project Courses</td>
<td>979</td>
</tr>
<tr>
<td>Özlem KURT ÇAVUŞ</td>
<td></td>
</tr>
<tr>
<td>A Holistic Outcome-based Approach to Design Healthcare Systems</td>
<td>983</td>
</tr>
<tr>
<td>Irma Cecilia LANDA-AVILA</td>
<td></td>
</tr>
<tr>
<td>Co-Developing STEM Activities by Using a Design Thinking Approach</td>
<td>989</td>
</tr>
<tr>
<td>Ahsen ÖZTÜRK</td>
<td></td>
</tr>
<tr>
<td>Co-Designing Gift in respect to Local Skills and Knowledge</td>
<td>993</td>
</tr>
<tr>
<td>Milad HAJIAMIR</td>
<td></td>
</tr>
<tr>
<td>Involving Users in the Development Process of Social Robots</td>
<td>999</td>
</tr>
<tr>
<td>Yasemin DÖNMEZ</td>
<td></td>
</tr>
<tr>
<td>Design Thinking Learning Object Design</td>
<td>1003</td>
</tr>
<tr>
<td>Can GÜVENİR</td>
<td></td>
</tr>
<tr>
<td>Facilitation of Design Students’ Tacit Knowledge Construction - An Interpretive Research in Interior Design Studios</td>
<td>1007</td>
</tr>
<tr>
<td>Aruna VENKATESH</td>
<td></td>
</tr>
<tr>
<td>Design of Spatial Pedagogical Tools for Fostering Number Sense</td>
<td>1011</td>
</tr>
<tr>
<td>Ekta SURENDER</td>
<td></td>
</tr>
<tr>
<td>Human-Material Interaction - Examining the Material Agency Concept in Making Processes</td>
<td>1017</td>
</tr>
<tr>
<td>Bilge Merve AKTAŞ</td>
<td></td>
</tr>
<tr>
<td>Improving Driver Experience for METU Campus Shuttle Buses</td>
<td>1023</td>
</tr>
<tr>
<td>Ayça KINIK</td>
<td></td>
</tr>
<tr>
<td>Material Information Platform for Environmentally Friendly Products</td>
<td>1027</td>
</tr>
<tr>
<td>İndji SELIM</td>
<td></td>
</tr>
<tr>
<td>Investigation of the Border as a Space of Becoming - Passages</td>
<td>1031</td>
</tr>
<tr>
<td>Canan GANIÇ</td>
<td></td>
</tr>
<tr>
<td>Aesthetics of Ecological Commitment - A Pragmatic Typology</td>
<td>1035</td>
</tr>
<tr>
<td>Yaprak HAMARAT</td>
<td></td>
</tr>
</tbody>
</table>
Editorial


Learn X Design is the biennial conference series organised by the Design Research Society Pedagogy Special Interest Group (PedSIG), cultivating symbiotic exchanges between design education and design research. The first symposium in the series was held in Paris in 2011 and included a number of invited presentations. The Oslo 2013 and Chicago 2015 conferences were embraced by the design education research community at large and involved an impressive number of contributions across design disciplines and educational levels. The fourth conference was hosted by Ravensbourne University London in 2017, continuing to represent diverse traditions in research and education. The history of the series and all publications can be found on the PedSIG website (www.designresearchsociety.org/cpages/design-pedagogy-sig).

The Fifth DRS Learn X Design International Conference for Design Education Researchers took place July 9-12, 2019 with the main theme “Insider Knowledge” at Middle East Technical University, Ankara, Turkey. In over sixty years, Middle East Technical University (METU) has built an outstanding educational and research environment in many fields including engineering, natural sciences and humanities. METU’s impact as a research university has increased with its alliance and collaboration with major industries in Turkey, through its top-ranked technopole. METU also played a pioneering role in industrial design education. The first course on industrial design in Turkey was offered at the Faculty of Architecture in 1969 by the American industrial designer David K. Munro, marking its 50th anniversary in 2019. METU Department of Industrial Design was established as a separate academic unit in 1979, making this year its 40th anniversary. The DRS Learn X Design 2019 conference has provided us with an excellent opportunity to contribute to the celebration of this significant year by sharing our knowledge and experience with the international community, which inspired us to choose “Insider Knowledge” as the theme of this year’s conference.

By bringing together the local and international design education community in Ankara, the capital of a country representing a passage from war-torn countries of the Middle East to the borders of a concerned Europe, we also hoped to make a call for peace and dialogue. Furthermore, we believed that having METU as the venue for the conference would be meaningful regarding emerging discussions about the decentralisation of design and be an incentive for a more diverse participation. The particular history of METU itself inspires conversations about the interaction of education, design, environment, urban development and policy, thanks to its award-winning campus and its on-going afforestation project of almost 60 years.

The visual identity of the conference was inspired by the motifs of the Anatolian carpets. The traditional symbols in these carpets communicate the dreams and wishes of the weavers or mark significant events in their lives. The eight-point star, one of these symbols, was interpreted to stand for the “X” of Learn X Design and has become the main reference for the conference identity. Its festive colours weaved together act as a reminder that Turkey stands at the crossroads of continents and cultures.

We first made a call for tracks 14 months ahead of the conference. Eighteen tracks were announced in the call for papers made to the design education community. The conference accepted papers submitted to 17 track themes. Forty-two track chairs were involved in the building of the conference scope, also taking responsibility in the review process and chairing of the paper sessions. A total of 111 paper submissions, 11 workshop proposals, and 28 PhD Pit-Stop applications were received. In all, 86 papers were presented and six workshops were conducted in a variety of topics, ranging from emerging practices in design education to innovative approaches in bridging design education and society. The conference hosted 150 delegates from 81 institutions in 31 countries.

The conference began on 9 July 2019 with a one full-day PhD Pit-Stop event hosting 24 PhD researchers and eight mentors. The presentations by the PhD researchers and the feedback by the mentors took place in the morning session. In the afternoon, the PhD Pit-Stop workshop was carried out in small groups guided by the mentors. The event was supported with four short lectures by Gülay Hasdoğan, Owain Pedgley, Peter Lloyd and Gülşen Töre Yargın, open to the conference audience and PhD Pit-Stop participants. The conference papers were presented over three days between 10 and 12 July, organised under 27 paper sessions. The range of research methods was similarly broad: from large-scale statistical analyses of data sets to rich descriptions and dramaturgical approaches of analysing the studio. The range of subjects of study expanded the anthropocentric to include, for the first time, both cats and squirrels! Questions from delegates on methods and approaches were as common as queries on results. The concluding panel titled “Design Education for Future Generations” brought together five academics in the field of design education, İpek Akpınar, Aykut Coşkun, Emre Çağlar, Stan Ruecker and Yasuko Takayama, representing
perspectives from different design fields, academic positions and cultural contexts, under the moderation of Derek Jones, PedSIG Convenor.

Three keynotes addressed the conference. The first keynote speech titled “Disciplinary Knowledge and the Design Space” was given by Gabriela Goldschmidt, who presented her work on design cognition and its inherent spatiality through theories such as Vygotsky’s Zone of Proximal Development. Goldschmidt argued strongly for the value of such spatialities to develop design expertise, not simply design-like behaviours and actions. The second keynote speech titled “Drawing Circles” was given by Zeynep Çelik Alexander, who gave an in-depth analysis of the pedagogical roots of the Bauhaus, arguing strongly that the design curriculum that has influenced a significant proportion of contemporary design education had prior pedagogical research roots. The final keynote speech titled “Learning and Knowledge Building Skills in Design Education” was given by Halime Demirkan on the subject of learning styles and their applications to student-tutor interaction. The speech highlighted the unique position of design education research in the intersection of theory, research, practice and design itself.

The conference experience was enriched with two exhibitions. The Nurus exhibition “Contemporary Turkish Architecture after 2010” took place at the conference venue, with photographs by Cemal Emden, displaying recent examples of architecture in Turkey. Nurus also furnished the conference main hall and foyer with examples from its product range, designed by the Nurus d.lab and Ece Yalım Design Studio. The “Nude… Simple is Beautiful” exhibition by Nude, also at the conference venue, displayed exquisite examples of glass work by local and international designers. We also experimented with a “Confessions of Design Educators” board for delegates to share with us their memorable teaching experiences, whether slightly embarrassing or soul-shattering.

The conference also gave the participants a chance to get together and strengthen the design education community through its social programme. Our Welcome Reception took place on the evening of 9 July by the pool at the Faculty of Architecture garden, which gave our delegates the chance to visit the faculty building and the 50/40 exhibitions on display. The reception was followed by the PhD Pit-Stop party in downtown Ankara. The social events planned for the evening of 10 July included the options of a Turkish traditional dinner at the Ankara citadel and a genuine Turkish bath experience at a historical hammam in the old city centre, allowing the participants to get a brief insider look at local cultural practices. The conference dinner took place on 11 July, during which the delegates had the chance to try out their belly dancing skills in a participatory dance show!

It was a busy conference, but one that allowed the community to reconnect, create new links and engage in discussion. By undertaking the responsibility of organising this conference, we hoped to contribute to the growth of the design education community and inspire others to continue the series. As we now arrive at the end of our journey by finally publishing the conference proceedings, we would like to thank everybody involved in the realisation of the conference. We would like to thank the former DRS PedSIG convenor Michael Tovey for his encouragement in our hosting of the conference and the Chair of the DRS Council Peter Lloyd for his unfailing support. Our thanks also go to the Conference Programme Committee members and the members of the administrative, editorial, visual communication and conference support teams for their dedicated hard work. We sincerely hope that all participants enjoyed both the academic content and the social activities, as well as the METU campus characterized by its unique natural and built environment as well as by its egalitarian culture and open intellectual milieu.

The proceedings book has been organised under two major parts reflecting the structure of the conference programme: Part 1 covers the double-blind peer-reviewed papers presented by the delegates, and Part 2 covers the PhD Pit-Stop short papers presented by the PhD researchers. Looking at the scope of the conference papers, we organised Part 1 under five sections, namely, Approaches and Attitudes, Educational Milieu, Tools and Methods, Making and Prototyping, and Social Contexts and Sustainability.

As we approach the end of our two-year conference journey, selective amnesia sets in. The gentle push by Michael Tovey at Ravensbourne back in 2017, and the sheer joy of being among friends for the farewell drinks at the neighbourhood pub on the last day of the conference loom larger. We thank you all for the companionship and support you provided at different stages of this journey. We look forward to exchanging warm greetings with you all in the next conference in 2021.

Proceedings Editors
Naz A.G.Z. Börekçi
Dalsu Özgen Koçyıldırım
Fatma Korkut
Derek Jones
Keynotes

Zeynep Çelik Alexander

Zeynep Çelik Alexander’s work focuses on the history and theory of architecture since the Enlightenment. After being trained as an architect at Istanbul Technical University and Harvard Graduate School of Design, she received her Ph.D. from the History, Theory, and Criticism Program at M.I.T. Çelik Alexander is the author of *Kinaesthetic Knowing: Aesthetics, Epistemology, Modern Design* (Chicago and London: University of Chicago Press, 2017), recipient of the Charles Rufus Morey Award from College Art Association. The book is a history of an alternative mode of knowing — non-propositional, non-linguistic, and based on the movements of the body — that gained saliency in the nineteenth century and informed the epistemological logic of modernism in the German-speaking world. A second volume, *Design Technics: Archaeologies of Architectural Practice*, co-edited with John J. May (Harvard University) and forthcoming from the University of Minnesota Press in 2019, examines the histories of a series of techniques that have come to dominate contemporary design disciplines. Çelik Alexander has published in numerous venues, including *Journal of the Society of Architectural Historians*, *New German Critique*, *Harvard Design Magazine*, *Log*, *e-flux*, *Grey Room*, *Journal of Design History*, and *Centropa*. She is currently at work on new book that explores nineteenth-century architectures of bureaucracy from the Kew Herbarium to the Larkin Administration Building. Çelik Alexander is a member of the Aggregate Architectural History Collaborative and an editor of the MIT Press journal *Grey Room*.

DRAWING CIRCLES

What kind of knowledge is produced at a design school? This talk inquires into the late-nineteenth century German context out of which schools such as the Bauhaus emerged in an attempt to make sense of the epistemological ideals still pursued in design schools today. The Bauhaus here appears less as the beginning of a modernity and more as the last manifestation of an epistemological project that was marked by faith in non-propositional and non-linguistic knowledge. Even though this project lost its credibility in the early twentieth century its techniques survived. Discussing these techniques as they were forged at the Bauhaus, this talk poses questions regarding the epistemological history of modern design education.
Halime Demirkan is a Professor of Architecture at the Faculty of Art, Design and Architecture, Bilkent University, Ankara. She currently is the Director of the Graduate School of Economics and Social Sciences. She holds bachelor’s and master’s degrees in industrial engineering and a doctoral degree in architecture from Middle East Technical University. Her previous professional experience has included appointments as research assistant and instructor in the departments of Industrial Engineering and Industrial Design, Middle East Technical University; and as a researcher at the Building Research Institute, Scientific and Technological Research Council of Turkey. Her publications include articles in various refereed journals, book chapters and papers in conference proceedings. Her current research and teaching include creativity in architectural design process, design education, and design for an aging population.

LEARNING AND KNOWLEDGE BUILDING SKILLS IN DESIGN EDUCATION

Learning as an interactive process is an important issue in design education. An individual’s preferred method for receiving information in any learning environment is the learning style of that individual. Learning style is the most widely used concept in Experiential Learning Theory (ELT). ELT considers learning as a cycle that begins with experience, continues with reflection and later leads to action that becomes a concrete experience for reflection. In the design process, information processing and decision making is very intensive in the conceptual design phase, as a consequence of generating and evaluating alternative ideas. An epistemological and methodological approach guides the designer to capture, describe, prioritize, act and evaluate alternative design solutions. Therefore, it is important that methods and knowledge are linked in designers’ cognitive strategies. With the emergence of digital technology, the design studio has changed from a studio-based learning environment to a technology enhanced active learning space. Educator’s role in the application of the ELT concepts of the learning style should match with the dynamic model of teaching around the learning cycle. Considering the learning and knowledge-building skills of students in design education, the educator should not only be a conveyor of knowledge but also a facilitator, encouraging students to develop their academic and artistic skills.
Gabriela Goldschmidt

Gabriela Goldschmidt is a graduate of the School of Architecture at Yale University. She worked as a practicing architect in the USA and Israel and had her own practice in Haifa until the mid-1980s, at which time she joined the Technion in a full-time capacity. Since the end of 2010 she is a professor emeritus. She taught a large number of design studios and theoretical seminars that reflect her research areas: design cognition, visual thinking and sketching, analogy, and design education. She served as a visiting professor or visiting scholar at MIT, Stanford, TUDelft, the University of Montreal, UNIST, and Bezalel Academy of Art and Design. Her publications include dozens of refereed journal papers, book chapters, papers in conference proceedings, and two books: an edited volume (with Prof. William Porter of MIT), *Design Representation* (Springer 2004), and *Linkography: Unfolding the Design Process* (MIT Press 2014). She continues to lecture around the world and supervise PhD students at the Technion.

**DISCIPLINARY KNOWLEDGE AND THE DESIGN SPACE**

When faced with a design assignment, designers –novice and experienced alike— conduct a search in a design space that comprises different types of knowledge that is relevant to the assignment. For experienced and certainly expert designers, this knowledge can be divided into three categories: general, cognitive, and disciplinary (professional). Novice designers often have similar general knowledge, they have cognitive knowledge, but they lack disciplinary knowledge, which is acquired with experience and with guidance, mostly as part of a professional education. Disciplinary [professional] knowledge is embedded in a disciplinary world into which the novice designer must be initiated. Disciplinary knowledge, both declarative and procedural, affects the way cognitive knowledge is implemented. The disciplinary world one is a member of, shapes the design spaces one constructs. In this talk we look at examples of design solutions generated by novices (children) and by professionals in different design disciplines, to see how they incorporate (or do not incorporate) disciplinary knowledge into their solutions. We then briefly touch on the learning processes that enable novices to benefit from input by their elders and develop independent design thinking skills and knowledge.
Conference Tracks

ALTERNATIVE STUDIOS

Derek Jones, Senior Lecturer in Sustainable Design, The Open University, UK.
Nicole Lotz, Senior Lecturer in Design, The Open University, UK.

Contemporary higher design education is making increasing use of online, digital and distributed studios to augment, or even replace, physical (or proximate) studio space. In part this is due to increasing pressures on resources but it is also in response to increasing professional and practical uses of online and digital tools. Both have been enabled by developments in online technologies and their associated adoption as broader socio-technical tools. The body of scholarship and knowledge around such ‘alternative studios’ has grown steadily but slowly over the past decades. Very often it is scholarship, small-scale projects, and case study-based work that contributes knowledge. Whilst this is valuable, especially to practitioners and teachers, it can often be at the expense of studying deeper ideas and themes. In particular, basic questions around how alternative studio pedagogy differs (if at all) from proximate studio pedagogy, are very often answered superficially or not addressed at all. This track proposes to bring together researchers, practitioners and educators involved in alternative studios to share knowledge, cases and consider deeper themes of these as a pedagogical mode in art, design, architecture and engineering education. This will be one of the earliest gatherings of experts to focus only on alternative studios as a specific mode of design education and a further intention would be to initiate the emergence of an international community whose interests centred around this particular research area.

This track would like to explore, but is not limited to, the following topics:

• Review of definitions (or frameworks) and meanings of alternative studio ‘spaces’, for example: proximate, physical, virtual, online, distance, social, dispersed, mobile, etc.
• Studies and work on the differences and similarities between proximate and virtual studios.
• Research into the affordances and affect in online and distance studios.
• Intersections between social media technologies and online studios.
• The boundaries of what an online studio is – technically, socially, professionally, and educationally.
• Theories of the pedagogy of alternative studios.
• Scholarship of alternative studios: case studies; learning and teaching design; practice-based theory(ies).
• Intersections between professional and educational online and distance studios – similarities, differences, modes and methods.
• Alternative studio modes and uses with a relevance to design pedagogy and practice or studio theory.

Bibliography

VIRTUAL MOBILITY AND DEMOCRATIZATION OF RESEARCH AND TEACHING PRACTICES

Ayşen Savaş, Prof. Dr., Faculty of Architecture, Middle East Technical University, Turkey.
Felix Sattler, Curator, Tieranatomisches Theater-Exhibition Research Space, Humboldt University, Germany.
Museums are primarily didactic institutions, and web-based education platforms bring innovative perspectives to object-oriented learning practices towards increasing the potentials of virtual mobility and democratization of research and teaching practices. New display environments also provide a medium to question the authority of museums as storages of knowledge and the authorship of producers (artists, designers, curators, etc.). This track invites designers, museum experts, historians and specialists in related fields, to seek and exchange alternative ways of sharing knowledge in e.g. museums, archives, and collections and initiate future research using the potentials of digital cultural heritage. It supports cross-disciplinary research initiatives that integrate science, design, engineering and aesthetics at the core and focuses on virtual mobility and democratization of knowledge and finds its space in museums. Professional engagement (curatorial, artistic, educational) as well as museum visits require mobility, which is highly restricted today due to various political, economic and social conditions. It is necessary to eliminate these boundaries with the establishment of shared platforms that can make the collections accessible and provide new ways of exploring and connecting knowledge and engaging with the objects.

This track would like to explore, but is not limited to, the following topics:
- Web-based education platforms
- Object-oriented learning practices
- Digital cultural heritage
- Cultural techniques
- Scientific narrations
- Visualization of intellectual data
- Monopolisation of knowledge
- Exhibitions and aesthetic practices
- Digital displays
- Scenographies of knowledge
- Aesthetics of didactic objects
- Other modes of representation

Bibliography
- Intralinguistic translation (the interpretation of signs by means of other signs of the same language);
- Intersemiotic translation (the process of transposition/transmutation between different semiotic systems, for example from verbal to visual, and from visual to sound);
- Cross-media/trans-media translation (the interactions between different media and their narrative potentialities);
- Interlinguistic translation (the mediation by design in the process of communication between different cultures, for instance through extra-textual translations).

This grid of the design process seen as translation, can be an open matrix for a new experimental pedagogy with the goals to improve the comprehension and accessibility of the content, characterize the most appropriate form of expression for a new medium, facilitate the quality of communication in a multilingual, intercultural context, promote self-reflection, and reinforce cross-disciplinarity.

This track would like to explore, but is not limited to, the following topics:

• The modernist tradition
• The new basics
• Structural approaches to design
• Translation processes in design
• Experimental pedagogy
• Intersemiotic translation
• Intermedial translation
• Synaesthetic translation

Bibliography

MORE-R THAN-HUMAN PROTOTYPING AS PEDAGOGICAL IMPUGNATION

Stanley Ruecker, Anthony J. Petullo Professor of Design, University of Illinois, USA.
Pablo Hermansen, Dr., School of Design, Pontificia Universidad Católica de Chile, Chile.
Martin Tironi, Dr. School of Design, Pontificia Universidad Católica de Chile, Chile.

Although modernist principles (e.g. form, colour, composition, ergonomics, structural analysis, etc.) are still in widespread use in design pedagogy, they have not for some time now represented the only option. One alternative is the ‘anthropological turn’, often referred to as ‘human-centered design’, where the defining concept is that the designer is not an adequate surrogate for the user. This anthropocentric epistemology has arguably become the common, uncontested and politically correct place from which to teach and practice design. Nonetheless, as every frame of action that is taken for granted hides political and epistemological standpoints, the concept of human-centered design silently influences not just the process, but also the kinds of questions we tend to ask when practicing and teaching. This track aims to precipitate a space for critically reviewing and contesting naturalized epistemological and methodological frameworks (e.g. user-centered design, problem-solving design). We want to dedicate special attention to the anthropocentric biases that encourage us to ignore the urgent ecological demands expressed by other-than-human beings in times of environmental crisis. Furthermore, we are also interested in the question of how
Critical action becomes an appropriate matter of design. Prototyping with other-than-human beings as a learning exercise, along with favouring a performative critique of anthropocentric politics, provide analytical keys to make the conceptualization of our modes of existence a matter of design, and in turn, to recognize design as a critical space to materialize unexpected and more-than-human ecologies. With this double challenge, we want to encourage participants to share experiences and reflections on design learning, where other-than-human actors significantly impact the affective and operative framework that a design classroom project produces.

This track would like to explore, but is not limited to, the following topics:

- Prototyping
- Speculative research
- Cosmopolitical design
- Experimentation in design education
- Interspecies explorations
- More-than-human correspondence
- Design facing the Anthropocene
- Environmental enrichment
- Design anthropology
- Situated knowledge
- Performativity

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COMPUTATIONAL DESIGN THINKING
Şule Taşlı Pektaş, Prof. Dr., Başkent University, Turkey.
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The new computational design paradigm indicates a shift from representation to simulation with a special focus on creating integrated systems. Material properties, performative qualities, natural evolution and other important knowledge is being integrated into highly interdisciplinary design processes. Designer-authored generative systems enable us to conceive and manage the design process as a dynamic ecosystem rather than fragmented practices of form-finding, analysis and production. All of these developments entail transformations both in design education and
practice. However, we can see an unequal pace of developments in both fields. A select group of pioneering schools and firms is pushing and developing the notion of computational design thinking, whereas a large section of both are struggling with the concept or altogether dismissing it. In schools, non-Euclidean geometries produced by the new media are embraced enthusiastically by the students, but mostly it needs to be incorporated in an educational pedagogy. The question of how to prepare graduates as “computational designers” remains unanswered from both schools and practice. The distinction between computation and computerisation in design education is critical in this sense, since the real potential of computational design lies in its conceptualization as a way of thinking. Within this framework, this track calls for innovative and thought-provoking work around the following 5W1H questions:

1. What is computational design thinking?
2. Why is computational design thinking important in design education?
3. How is computational design thinking employed in practice and design education?
4. Where and when is computational design thinking best employed in practice and education? What does the transformed practice/curriculum look like?
5. Who is responsible for teaching and managing computational design?

This track would like to explore, but is not limited to, the following topics:
- Material-based design
- Digital fabrication
- Computational making
- Biologically inspired design through computational methods and tools
- Shape grammars
- Parametric design
- Performative design; performative architecture
- Responsive design; responsive architecture
- Coding education
- Computational thinking in the design studio

Bibliography

INTERCULTURAL COLLABORATION IN DESIGN EDUCATION

Yasuko Takayama, Dr., Department of Design, Shizuoka University of Art and Culture, Japan.
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The ability to work effectively in a global environment has become essential for designers in the current workplace. Educational institutions need to nurture student skills not only from a design skills perspective that takes into consideration a broad worldview, but also from an intercultural perspective that incorporates the necessary communication skills, cultural sensitivities and flexibility. Design schools around the world have been collaborating through international events such as design workshops, summer schools, or design projects for the generation of solutions developed by intercultural student teams. Since 2014, we have been conducting the annual series of International Collaboration Workshops between Turkey and Japan. In addition to the aforementioned educational objectives, these workshops have proven to be beneficial for the instructors regarding the management of the differences in educational approaches and cultural traditions between the participating countries. It also provided the
instructors with the opportunity to conduct joint research. Furthermore, the design solutions developed by the intercultural student teams have attracted the attention of local industries. Based on these arguments and experiences, we suggest that in situ intercultural collaboration has significant benefits and implications for design education, research and practice. We expect to uncover further insights through your experiences concerning international or intercultural collaborations in design education.

This track would like to explore, but is not limited to, the following topics:

• International collaboration in design education
• Intercultural design student teams
• International workshops, summer schools, projects, etc.
• Intercultural management

Bibliography


INSIDER OUT: KNOWLEDGE TRANSFER IN ALTERNATIVE DESIGN PRACTICES

Dilek Akbulut, Assoc. Prof. Dr., Department of Industrial Design, Gazi University, Turkey.
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Design education mainly targets skill development and knowledge enhancement. Design information, which is used to establish design knowledge, comprises of data ranging from raw to structured. Consequently, educational practice in design aims to create and utilize these data. However, the design knowledge is usually implied, or tacit and design act is generally based on implicit utilization of this domain knowledge. The knowledge transfer is usually performed on an experience base. This experiential nature often pushes design act to a non-institutional ground. With the advancement of technology, new forms of design practice has emerged both in handicrafts and technology centred making. The emerging mind-sets and skills enabled new design practitioners and communities to appear in small-scale making, analogue and digital crafts. Therefore, new forms of experiential knowledge transfer occur in the practice of ‘designers’ who have not gone through a formal design education, such as craftsmen, or makers. The track aims to scrutinize this issue. Possible questions may be as follows:
- How is knowledge transfer made within these communities?
- How are the skills acquired?
- What are the alternative mediums of communication and transfer?
- What are the training programs offered?
- Can these new communities integrate with design education or practice?
- How can these emerging mind-sets and skills contribute to formal design education?
- What are the ways of transferring tacit knowledge generated and acquired by these communities to novice design students?

This track would like to explore, but is not limited to, the following topics:

• Craft communities
• Maker movement
• Knowledge Transfer
• Mental Models
LEARNING FOR AUTONOMOUS DESIGN

Çiğdem Kaya Pazarbaşı, Assoc. Prof. Dr., İstanbul Technical University, Turkey.
Anne-Marie Willis, Independent Researcher, Studio at the Edge of the World, Tasmania.
Julia Keyte, Course Leader for Furniture and Product Design, Bath School of Art and Design, UK.

This track is intended to address concepts, methods and practice in design education that coach students towards awareness, criticality and mindfulness of their future professional practice. In a world of rapid technological, economic and environmental change where it is possible to design and make so much, there is a need for a designer who is able to respond not just to the global market but to global circumstances. Design education is overwhelmingly defined by the instrumental role of design in the global economy, but must re-orientate towards practices of sustainment. Design communities and individuals are driving change from within and outside the traditional boundaries of design practice, but such critical approaches are marginal. This relation must be reversed. A designer is needed who can respond to global circumstances, named by Arturo Escobar as “the autonomous designer” (Escobar, 2018). Critical pedagogical methods are emerging that challenge traditional approaches embedded in design education. Central to this is identification of new and re-configured essential knowledge for future designers. This equally involves critical engagement with implicit design values, norms and rules within design education that sustain the unsustainable. This track aims to engage dialogue across design disciplines and practices, and build on previous literature such as transition design (Gideon et al., 2015), social design (Armstrong et al., 2014), redirective practice (Fry, 2010) and design after design (Willis, 2006). Of relevance to this track are both successful and failed experiments, critical dialogue within education and industry, and the challenges inherent to capturing critical methods. While criticality may implicitly be part of some designers’ insider knowledge, it needs further elaboration and theorization to be disseminated within design education and beyond.

This track would like to explore, but is not limited to, the following topics:

- Mindfully experimental approaches to learning and designing, and how we express these.
- Methods to support learners in defining their relationship to the material world, and to build up a critical sensitivity to it.
- Supporting agency of the learner in defining their own projects.
- Developing self-awareness of the design educator.
- How to engender enthusiasm for redirecting design creativity towards the conditions of now.
- Intellectual resources: which non-design areas of knowledge are essential for future critical designers?
- Developing new skills, learning and dispositions needed to work meaningfully in the gig economy.
- How to elevate the importance of non-traditional design practices (co-design, social-change design, etc.) as desirable career paths.

Bibliography
DESIGNING FOR SOCIAL INCLUSION AND PUBLIC ENGAGEMENT

Wyn Griffiths, Senior Lecturer in Product Design and Engineering, Middlesex University, UK.
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Public Engagement initiatives in UK higher education institutions offer one route to confronting elements of social exclusion in society. Diversity - ethnic, gender and socio-economic - in STEM and arts education and careers is low (The Warwick Commission, 2015; Archer et al., 2013), linking to low levels of social inclusion. Design-led approaches such as SMASHfestUK and the Heart and Lung Repair Shop have been recognised as successful mechanisms for engaging underserved and underrepresented publics, and challenging institutional public engagement culture. The prevalence and effectiveness of design as the driver for public engagement and social inclusion development is, however, underexplored and uncertain. Design, often through the concept of design thinking (Brown & Wyatt, 2010) has been popularised as a universal approach to innovation across disciplines. Can the claimed benefits of a design approach enhance social inclusion, and develop the effectiveness of public engagement strategies and delivery? Some initiatives are explicitly design-focused, whereas many others are carefully designed (but without acknowledgement of the discipline and approach), while others have evolved from the disciplinary heritage within which they sit. The aims of public engagement, as defined by the National Coordinating Centre for Public Engagement, are “the activity and benefits of higher education and research [that] can be shared with the public” and that can enhance inclusion in higher education (Ćulum, 2015). Across public engagement initiatives, human-centred, design-led innovations seem to be emergent.

When Emi Kolawole (2016) asks that we “…consider what a human-centred approach to growing diversity and inclusion might look like”, this consideration has resonance with the emergence of design within this sector. This track aims to explore the state of the sector, and landscape in expert and diffuse design for public engagement and social inclusion (Manzini, 2015), interrogating a diverse range of perspectives about philosophies, practices and impacts within the landscape. This track also aims to explore the understanding, prevalence and impact of design and human-centred approaches within this field. What do researchers and practitioners recognise as ‘design’? Whether there is recognition of design as explicit (expert) or implicit (diffuse) within these approaches? Whether diffuse or expert design lead approaches (Manzini, 2015) are considered the optimum approach within the community of practice? How are initiatives and individuals confronting embedded ‘feet-on-the-ground’ recruitment metrics in higher education and cultural organisations? The track seeks contributions from researchers or practitioners engaged within design, design for social innovation, public engagement/public engagement with research, social policy, STEM or arts communication, and general or design education to enable a broad consideration of the state-of-the-landscape and to drive future conversation within the area and in society.

This track would like to explore, but is not limited to, the following topics:
- Design thinking
- Design for social inclusion
- Design for social justice
- Design for widening participation
- Embracing diversity
- Public engagement
- Public engagement with research (PER)
- Experience design for public engagement
- STEAM
- STEM communication
- Arts communication
- Socio-economic status
- Social policy
INTEGRATING SOCIALLY AND CRITICALLY ORIENTED APPROACHES TO DESIGN EDUCATION

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Recent literature on design competences reports how design education has changed both its emphases and contexts over the last decades. As design educators, we all seem less concerned with the traditional, technical and designerly skills, than ‘soft’ skills, which are expected to help design graduates at the job market navigate a wide range of job offerings as curators, coordinators, design thinkers, and strategists. In these roles designers collaborate with a wide range of stakeholders for a seemingly endless range of innovation problems. A common sight in design curricula are those projects that are shaped with social and political considerations: projects where design students work with communities, with schools, with local craftspersons; projects of criticality and fiction through which they inquire into todays and futures; projects where they learn to position themselves not only professionally but politically within real-world environments. Rather than considering merely to prime our students for a more flexible job market, however, design educators are genuinely enthused by the learning opportunities that socially oriented projects offer: in teaching design students lessons in social responsibility, critical thinking, political awareness, and empathy. We are interested in papers that contribute to a discussion over possibilities of integrating socially and critically oriented pedagogies in design education.

Possible topics are as follows:
• Strategies for integrating social responsibility, critical thinking, feminist epistemologies and intersectional positions, politics of dissent, etc., into design curricula.
• Use of ethnographic, generative and other design research methods in teaching for fostering awareness, reflexivity, criticality and empathy.
• Shortcomings of novel learning models or practices as currently applied in design education.
• Studies of power asymmetries within social, participatory and critical design practices in education, not least between design educators, design students and project stakeholders.

Bibliography
SYSTEMIC DESIGN APPROACH FOR TRANSDISCIPLINARITY

Pier Paolo Peruccio, Assoc. Prof., Department of Architecture and Design, Politecnico di Torino, Italy.
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Design discipline is currently undergoing a phase of great and challenging debate, chiefly sprung by the expression and acquaintance of a reality that is intrinsically complex. This feature is still emerging and figures out the world as a sole living system. Design has to face unprecedented social, environmental, political and economic challenges with a new perspective, questioning the role it plays, its tools and methodologies. This track invites to explore how design, finding itself transdisciplinary and acting so, can face the complexity of issues, actualizing a one design act by the interplay among all disciplines. Moreover, it encourages critical reflections on how disciplinary contamination affects the design pedagogy of present and future generations of researchers and practitioners. Design studies acquire the awareness not to be a self-standing discipline anymore, taking the advance of a systemic thinking. This has been the first real contamination among knowledge and led inter alia to the flourishing of a completely new approach to design, in meaning and doing. From this angle design moves from being solutions supplier to critical reader, with the capacity of grasping facts with an holistic point of view. The current purpose and requirement of design gets close to a social function, assuming a key responsibility in understanding how to manage complex challenges by setting networks of people and professionals to plan mesh of solutions. Systemic design embraces designers’ expertise in an advanced position. Based on interconnected knowledge, spins over them to envision and draw strategies by founding relations and implementing a comprehensive cross culture. Contributions are welcomed from students, researchers and professionals from the fields of design, architecture, education, anthropology, sociology, economics, management, environmental sustainability, among others.

This track would like to explore, but is not limited to, the following topics:
- Systemic design
- Holistic approach
- Founding relations
- Designer roles
- Fluid disciplinary boundaries
- Multi-Inter-Trans Disciplinarity
- Insider/ Outsider knowledge
- Complex issues management
- Design to mediate
- Design to connect
- Mutual strengthening

Bibliography

LEARNING FROM PROTOTYPES

Gerry Derksen, Professor, Winthrop University, USA.
Zhabiz Shafieyoun, Postdoctoral Research Scholar, University of Illinois, USA.

Prototyping is central to design and teaching students to prototype well must be central to their education. The scope of prototyping has expanded to enabling each level of study, from undergraduate to PhD, to reify their ideas. We propose a set of topics outlined by Scaletsky et al. (2014), which include developmental, experimental and provocative prototypes. Currently, design education uses studio time for developmental prototyping; learning the process, skills
and forms of production. These are useful skills, however it is only one area of prototyping currently covered in design education. There are new pressures on design educators to include topics such as new technologies, added theory, and methods that have changed studio curriculum. What have we learned from the ‘prototyping’ class? How do we teach designers to learn from making? Can we offer the ‘werkbund’ experience to all design students where they can produce full-scale prototypes? To paraphrase John C. Maxwell, ‘learn fast by failing early and often’ describes the strategy of experimental prototyping. The goals of experimental prototypes are not to create something for production, but rather to create something that embodies a theory to be explored. In the experimental type the notion of learning is more strongly bound to the observation of the user and objects in use. Theory is meant to benefit practice as generalizable knowledge that is applied to a variety of scenarios and contexts. Design students at the master’s level should be well versed in the experimental form of prototyping. It is uncertain which form of prototyping comes first, experimental or provocative, but it is clear that we use the latter less often in the design process. Using prototypes as a form of brain-storming can help explore new behaviours, challenge presumptions, and offer new approaches to old ways of doing things. Provocative prototypes do not attempt to refine or address research questions but rather challenge people to think in novel or interesting ways. Prototypes are more important to the design process in all forms of design and often underutilized as a way of thinking about design problems. The subject is broad enough for new designers to learn more about their function and to be expanded further by many design researchers.

This track would like to explore, but is not limited to, the following topics:

- Developmental - Production prototyping.
- Experimental - Prototype as thought experiment.
- Provocative - Prototype as idea generator.
- Prototypes are central to design - Design education starting with prototyping.
- Boundary objects - Prototyping consensus, collaboration.
- Large format prototypes - Systems designing for scale and complexity.
- Evaluation and analysis of prototypes.
- The dark side of prototyping - Catastrophic failure, fixation, and other prototyping problems.
- New tech beyond the rapid - High and low fidelity, functionality, add-on features.
- Observing users - Prototype testing.

Bibliography


BRINGING USER EXPERIENCE (UX) AGENDA INTO DESIGN EDUCATION

Aslı Günay, Dr., BİLTİR-UEST Test Product Usability Unit, Middle East Technical University, Turkey.
Sedef Süner, Assist. Prof. Dr., Department of Industrial Design, TED University, Turkey.
Gülşen Töre Yargin, Assist. Prof. Dr., Department of Industrial Design, Middle East Technical University, Turkey.

The rapid technologisation of the work, leisure and educational aspects of everyday life imposes a change in the design practice from object-focused towards a more comprehensive, experiential approach to designed artefacts. The reflection of these transformations on both academia and industry has recently brought about an interest in integration of UX knowledge and skills into the educational programs. Although different fields of design and technology pose varying approaches, we find it vital to develop a multi-faceted yet common educational agenda in order to secure a meaningful position for design students in their upcoming professional lives. Current professional
The practice of UX shows a strong tendency towards methods and skills relevant to screen-based interaction; all the same, the academia sustains a theoretical interest in instrumental or non-instrumental aspects of the user experience. Focusing on the design of meaningful interactions for users as the major premise of the experiential approach well aligns with the conventions of design education, especially the user-centred design perspective. Although having roots in ergonomics and human factors, user-centred approach in design education has been evolving into an awareness of user contexts, and designing for positive, holistic user experiences. The relevance of the UX process and methods for design education is also evident in recent publications reporting on local, institutional and independent efforts to equip the students with such emerging requirements of the professional life. From this point of view, we aim to create a space for dialogue between design educators and researchers who are interested in integrating UX awareness and skills into design education. We welcome contributions sharing teaching experiences as well as theoretical work aiming at bringing the UX agenda into design curriculum, hence preparing future designers and researchers for the emerging demand in design and technology industry.

This track would like to explore, but is not limited to, the following topics:

- Theoretical models for the integration of UX theory and methods into design education.
- Methods developed to familiarise students with UX awareness, tools and skills.
- Equipping design students with technical UX knowledge and skills.
- State-of-the-art examples of applied user research in design education.
- Hands-on experiences in integrating user experience factors into student design projects.
- Contextual design practices in design education.
- Practices of teaching design for special user groups and needs.
- Collaborations with UX industry in educational projects.
- Multidisciplinary collaborations in student UX projects.

Bibliography

DESIGN EDUCATION FOR SUSTAINABILITY: NEW DIRECTIONS AND DIMENSIONS THROUGH INNOVATIVE METHODS AND RESEARCH

Çağla Doğan, Assoc. Prof. Dr., Department of Industrial Design, Middle East Technical University, Turkey.
Senem Turhan, Assist. Prof. Dr., Department of Industrial Design, Middle East Technical University, Turkey.
Yekta Bakıröğlu, Postdoctoral Researcher, School of Design, University of Limerick, Ireland.
Dilruba Öğur, PhD Candidate, Department of Industrial Design, Middle East Technical University, Turkey.

Design considerations focusing on the diverse aspects of sustainability have become a key source of drive for design education, which would include the development of design solutions in line with local needs and preferences, localization and personalization, open design and maker culture in relation to sustainability, enabling maintenance, repair and upgrade, design for behaviour change, and effective use of resources. To better address and reflect on these considerations, design educators and researchers could incorporate various tools and methods into the design process, aiming to equip design students with the knowledge and skills related to design for sustainability and help them better understand and internalize sustainability considerations at the early stages of idea generation. Through critical discussion and reflection, and the employment of the innovative and generative tools and methods, design education projects could be effectively tailored to the principles of sustainability.
The following items would be suitable to cover as topics under this track, and the list can serve as a guide to those interested in contributing to this track with a paper:

- Design education,
- Sustainability considerations,
- Generative design research,
- Exploratory design for sustainability,
- Design process,
- Localization and personalization
- Post-use,
- Maker culture,
- Open design,
- Effective use of resources,
- Design for behaviour change,
- Circular economy.

**Bibliography**


**DESIGN MATERIALIZATION**

Owain Pedgley, Professor Dr., Department of Industrial Design, Middle East Technical University, Turkey.

Elvin Karana, Associate Professor Dr., Faculty of Industrial Design Engineering, TUDelft, Netherlands.

Valentina Rognoli, Assistant Professor Dr., Department of Design, Politecnico di Milano, Italy.

The transition from ideas and concepts held in the designer’s mind or on paper into physically achievable artefacts describes a process of ‘materialization’. The prevailing approach to materialization has been a staged and rather engineering-dominated process, involving material elimination and selection using material database metrics allied to material family knowledge. Design educators have often complied with this approach for lack of resources or methods defining alternative ways of teaching and learning materials. The currently developing situation is rather different and more exciting. Materials of today are more dynamic, expressive and adaptable than ever. They make us think, feel, and act in complex ways. Research and case studies on ‘materials experience’ have grown significantly in recent years. Broadly, this body of work is (a) defining how the practices of material ‘selection’ are evolving into more complex and active events during material ‘creation’ and ‘appropriation’, and (b) establishing the knowledge and skills needed to use materials as an influencer of people’s experiences of the designed world. Materialization crucially attends not only to performative but also experiential requirements of artefacts. Introducing design students to this duality and defining confident, creative, engaging and effective ways for its teaching and learning is a major responsibility and challenge for design educators. Traditional approaches no longer adequately deliver.

This track invites contributions from educators using, adapting or creating contemporary methods to teach materials and design. Industrial, product and fashion design perspectives are obvious candidates, but submissions are also encouraged from interaction design perspectives, concerned with the physicality of user interfaces, as well as educational practices within interior design, architecture and the built environment. Of particular interest are submissions focused on teaching and learning of NEU (new, emerging, unusual) and ICS (interactive, connected, smart) materials, especially when exemplified through student projects and coursework.

The track would like to explore, but is not limited to, the following topics:

- Material driven design projects
• The material studio versus the material lecture
• Integrating fab-labs and 3D printing in design curricula
• Relevance of ‘making’ and ‘workshops’ in contemporary design education
• DIY materials, material tinkering and material design
• Active learning for materials and design
• Educational exercises to learn materials and design
• Tools and methods for acquiring materials experience
• Material resources for design students
• Materialization in the absence of materials

Bibliography

LEARNING SPACES
Open track for topics related to learning spaces such as:

Learning in Situ. Factories, design offices, workshops, labs, nature. Benefits, challenges, and ways of integrating learning in situ into designers’ education. Learning at the workspace; summer practices in factories and design offices; impact on curriculum. Onsite observations, field trips, field study.

LEARNING CULTURES
Open track for topics related to learning cultures such as:

The “Project”. The studio project as “the curriculum in a nutshell”. Projects and design briefs, what do they tell us about the design education we offer/receive? What happens while we are busy making projects? Problem-based learning.
Teamwork. Dialogue, discussion, decision making, conflicts, crises, performance, evaluation. Consensus and dissensus. How can we get ready?

EVOLVING SKILL SETS AND MIND SETS
Open track for topics related to evolving skill sets and mind sets such as:

Design Education and Intellectual Property. Educational design projects as intellectual resource; students, tutors and educational institutions as right holders; the use of IP resources in teaching design history and design management; alternative IP management approaches in design education; intellectual property and collaboration with external partners in design education.
**PhD Pit-Stop Track**

**SHORT LECTURES**

**Formulating Research Goals and Questions**

_Gülay Hasdoğan_ is a professor at METU Department of Industrial Design. After completing her PhD on the role of user modeling in design process at Central Saint Martin’s College of Art and Design in London (1993), she took part in the establishment of graduate programs at the Department of Industrial Design at METU. Her research interests are research and design methods in design practice and education.

**Conducting Research through Design**

_Owain Pedgley_ is full Professor of Industrial Design at METU Department of Industrial Design. His academic expertise centres on design for product interaction and experience, notably within the emerging domain of materials experience. Between 2014-2017 he was a founding member of the Industrial Design programme at the University of Liverpool, UK. Owain is a strong advocate and early practitioner of academic research conducted through designing.

**Quality in Design Research: Tales from a Journal Editor**

_Peter Lloyd_ is Professor of Integrated Design Methodology in the Faculty of Industrial Design Engineering at Delft University of Technology. Peter is also Acting Chair of the Design Research Society, and Editor-in-Chief for the Journal Design Studies. He teaches in the areas of design methods, design thinking, and design ethics and his research looks at all aspects of the design process. He was previously Professor of Design Studies at The Open University, UK and Professor of Design at the University of Brighton, UK.

**Communicating Design Research: Evolution of a Research Framework from a PhD to Postdoctoral Research**

_Gülşen Töre Yargın_ is an assistant professor at METU Department of Industrial Design and director of UTEST Product Usability Unit. After completing her PhD on effective communication of user research knowledge to design process, she conducted post-doctoral studies at University of Cambridge. Her current interests focus on UXR methods and education, and identifying user-centred use cases for emerging technologies.

**PRESENTATION PROGRAMME**

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Reimagining the Future of Design Education: Nurturing Mindsets and Skillsets in Students

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Abstract: This paper reveals the outcomes of an investigation to develop a radical manifesto for the future of creative design and media higher education. The result was the development of a manifesto (Mindsets and Skillsets) that sought to profoundly redefine how creative design and media education could be delivered. At its heart, the manifesto attempts to create the optimum environment for students to thrive in education, careers and through life. Ravensbourne University began a review of its portfolio of courses and academic delivery in May 2016. This provided a unique opportunity to evaluate the existing programme delivery philosophy along with the practices and models of a range of international creative educational contexts, and to review relevant literature and practice. Using a combination of the Double Diamond design-thinking approach and a grounded theory-light research methodology this study gathered data from international college visits, pedagogic conferences, literature reviews around student learning, delivery modes and learning spaces, and a hosted symposium anchored by an international educational panel and a creative industries professional panel. The five resulting principles emerged from the analysis of the data and materials were identified as: Cultivate / where the whole person thrives; Collaborate / where disciplines evolve; Integrate / where education engages industry; Advocate / where purpose informs practice; and Originate / where creativity harnesses technology. This paper attempts to position the Mindsets and Skillsets Manifesto as a visionary, pragmatic and deliverable new model of creative higher education.

Keywords: interdisciplinarity; transdisciplinarity; pedagogy; thriving; creative higher education

1 Introduction

Rationale for Change
Ravensbourne University, based in London UK, began a review of its portfolio of courses and academic delivery in May 2016. This provided a unique opportunity to evaluate the existing college philosophy along with the practices and models of a range of international creative educational contexts, and to review relevant literature and practice.
The rationale for evolving and realizing a strong and distinct higher education (HE) proposition was not simply cosmetic; Brexit had introduced a previously unforeseen mix of challenges and threats to European HE. The GuildHE Brexit Update 2 (20th January 2017) predicted the following challenges to Higher Education Institutions (HEIs): staff retention, research funding, student recruitment, collaborations, student loans, ability to plan, and xenophobia. The report cited opportunities as: new partnerships, focus on HE for UK growth, favourable exchange rate, International refocus and growing talent.

There were additional factors that were requiring a change culture at this institution and these included; the institution’s move towards university status with the application for Teaching Degree Awarding Powers (TDAP), the UK Government’s Teaching Excellence Framework (TEF), Tier 4 Visas and the attempt to tighten control of and potentially reduce overseas (Tier 4) student numbers, research funding challenges, the proportions of Further Education (FE) and Higher Education (HE) student numbers at the institution, the role of apprenticeships, school education reform and the decline of arts-based subjects in primary education.

It was also felt that creative design and media education is due a major review; the traditional subject lecture, seminar, tutorial model has barely changed in 40 years. In light of the above, this change project sought to position this institution as a dynamic and agile player in the HE creative education sector within the London context and both nationally and internationally.

**Scope, Scale and Methodology**

This study utilized a mix of methodological approaches in order to accommodate the wide range of data gathered. In the first instance the researchers employed a grounded theory-light methodology to interrogate the range of materials and contexts. These materials included data from international college visits, pedagogic conferences, literature reviews around student learning, delivery modes and learning spaces, and a “Futures in the Making” symposium. The symposium also included presentations by each course at the university and data collected via a course questionnaire, market intelligence data, a range of workshops and the central external inputs anchored by two panels; one comprising of international educators and academics and the other panel of creative industries experts and practitioners.

The study used a combination of systematic and emerging design concepts (LeCompte & Goetz, 1982). Initial analysis of data used various established coding protocols to develop the emerging theory. It used the seminal Strauss and Corbin (1990) model of open, axial and selective coding. Open coding forms initial broad categories from the information gathered; axial coding then focuses on a specific category, connects open-coded groupings, and views them in relation to other categories; and finally, selective coding develops a theory based on the interrelationship between the categories from the axial coding process.

**Chronology of the Coding Process**

Analysis of the data was initiated with an open coding process. This transpired with a line-by-line reading of all data to acquire a general overview of the process. This noted the central idea, focus and phenomena of each sentence, paragraph or segment of the transcript. This stage also included cross-referencing with field notes taken before, during and after the interviews, along with initial descriptor coding notes. Categories were then identified and organized according to collective similarities in meaning and intonation. The organization of the categories stage of the open coding process informed the next level of analysis, properties. Properties emerge from the multiple perspectives of the participants into any one given category or unit of meaning. These categories would then begin to develop into an emerging rough picture of a labelling or categorization of these narrative units emerging from the students’ perspectives.

**Axial Coding, Selective Coding, Explanatory Model**

The second phase saw the axial coding process take the initial open-coded categories organize them into an emerging central phenomenon. This would act as an axis or central category around which the various related factors could revolve and emerge. The final coding level saw a refining of the axial coding process to identify the clearly identifiable themes to emerge from the data that would form the developing theory grounded in the student responses to the intervention. An explanatory model was then developed to support the organization of the developing narrative that would serve the emerging Mindsets and Skillsets Manifesto that resulted from this study.

The researchers also maintained an on-going field note documentation throughout the project that informed any clarification of details or emphasis. Forty pages of field notes (see above) were constructed over the period of the
study, and were organized as either descriptive or reflective field notes. Descriptive field notes recorded the various events and activities during the study such as the emotional intonation or particular emphasis of individuals expressed during discussions or events. Reflective notes recorded the researchers’ insights, broad ideas, and emerging themes (Creswell, 2002). The field notes were also analysed for actual or potential errors during the coding process. Dialogue from events and discussions were cross-referenced with field notes to aid analysis and category allocation. Corbin and Strauss (1990) describe the three fundamental elements of a grounded theory approach as concepts, categories, and propositions. This construct provided a useful analytical framework to evolve a cohesive range of outcomes from the study.

The five key meta-themes to emerge from this process can be best summarized as:

- Then need to education the whole student – in other words to teach both hard, and so-called soft skills and competencies (EH emotional inelegances).
- To ensure practice-based curricula embraced interdisciplinary approaches
- Where possible, to ensure the curriculum reflect industry practices and cultures
- Nurture and provoke an ambition in students to make work that addresses their curiosity, passion and to address some of the bog challenges on our globe.
- Ensure that the tension between technology and creativity is harnessed productively.

Once the data had been organized and categorized, the research then employed the “Double Diamond” design-thinking methodology as the basis to progress the study into process with a coherent set of outcomes and recommendations. Divided into four distinct phases – Discover, Define, Develop and Deliver – the Double Diamond is a simple visual map of the design process. In all creative processes a number of possible ideas are created (divergent thinking) before refining and narrowing down to the best idea (convergent thinking), and this can be represented by a diamond shape. The Double Diamond indicates that this happens twice – once to identify the problem and once to create the solution. Discovering the best ideas in the creative process is iterative – ideas are developed, tested and refined. In Discover designers look at the problem in new ways, discover new things and gather new insights. In Define designers try to make sense of the possibilities identified in Discover. Develop is the part of the process where concepts and potential solutions are created, prototyped, tested and iterated. In Delivery the solution is finalized, produced and launched.

Through the Design Double Diamond creative process and the coding procedure, the resulting Mindsets and Skillsets Manifesto, with the underlying Five Principles, was designed and written forming the basis of the re-launch of the curriculum structure, content and delivery modes.

2 Literature Review

The initial data gathering and analysis for this study included a literature review around themes that were deemed pertinent to the context of Ravensbourne: student learning, multidisciplinary approaches to subject pedagogy, and innovative educational delivery models. This led to the evolution of the Five Principles of the Mindsets and Skillsets Manifesto and has subsequently led to a more focused distillation of these themes around inter and trans-disciplinary approaches to portfolio delivery; student thriving; purposeful design and media practice; technology and creativity. The following is a summary of the literature review that informed the Mindsets and Skillsets Manifesto.

Student Thriving

A key driver in this project was to ensure that student experience was at its heart. Student success can be defined broadly as “satisfaction, persistence, and high levels of learning and personal development” (Kuh et al., 2005, p. 14). However, while such indicators tend to focus on academic performance and graduation rates, a successful university experience must reach beyond such criteria.

The concept of thriving as utilized by Schreiner (2010a) is useful in her examination of what it takes to create a holistic university student experience. There are three main types of thriving according to Schreiner (2010a): academic thriving, intrapersonal thriving, and Interpersonal thriving. Academic thriving is characterized by engaged learning and academic determination. Students who are thriving academically are psychologically engaged in the learning process, not merely engaged in behaviours. The learning process energizes them. Intrapersonal thriving requires the development of healthy attitudes toward the self as well as toward the learning process. Lastly, interpersonal thriving includes meaningful connections with other people.
Schreiner’s (2010a) validated and reliable 35-item Thriving Quotient has been administered to over 15,000 college students across more than 70 institutions in the USA and Canada. The goal was to measure aspects of college students’ psychological functioning that were amenable to change, so that interventions could be designed to enable a higher percentage of students to get the most out of their college experience. The research shows that thriving is a distinct construct comprised of the following: The idea of thriving was conceptualized as optimal functioning in five key domains: (1) Engaged Learning, (2) Academic Determination, (3) Social Connectedness, (4) Diverse Citizenship, and (5) Positive Perspective.

Engaged Learning occurs when students are meaningfully processing the material, making connections between what they already know or are interested in and what needs to be learned (Schreiner 2010b). They are focused and attentive to new learning opportunities and actively think about and discuss with others what they are learning. In short, they are energized by the learning process. The second of the key domains, Academic Determination, is necessary to academic thriving (Schreiner 2010b). Here it is not just about the motivation to engage in learning, but is also about the behaviours and attitudes that enable students to push through challenging times and persist in reaching their academic goals. Academic Determination is characterized by an investment of effort, an ability to manage one’s time and the multiple academic and personal demands of the college environment, a motivation to succeed, the intentional pursuit of one’s goals, and normalizing the help-seeking process. Social Connectedness can be distilled into the following: healthy relationships, nurturing a sense of belonging, encouraging positive interactions with others, cultivating students’ voices and contribution, working together toward common goals, and an openness to diversity.

Diverse Citizenship consists of encouragement of students to engage in specific activities that will enhance their diverse citizenship, and a structuring of campus events and activities to promote interactional diversity. When the institution sends a strong signal that honouring differences is a key value of the institution, the foundation is set for positive interactional diversity – conversations in and out of class around politics, world events, differing religious views, cultural differences, and divergent world views. It is not simply the interaction with difference that matters; it is also the quality of that interaction. Lastly, Positive Perspective consists of equipping students with an optimistic explanatory style, and helping students envision their future success (Schreiner 2010a).

How students explain the setbacks and failures that are an inevitable part of life affects their likelihood of recovering more quickly from such events, as well as an ability to approach future challenges. When students have a positive perspective on life, what psychologists call an optimistic explanatory style, rather than an unrealistically positive view of the world, this perspective actually enables a person to come to grips with difficult situations more readily. The coping strategies that distinguish this optimistic explanatory style can be characterized as proactive and problem-focused, rather than reactive and avoidant.

Another strand of the thriving literature refers to so-called strengths-based education (Epstein, Rudolph & Epstein, 2000; Cave, 2003; Anderson, 2005; Austin, 2005; Cantwell, 2005; Gillum, 2005; Pritchard, 2006; Pritchard & Pritchard, 2008). A strengths-based approach to education can be defined as the identification and development of the unique individual strengths and talents of each student. Anderson describes this approach as supporting students as they “apply their strengths and talents in the process of learning, intellectual development, and academic achievement to levels of personal excellence” (2004, p. 1). Strengths-based approaches attempt to help students identify their own unique talents and then use them to develop a strategy for utilizing such gifts in negotiating their academic progression and careers. As Anderson and Schreiner (2004) state, “Research ... has led to a potentially revolutionary discovery: individuals who focus on their weaknesses and remediate them are only able to achieve average performance at best; they are able to gain far more –and even to reach levels of excellence– when they expend comparable effort to build on their talents. This discovery is of enormous import to higher education...” (p. 4). A strengths approach encourages students to develop into individuals capable of capitalizing on their gifts and abilities in various contexts. In identifying and cultivating students’ strengths, it seeks to encourage self-awareness that also nurtures a confidence to then apply those strengths to their academic studies. Anderson (2004) suggests that, “a strengths-based approach to teaching involves a process of assessing, teaching and designing experiential learning activities to help students identify, develop and apply their strengths and talents in the process of learning, intellectual development, and academic achievements to levels of personal excellence” (p. 1). It could be argued that applying a combination of both the thriving and strengths-based approaches has much to offer in nurturing student academic success.
**Multidisciplinary, Transdisciplinary, and Interdisciplinary**

As subject disciplines within creative approaches begin to overlap or even blur in their distinctiveness (e.g. digital/analogue, film/digital effects), this study sought to explore pedagogic models that could exploit the potential of intentionally facilitating cross-disciplinary methodologies. For the purposes of this summary, definitions of multidisciplinary, transdisciplinary, and interdisciplinary models will be defined as the following: a multidisciplinary model occurs when disciplinary scholars collaborate while remaining within their respective disciplinary frameworks. In this framework research tackles issues from several disciplines, however the subjects are taught in parallel to each other rather than integrated together (Harris, Lyon & Clarke, 2009). This paper, while acknowledging this method as valid, will primarily focus on transdisciplinary and interdisciplinary models. An interdisciplinary model integrates subject knowledge with working methods from a range of disciplines to create a synthesis of practice. It integrates ideas from different disciplines and sits in the space between existing disciplinary knowledge and original research approaches (Harris, Lyon & Clarke, 2009; Learning Teaching Scotland, 2010).

A transdisciplinary model transcends disciplinary boundaries, and creates new and innovative disciplinary modes through the unity of theory with praxis among multiple disciplinary perspectives. It is characterized by a knowledge production that attempts to span both academic and professional frontiers, using an integrated approach to create bridges between different disciplines (Lawrence & Despres, 2004; Harris, Lyon & Clarke, 2009; Russell, Dolnicar & Ayoub, 2007).

Interdisciplinary and transdisciplinary approaches provide potential educational benefits that can develop into lifelong learning skills that remain essential to a student’s future development. The benefit of working within and across disciplines provides a thorough and well-rounded approach to preparing students for creative knowledge production in the creative disciplines. More standardized disciplinary approaches to education are critiqued as unable to provide sufficient breadth to develop and address students’ collaborative skills and knowledge. Interdisciplinary methods are recognized as fundamental to addressing this challenge. When students are educated with a single discipline method, or one subject at a time, knowledge is fragmented and a student’s understanding of themselves, the world, and their culture becomes restricted. Generally, students are more highly motivated when they are actively interested in pursuing an education which intrigues them and uses content based in life experiences, creating an authentic purpose for learning. The exploratory nature of interdisciplinary methods causes students to look at a wide variety of perspectives from which a topic can be explored, and internalize an open-minded approach - not just toward research but to fellow students with different ideas (Boyer & Bishop, 2004). Transdisciplinary study is also necessary to provide students with the proficiency necessary to manage the plurality and complexity of knowledge (Bracken & Oughton, 2009).

The emphasis on personal growth, or thriving for students, is often forgotten in the quest to grow within a predetermined framework, as Jantsch (1970) predicted nearly five decades ago. But with transdisciplinary and interdisciplinary methods of education, the university produces dynamic, sharp graduates who do not simply function well in society but can often become leaders within it. Arguably, this discipline blurring approach also mirrors the practices and breadth of experience that graduate will encounter in the industries they aspire to work in.

There are three key cautions and critiques however, when undertaking the project of incorporating transdisciplinary and interdisciplinary methods into the educational system. Firstly, there is a balance to be struck between detailed specialization of a subject area versus generalized knowledge of several subject areas (Burchell, 1971). Secondly, it is crucial that curriculum is fully developed and rationalized in order to support a successful programme. Finally, achieving genuine interdisciplinary or transdisciplinary education relies heavily on the collaboration among the educators. When these critiques are addressed, students and teachers alike can advance in critical thinking, communication, creativity, pedagogy, and essential academia with the use these two techniques (Jones, 2010).

**Purpose-driven Approaches**

Another key driver in this study was the desire to ensure that any new academic framework would nurture and harness so-called purpose-driven approaches to creative education. Arguably, the diversity of communities - both stakeholders and constituencies, has resulted in new relationships within and between higher education institutions and in the external local communities they serve. The ability to devise efficient means of curating these relationships is held to be a prime criterion for higher education institutions to be considered as innovative and responsive (Brennan, 2008). As well as playing an essential role in the process of social reproduction, education is always, simultaneously, a major source of social transformation, providing learners with those critical and reflective forms of consciousness and understanding that will enable them to participate in the creation of an improved and more
desirable form of social life than that which currently exists. Bracher (2006) argues that real learning involves a transformation of the student, and therefore there can be no such thing as a purely neutral or amoral educational transaction. Thus, in higher education pedagogy of widening participation (as is at this institution) would involve processes of the educational development of individuals in a participatory and inclusive university and its external communities in which gaining knowledge and constructing successful learner identities go hand-in-hand (Walker, 2003).

In seeking to embed such purpose-driven creative educational approaches into the curriculum, it seems that a social justice imperative needs to present. Social justice can be defined as encompassing themes of empowerment, integration, and transformation (Walker, 2003). Whether the focus is on the individual student learning in new ways through a service-learning course to become a self-motivated learner or on a university/community collaborative venture involving multiple government agencies and public institutions, the goal should remain to facilitate the empowerment of those in statuses that have been traditionally disempowered. At an institutional level, it is important to transform community-based scholarship and teaching so it becomes a catalyst for larger societal change. Although space here does not permit in-depth case studies, both the University of Brighton’s Social Engagement Strategy and the University of Pennsylvania’s Netter Center for Community Partnerships are often cited as examples of what some universities are currently doing to engage their institution, faculty, and students with the surrounding community.

**Learning and Technology**

Ravensbourne University has identified itself as a *digital creative village* in recent years, and the role of technology in learning has become central. Learning highly technical skills does not necessarily have to come at the expense of creativity, however. In fact, technology can be creatively driven (Bryant, 2010). There is a reciprocal relationship between creativity and digital technologies; technologies allow for new and creative pedagogical practices, but educators in turn must also develop a creative mindset to teaching and learning. The best uses of educational technology seem to be grounded in an approach that embraces openness for new and intellectual risk-taking. (Mishra, Koehler & Henriksen, 2011). Progressive creative education programmes then, arguably need to combine strong pedagogic content and processes as well as space to allow students to use this content for their individual creative self-expression using technology.

Henriksen, Mishra and Fisser (2016) suggest that progressive academic frameworks need to connect creativity and technology to curriculum development strategies. There needs to be specific modules or programmes which focus explicitly on creativity and technology, as well as a broader application of integrating and embedding these concepts across the curriculum, and featuring creativity and technology in policy at all undergraduate levels. Assessment of creativity, with and without technology, exists within a range of tensions and dilemmas, so it is important to use alternative forms of assessment with dynamic and flexible approaches to support the widest possible student achievement.

Bryant (2010) suggests several strategies to nurture well developed high-tech abilities with high concept applications. High concept here involves the ability to create artistic and emotional beauty, to detect patterns and opportunities, to craft satisfying narrative and to combine seemingly unrelated ideas into a novel invention via technological mediums. The first suggested strategy is the use of open-ended assignments, provoking students to make personal choices about fluid problems. The second is mind-mapping, brainstorming, and storyboarding, to encourage planning before diving into a technically charged environment. The third strategy involves the inclusion of symbolism or metaphor, as it is described as being partially rational and partially creative. The fourth is peer conversations, which help to encourage a collaborative culture that allows creativity to flourish. The fifth and final strategy is teacher-directed critique, which considers the overall meaning of an artifact - the effects used to achieve that meaning, and areas for improvement. If a reciprocal relationship between creativity and technology in learning and teaching is to thrive in education institutions, there needs to be active institutional support and tolerance of experimentation and risk taking by staff and students (Martin, Morris, Rogers, Martin & Kilgallon, 2009).

**3 The Mindsets and Skillsets Manifesto: The Five Principles**

The culmination of the overarching research, that included the Literature Review, the various visits to national and international conferences and institutions, the Futures in the Making Symposium, the 20/20/20 Lecture Programme and the market analysis of courses was the creation of *Blueprint for a Manifesto*. Presented as a new academic vision that, through the implementation of *Mindsets and Skillsets Manifesto*, will position the institution with a unique offering; competitive advantage, an enriched and relevant student experience and situate the institution as an innovative world-leading design and media university. This vision was then presented as the *Mindsets and Skillsets*
Reimagining the Future of Design Education: Nurturing Mindsets and Skillsets in Students

Manifesto at three key forums: the Ravensbourne Staff Conference, Course Leaders’ Away Day, and to the Board of Governors, and became the guiding framework for all training, briefing and implementation.

**Mindsets and Skillsets Manifesto:**

**Principle 01: Cultivate / where the individual thrives**

- Holistic Education: beyond the discipline
- Life Skills: resilience, self-efficacy, multiple intelligences

This principal drew heavily on the *thriving* literature discussed here and indicated a radical motivation to put so-called ‘soft skills’ personal development on equal footing with skills acquisition and intellectual rigor. Traditionally such emotional intelligence (EQ) nurturing is partitioned off into Student Services or ‘specialist workshops’ outside of the core curriculum. By positioning this critical developmental range of mindsets at the heart of the manifesto, an intentional signal was being communicated: nurturing the development of the whole individual has to be prioritized.

The final descriptor developed to articulate this read as:

Extending the norms of skills-acquisition and competency-based approaches *Cultivate* nurtures the creative individual beyond the academy, embracing the holistic notion of educating the whole person. Critical life-skills are investigated and multiple intelligences explored through a model that supports professional and personal development to create and support resilient and inclusive individuals prepared for work in the ever-changing creative industries and for living with wider societal and cultural flux in the 21st century. *Cultivate* intends to embed such modes into the curriculum in order to nurture rounded practitioners who are strong team players and self-reflective Creatives who are fully prepared for the world of work.

**Principle 02: Collaborate / where disciplines evolve**

- Blurring Disciplines: petri dish for new thinking and practice
- Shape-Shifters: new practice demands new practitioners

The *Cultivate* principal sought to reflect on many of the great pockets of innovative practice seen at a number of visited institutions (E.G. Stanford’s D School/ University of Southern California’s Jimmy Lovine and Andre Young Academy), and on the inter/transdisciplinary literature. This institution’s course programmes have historically been designed to nurture a broad skills and attributions base in students. There is, however, a need to reinforce the transferable skills students gain during their study (e.g. communication, critical thinking, time management, problem solving etc). The rapidly shifting nature of the digital creative industries also requires the advanced development of a robust range of cross-disciplinary employability skills such as: teamwork, negotiation, collaboration, self-awareness and being able to reflect on one’s own practice, and able to generate one’s own workload and self-management.

Working across discipline and course boundaries students can be introduced to each other’s working environments, exposing them to alternative curiosities, methods, practices and social concerns. Such an approach fosters new questioning and knowledge that changes traditional learning habits and develops agile high performers. The resulting descriptor developed to articulate this principal read as:

The *Collaborate* model enables students with discipline-specific knowledge to apply their own creative thinking, design and media practices and methodologies and production techniques to inter-disciplinary and trans-disciplinary projects. Inter-disciplinary project models integrate subject knowledge and working methods from a range of disciplines to create synthesis of practice, whilst the trans-disciplinary model creates new and extended disciplinary modes through the unity of intellectual and practice-based frameworks to reach beyond single disciplinary perspectives.

**Principle 03: Integrate / where education engages industry**

- Professional Modes: education mirrors industry
- Depth and Breadth: specialists and generalists

This principal sought to build on the interdisciplinarity of the *Collaborate* principle and integrate its core ambition - to exploit the blurring of the lines between single subject disciplines into the curricula of each Course, Department and School. As far back as 1971 Burchell was highlighting the benefits of such as approach:

The single discipline (or subject-at-a-time approach…) fragments a student’s world view and restricts rather than promotes his understanding of himself, his culture, and the world. Justification for transdisciplinary study is based
on the key assumption that, as a result of such study, the learner will be equipped to cope with the plurality and complexity of organized knowledge... The main task of the human intellect is to put things together in comprehensive patterns, not to separate them into separate compartments. This means that the education of college students must be arranged so that each will have the chance to escape from the constriction of specialized knowledge, and can learn to look at the world as a spaceship with identifiable and world-wide characteristics.” (p. 1)

The Integrate principle imagines a creative container that becomes such a fluid hub of pedagogic excellence and professional practice. These hubs should also mirror as accurately as possible the professional structures that serve the creative industries. So for example the engine of any advertising agency is its creative department that functions to develop concepts and campaign briefs to diverse content outputs. The roles that serve this endeavour include: art directors, designers, production artists, web designers, creative directors, and specialist creatives in print, broadcast or digital media, photographers and video production. By designing curricula and pedagogic structures that support the cross over and collaboration of these functions (which span many of our courses), This institution can more dynamically engage its students, staff, and employers.

The descriptor developed to articulate this principal read as:

This model integrates academic delivery with industry practice; enabling subject specific, interdisciplinary student teams to replicate modes of working found within relevant professional models; the Production House in Film and TV, the Design Studio in communication and media design, the Fashion House in fashion and textiles, the Advertising Agency in advertising and promotion and the Architecture Practice in architecture and interiors.

Typically, the Integrated Team, with each member assigned a specific role, works to a phased delivery that may include the Discover, Define, Develop and Deliver stages of the Design Double Diamond. Integrate challenges traditional constraints in the teaching of the solo practitioner and embraces the notion of disciplinary discovery and practice through team working. The Integrate principle imagines a creative container that becomes such a fluid hub of pedagogic excellence and professional practice.

Principle 04: Advocate / where purpose meets practice

- Citizen Practitioners: tackling real-world problems
- Self to Selves: from the individual to the collective

The development of the Advocate principle sought to harness student creativity and reflect a commitment to purpose driven and sustainable education. As the British Government’s own research on this concluded: “The best way to educate people about sustainable development is to help them discover what the term encompasses, what it means, and how it should affect the ways they live their lives ... By helping people to understand and engage with the concept... they will discover sustainable development for themselves and begin to apply it within their world...” (Higher Education Partnership for Sustainability).

As such Advocate intends to nurture a greater commitment by all staff and students to reflect this in its creative outputs. Assessment briefs and industry and social projects should aim to provoke and inspire our cohorts to produce provocative and inventive work portfolios, show-reels and creative collections. Working with external agencies, charities and businesses, this institution will be at the forefront of producing and exhibiting work that is recognized for developing innovative solutions to the problems of sustainable development.

The descriptor developed to articulate this principal read as:

Putting purpose first, Advocate recognizes the responsibility for creative education to address the unprecedented environmental, social and economic challenges facing humankind; tomorrow’s designers and media practitioners are increasingly aware of their responsibilities as global citizens to engage with complex ethical issues related to climate change, social justice, interdependence, wellbeing and bio-diversity.

Advocate puts studio projects and commercial and charitable industry commissions at the centre of the educational experience enabling the student real-world opportunities to improve the communities in which they live and work and in turn begin to transform the wider world. As such Advocate intends to nurture a greater commitment by all staff and students to reflect this in its creative outputs.
Assessment briefs and industry and social projects should aim to provoke and inspire our cohorts to produce provocative and inventive work portfolios, show-reels and creative collections. Working with external agencies, charities and businesses, this institution will be at the forefront of producing and exhibiting work that is recognized for developing innovative solutions to the problems of sustainable development.

**Principle 05: Originate / where creativity meets technology**

- Mind-Sets + Skill-Sets: the dynamism of ideas + technology
- Applied Mastery: leveraging theory, practice and innovation

This institution has a historic commitment to the creative use of technology at the core of its DNA. As reflected in the ambition of all Five Principles here, the skills necessary for success in the modern world transcend traditional academic, creative and technological boundaries. The Originate principle builds on the outstanding reputation the college has for its ability to produce technically strong graduates who can seamlessly move into industry level jobs. Originate will more deeply integrate the leveraging of theory, practice and innovation in its students leading to breakthrough visualisations, products, systems, technologies and disruptive creativity.

The ideas-led use of technology, underpinned by a relevant and integrated contextual studies programme will foster highly original and thoughtful course project outcomes. Innovative briefs and reflective practice to create thought-leading solutions by employing leading edge technology to express the necessary business, entrepreneurial and creative expressions, will support students in this aim.

The descriptor developed to articulate this principal read as:

Sitting at the intersection of creativity and technology, Originate enables the merging of visionary mind-sets and skill-sets to provide provocative and challenging design and media approaches. Originate embraces both integrated and agile design-thinking and design-doing practice and research methodologies to forge dynamic technologically-savvy and creativity-driven responses and solutions to given and self-directed industry-leading projects.

### 4 Conclusion

This study proposes a new manifesto for the delivery of a more holistic creative education in design and media at Ravensbourne University. Questioning historic paradigms across the sector, mainly unchanged for many decades, this study determines that only radical rethinking of the rationale for design and media education will create a meaningful and purposeful student experience.

Data gathered for this study included a literature review, feedback from national and international institutional visits, an industry and academic panel symposium, and consultations with the university’s academic community. The resulting Mindsets and Skillsets Manifesto and its Five Principles offer a radical new curriculum framework.

The Mindsets and Skillsets Manifesto commits to placing student thriving, a key feature, at the centre of the student experience. Thriving, in this case, refers to the broadest notion of student success, from nurturing multiple intelligences and developing resilience to modes of working and studying that will prepare graduates for the rapidly changing industries into which they graduate. Mindsets and Skillsets is also designed to inspire student cohorts to reach towards purposeful approaches to their practice and intellectual endeavour.

Critical next steps in the development of the Mindsets and Skillsets Manifesto include the crucial the implementation of and the embedding of the manifesto across the institution. It is envisaged that this study will also provoke deeper investigation and research into developing creative curricula that will serve students in supporting their ambitions to shape and influence the industries and cultural sectors they will be employed within. In an uncertain and changing economic and political climate, this must be an essential ambition for the whole sector.

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**About the Authors**

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Abstract: Historically, the design discipline has been strictly connected to the productive sector. For this reason, past design education was mainly related to the world of arts and crafts and technology. With such a vertical specialization, designers could not deeply grasp the potential repercussions of their design choices. Their commitment was largely tied in with mass-production and unconstrained technological innovation. Increased awareness of the complexity of the world has emerged in the last decades. Designers nowadays are requested to achieve new transversal skills and competencies, to cope with the incumbent metamorphoses of cultures, societies, economies, and natural environments. Thus, a linear mono-disciplinary outlook is not anymore adequate in design pedagogy. Educators need to embrace a holistic approach and to activate new collaborations, to train experts capable of configuring and managing complex design activities. This paper analyses the rise of systemic thinking and its reverberations on design studies, with an overview of geographical and temporal contributions. It invites to reflect on the role of present-day designers and on the importance of embedding humanistic and economic values in the design knowledge. Furthermore, it illustrates the directions for a systemic transdisciplinary education in Master’s degree programs and Ph.D. courses in Design, aimed at providing the necessary tools to a new and responsible generation of professionals. The awareness of their important and influential roles in society should be inspiring and lead to the creation of innovative entrepreneurial activities.

Keywords: systemic design; transdisciplinary education; awareness; societal influence; relational mediation

1 Grasping Dynamic Complexity

It was the first half of the twentieth century when the primary signs of a rising and diverse dimension of the reality surfaced. The complexity of worldwide phenomena was no longer explainable as a number of events or a variety of elements. The emergence of new events interconnected with each other, and their increasing frequency in an invisible yet powerful network, testified the appearance of a novel view of the environment and the rise of unexplored fields or...
investigation. This network thinking has influenced not only the vision of nature but also the way to consider scientific knowledge (Capra, 1996, p. 38). Discoveries of new laws and mechanisms, like the quantum theory, came up from biological and natural sciences, marking the passage from the Cartesian and Newtonian paradigms to a holistic and ecological view of the circle of life. They proved to be essential in incubating the first theorization of systemic thinking from micro to macro scale. These steps led to the publication of the General Systems Theory by Ludwig von Bertalanffy (1968), a milestone in systems studies and their following evolutions. Today, in the early 21st century, the consciousness of the complexity of the world is a shared matter of fact. It happens whenever people look at the dynamics concerning the society without any possibility to separate the single event from the strong or more slackened correlation with other circumstances, already occurred or still underway even in different and diverse contexts.

The issue of complexity has extended its boundaries over time and, from being a matter for specialists, became a discussion in the public domain. This is due to its direct involvement in people’s lives as much as the progressive and internalized understanding learned through personal experiences. In fact, the reality, seen as the natural realm in which mankind takes part, instead of mankind having his own essence and an independent existence, subsists also at the design level. Humanity intervened on the reality, modifying the world since its origins, in search of practicable alternatives through the efforts of improving it. These interventions aimed at making the world more correspondent to his interests, needs, and values that have certain importance and urgency at a given time. The act of designing, as well as the personification in the figure of the designer, advanced with the same premises but more competently and with more structured methodologies as a consequence of the propulsive push of the industry and of its strength, and because of the job enrichment. If the existence and the extent of complexity were ignored until one century ago, it’s because the act of intervening attributable to the design held consequently limited forms. Design was performed by restricted modus operandi working for compartments of problems not considering them as a whole. Design at the time of the unveiled complexity has to reach a great knowledge that allows finding the causal and relational network of events where it is called to operate. The connection between the systemic discourse and transdisciplinarity is founded on the fact that complexity cannot be considered without taking into account all its congenital and multifaceted factors. This also implies the ability to view and explore still unknown concurrent and causal factors that are too complex to grasp intuitively (Alexander, 1964). The substance on which the designer has to confront with has broadened from the communication of products to objects, from the organization of services to the intervention in complex systems.

Starting from these considerations, the paper presents a brief introduction on the evolution of the design discipline and the approaches that consider the complexity of the systems. It will further illustrate two relevant cases in systemic design education, carried out at Politecnico di Torino. These are useful to reflect on new perspectives of educational paths and on how to iteratively structure them. The paper presents relevant reflections to this scientific field of study, shedding light on the emerging aspects of the complexity in educational contexts, broadening the dialogue with the design community.

2 A Systemic Design Approach

The rising of complexity is read neither as the appearance of a new phase of design history nor as an exercise of creativity nor as a new consistency of the material with which design creates. The feature that has imprinte the new flow of knowledge should be read as the intrinsic characteristic of the world where we live and where humanity has brought forth by its own operations. Systems of services, healthcare systems, city-systems, the governance of natural resources and of territories, and business strategies are all examples of complex systems. They represent the unavoidable necessity to take on the responsibility of their undeniable presence, understanding and actualizing new modality of designing where the previous attempts failed or showed to be not completely effective. Complex systems are those related to the major issues at the global level, part of the reality being the active property of its phenomena and equally those which are meant as a matter of study and design. The meeting and the contamination among systems studies, system thinking, and design occur in the wake of the awareness that contemplates the natural laws closely related and interdependent in the same way the processes that rule the social, economic and political human life in the ecosystem do.

Designing in the world today, cannot be limited in studying and implementing daily objects produced by industry because the result would appear reductive, partial and not thought of. Reality calls for multilevel reflections and design activities simultaneously stretch out to more languages and are conducted following more international directions toward the achievement of the results (Ekuan, 1997). The earliest notices of an augmented level of complexity in design activity emerged in the 1950’s in industrial environments. They argued the requirement to adopt
new approaches that would ferret out interdisciplinarity and help manage the overall high quantity of coexistent variables. Consecutive researches and studies confirmed the magnificent systemic relationship across global issues, realizing the traits of persistence and interconnection. The trend that consolidated and on which the current systemic culture is established marked the detachment from the mono-disciplinary and specialized orientation which characterized the first half of the 20th century. The convergence of the project lato sensu and systemic culture was, among others, due to a step forward in the education that revised the design teaching with the integration of more technical knowledge with others from humanities. These passages outlined and foresaw the hybrid nature on which the profession is counting ever more. One of the most significant contributions in that sense refers to an avant-garde school, the Ulm School of Design (Hochschule für Gestaltung Ulm), that introduced an educational design system influenced by new fields of study like cybernetics, system theory, information theory, semiotics and ergonomics among others. Nonetheless, different current schools that deal with the systemic thinking in complex sciences do not foster the bond with neither design sphere nor design thinking (Jones, 2014).

It is hard to delineate the exact contours of what systemic design actually is. This intent has not found unanimity yet, as several definitions and various fields of application coexist. Some scholars recognize and locate it in strict relation with research on environmental themes, entrusting it a key role in the reading and in the development of systems in the productive processes with particular attention to their relationship with the ecosystems. Systemic design in these terms treats the complexity at both material and relational levels, studying connections and reactions among materials, resources, processing procedures and natural surroundings. The attention that design can pay on these multiple aspects is appreciable, focusing more on one or another, and is worth undertaking as much as any other investigation. One of the present interpretations defines systemic design as “a design-based approach that outlines and plans the flow of matter running from one system to the others, pursuing a metabolization process which should reduce the ecological footprint and generate profitable economic flows” (Bistagnino, 2014). The systemic design can have a varied scope and impact numerous sides: it can deal with the reduction on the ecological footprint, the generation of sustainable economic perspectives, the creation of new business models within new paradigms, it can be responsible of the limits of growth, the enhancement of local resources of a precise territorial district and the generation of sustainable economic perspectives, the creation of new business models within new paradigms, it can be responsible of the limits of growth, the enhancement of local resources of a precise territorial district and the rebalancing of the employment market. In recent years there have been copious efforts in tracing with more clearness a unitary identity of systemic design, a meeting point between system thinking and design thinking. They share a common vision of design in general terms as a practical problem-solving epistemology, to be considered a third culture adjacent to science and humanities (Cross, 1990). The knowledge in design, repositioning itself among the disciplines, is creating an evolving space in time, increasing its own competencies from the level of knowing shapes, processes, methods, and practices, to other actions. Designing today means assuming the act of describing, mapping, proposing and reconfiguring complex services and systems (Jones, 2014), forecasting, anticipating, inspiring scenarios and changing behaviors. “Design is now becoming more about listening, asking, understanding, and drafting new possibilities and alternative realities” (Muratovski, 2016, p. 14).

In conclusion, systemic design, hardly definable as a discipline itself, takes shape more as an orientation, as an emerging practice aimed at facing systemic problems through methodologies and approaches in a chorus that possesses a holistic vision and an oversight on multidisciplinarity. The role of schools and education is indispensable to realize and nourish those practices, to encourage this process in the direction of a stage of maturity, made by experimentation and contamination of thoughts. Education must reform itself and implicate a change in its system of values and, in order to compare, listen, and understand the world and its realities, it has to teach how to act in advance. New professionals need to work as a team and among teams, with the view of manifold participation not only between experts but also with citizens. According to this reference point, everyone is a conscious designer in the statement, assessment, and revision of programs for the future society (Peccei, 1981).

3 Transdisciplinary Higher Education

As described above, the rise of systemic thinking and its resonance on the design world has been undoubtedly an attempt to deal with new challenges and to follow the evolution of contemporary trends. The systemic reasoning, due to its intrinsic principles, is not complicated but rather complex (from the Latin cum pilècto: interlacement, weave). It surpasses the rigid and outdated Manichean and Cartesian strands of thoughts, embracing an inclusive, holistic vision. Due to these characteristics, it is not immediately communicated and understood. Without previous notions and experiences, it may be hard to assimilate. Systemic higher design education is thus of great adaptability to superior degrees of pedagogy like Master’s degree programs and Ph.D. courses instead of Bachelor’s. A systemic education is characterized by three prominent levels of interaction between disciplines: multidisciplinarity, interdisciplinarity, and transdisciplinarity (Piaget, 1972), defined in order of their levels of efficacy. Multidisciplinarity is intended as the use of solutions borrowed from another discipline. Interdisciplinarity, instead, is an interactional exchange of knowledge
among two disciplines, aimed at the enrichment of both. Transdisciplinarity is not only the interaction of separate branches of knowledge but the integration of them as a whole (Celaschi, Formia & Lupo, 2013, p. 5). The fluidification of disciplinary boundaries is manifestly a necessity of keeping up with the times and to educate designers to their role of mediators and integrators of knowledge and needs (Celaschi, 2008, p. 44). At this moment in time, design educators should, in fact, be talking less within the design community, on behalf of more fruitful dialogue with other disciplines, broadening the gaze to complexity as a world-shaping force and trying to help explain it (Fry, 2009). This interplay is an internal prerequisite, but first of all a peremptory condition of a current being and of the responsibilities that design is tied to (Peruccio, Vrenna, Menzardi & Savina, 2018, p. 755).

It is needless to say that a typology of knowledge like that is oriented toward the professional formation of accountable figures, with a vast and transversal set of skills. Younger designers, with a well-rounded educational background, are supposed to be able to conceive innovative products, services, and systems with the intent of improving collective conditions, towards a shared responsibility. Such a mindset goes well beyond the current institutional and societal arrangements, envisioning a radical paradigm shift that would help to deal with the uncertainties and metamorphoses of the present and future times. Education moves from the exclusive exchange of theoretical knowledge and the execution of practical formative projects to the substantial raise of deep awareness, capable of achieving a self-regenerative power, essential engine for this change of direction (Bistagnino, 2011).

Compared with other teaching methods with the final purpose of training specialized profiles, a systemic approach to education results in the formation of highly knowledgeable subjects with a horizontal and generalist grounding. Ongoing research recognize that design students are suggested to take in information from many sources, rather than attempting to develop deep expertise in a particular field. Far from being a weakness, this represents instead the real strength of a generalist (Rodgers, 2007, p. 7).

"In a world of specialists, there is a need for those who can reach across disciplines to communicate and who can bring diverse experts together in a coordinated effort" (Owen, 2007, p. 24). That being so, it is not the main responsibility of the academia to educate specialized profiles for the sole sake of satisfying the needs of the design market. Significant to the purpose of education is the kind of qualitative knowledge that is transmitted. As illustrated by Celaschi in Man at the Centre of the Project (2008, p. 23), design has the great contemporary potential to bridge the gaps between theory and praxis, possible and realizable. Design as a discipline assumes a central position from where it stretches out mutual connections and influences with other domains. It can be inscribed between four different systems of knowledge, diametrically opposed to each other. These are Humanities and Technology, and Art and Economy. A transdisciplinary systemic education is based on the transmission of values, the result of the tensions between Economy, Management and Humanities. Systemic knowledge is dealing both with necessities, needs, and new possibilities (Figure 1). It does not mean that systemic designers are not educated to be sensitive to aesthetic appearance, form, and functions, but surely these characteristics assume a secondary level of priority at the design phase.

With regard to these considerations, the study programs here introduced for the sake of the argument are a second level Master’s Degree in Systemic Design\(^1\) and a cutting-edge Ph.D. course in Management, Production and Design\(^2\), both already delivered at Politecnico di Torino (Italy). The Master’s degree prepares graduates capable of configuring and managing the complete industrial product design activity, with the aim of achieving zero emissions. It aims to promote a design culture that places man at the center of his social, cultural and environmental surroundings. One of the main academic labs, the Open Systems Lab, lasts one semester and is organized in four interconnected courses. The principal one, entitled Systemic Design, teaches students to design relations and systems aimed at activating new business models. Three complementary courses strengthen the study, giving support from the fields of economy, engineering, and humanities: Economic Management of Projects helps define the economic assessment, evaluating outcomes and new resources, Procedures for Environmental Sustainability offers technical knowledge for a responsible design awareness and Theory and History of Open Systems provides the cultural background in which systems studies originated. Graduates in Systemic Design have the skills to interact with specialists in other sectors, to develop the design of open industrial systems and new and ecological products. Concerning the Ph.D. programme in Management, Production and Design this aims at training design and engineering researchers who are able to carry out research activities in the fields of design, technology, organization, economics, management, and policymaking. Among the rich educational assortment of courses addressed to students with disparate backgrounds, the set of

\(^1\) Presentation, course programme and specifications of the M.Sc. in Systemic Design “Aurelio Peccei” are available on the official website of Politecnico di Torino. [https://didattica.polito.it/laurea_magistrale/design_sistemico/en/presentation](https://didattica.polito.it/laurea_magistrale/design_sistemico/en/presentation)

\(^2\) An overview of the Ph.D. programme in Management, Production and Design, can be found on Scudo – Doctoral School website. [http://dottorato.polito.it/gpd/en/overview](http://dottorato.polito.it/gpd/en/overview)
lectures in *Design Studies* consists on the historical-critical reading of contemporary design processes, systems, services, and experiences, to provide the interpretative tools to analyze the phenomena in fieri. Students have the possibility of comprehending the many methodological/design processes in use today, in order to acquire the skills to consciously design systems at a high coefficient of innovation.

Both the above-mentioned higher education programs serve as self-explanatory cases, from which it is possible to extrapolate precious directions for a transdisciplinary systemic education, recognize its limits and the necessary implementations.

![Figure 1. Design knowledge. Redesign of the authors to emphasize the field of action of a transdisciplinary systemic education (Celaschi, 2008, p. 25).](image)

### 4 Considerations

As described by Herbert Simon in *The Science of the Artificial* already in 1969, the proper study of mankind is the science of design, not only as the professional component of technical education but as a core discipline for every liberally educated man. This valuable notion is more than ever contemporary, and the role of teachers to educate in such a transdisciplinary way is undoubtedly crucial. A systemic approach is, therefore, one of the several attempts in pedagogy to be all-embracing and comprehensive. In a world that is constantly evolving, requiring professionals to achieve a vast set of skills and competencies like creativity, collaboration, productivity, innovation, critical thinking, decision making, communication, and management (Ananiadou & Claro, 2009), a transdisciplinary systemic design education represents an advanced formula. Designers are, in fact, gradually recognizing the change of their contribution in the society, assuming more important functions in both public and private institutions. “This demands high social and moral responsibility from the designer” (Papanek, 1973, p. 14), that has to be properly educated and that should make himself fully conscious of the implications of his choices. The responsibility has to be embraced, demonstrated, taught and communicated. The consciousness of such an influential societal role is now leading to the taking up of innovative entrepreneurial careers that are of inspiration for other young professionals. Examples of virtuous and profitable activities are frequent but, as stated in the previous paragraph, systemic reasoning is not of immediate comprehension for a larger audience. It may hence happen that the world of practitioners and the markets are not yet ready to understand, welcome and incorporate a radically new kind of approach, having a preference for far long-established business models and profiles within design or other fields. In order to promote best practices,
design educators, and designers themselves, should have the duty to stimulate new win-win collaborations with architects, biologist, economists, engineers, politicians, and sociologists among others, besides transforming their knowledge into a much more powerful tool, that is the full awareness that leads to a deep commitment. Many Universities worldwide are already operating in this direction, achieving meaningful results. Parallel to one other, they are refining and sharing their studies. Apart from Politecnico di Torino, it is worth mentioning the Carnegie Mellon School of Design in Pittsburgh, the Schumacher College in Totnes, the OCAD University in Toronto, and the Oslo School of Architecture and Design, among others (Peruccio et al., 2018, p. 757). These kinds of approaches to education and thinking, somehow spontaneous, lead to “focus and reflection” on the man in the context of his life, as part of a new form of Humanism that is both real and cultural” (Bistagnino, 2008).

This paper contributes to building knowledge on the emerging topic of design and complexity in education. The challenging perspectives and applied paths presented are already contributing to how professionals respond to real present-day needs. At the same time, there are still critical issues related to the effective communication of this innovative framework of competences, such as recognizing and giving credit to these professional profiles. Breaking the boundaries of traditional competencies and disciplines is not an easy task, but it is necessary to address impelling global issues with the exploration of new learning directions. Academics from all over the world are constantly called to redefine their teaching methods. The paper pictures a rising systemic approach to design education while inviting to reflect on the value of what is taught today and on the real contribution of existing mono-disciplinary courses of design study.

References


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**Maurizio Vrenna** is a Ph.D. candidate in Management, Production, and Design at Politecnico di Torino, Department of Architecture and Design. During his professional career in Europe and Asia, he has been involved in the development of sustainable products and services. His current research revolves around the topics of systemic design, sustainability, and the production of microalgae in urban areas.
This paper presents a literature review conducted to establish the current state of the discussion on the topic of metacognition in design education based on a review of empirical studies that present the results of educational interventions that introduced aspects of metacognition to design students. Inspired by Edwin Hutchins' seminal book "Cognition in the Wild," this paper intends to start a discovery trip to study metacognitive processes in real-world educational settings as part of a long-term research plan to investigate the intersection of metacognition and design. The paper presents the theoretical framework that contextualizes this review in which the concept of metacognition is discussed and is contextualized in design education. Likewise, the paper presents the methodology that was followed to complete this review, which consisted of four phases: search of relevant literature; sampling and selection of relevant articles; analysis and summary of each source; and synthesis of the body of research. Based on the reviewed articles, it was found that in design education metacognition is addressed as an instructional outcome, as a mechanism to promote other learning outcomes, and as a result of educational interventions. Likewise, it was found that the reviewed studies report, in general, positive results in terms of learning outcomes after conducting metacognitive interventions in design educational settings. Finally, this review identifies the field of metacognition in design education as a research opportunity for further research given the positive results that were found, and the limited body of research that has explored this topic.

**Keywords**: metacognition; self-regulation; design education; design learning; educational research.

1 Introduction

Almost 25 years ago, Edwin Hutchins —former head of the Department of Cognitive Science and former director of the Distributed Cognition and Human-Computer Interaction Laboratory at the University of California, San Diego— published his very influential book “Cognition in the Wild,” in which he highlighted the utmost importance of exploring cognitive phenomena in the real everyday world where these occur. For Hutchins, the phrase “cognition in the wild”
referred to “human cognition in its natural habitat” (1995, p. xiv), which was necessary to study in context as “an attempt to put cognition back into the social and cultural world... to show that human cognition is not just influenced by culture and society, but that it is in a very fundamental sense a cultural and social process” (1995, p. xiv). We could not agree more with Hutchins’ call to explore mental phenomena in context, which we — as researchers and educators in design, education, and cognitive science — embrace as an invitation to study metacognition and design learning in real-world educational settings. As a consequence, this paper, entitled after Hutchins’s book, is a first step in a discovery trip into the wilderness of the mind that learns to design and designs to learn.

To start this long-term research endeavor, we chose to participate in the DRS Learn X Design 2019 Conference, given the natural connection that we see between our academic interest in metacognition and the conference’s main theme: “Insider Knowledge.” From our perspective, metacognition — the ability to monitor, evaluate, and plan our learning (Flavell, 1979) — can be understood as a form of “insider knowledge” at three different levels: (1) the knowledge held by educators who consciously and purposefully teach metacognitive processes and designerly ways of thinking; (2) the knowledge that emerges from the interactions that occur in the classroom between educators, students, participants, artifacts, and content knowledge; and (3) the knowledge that design students construct about their ways of learning, thinking, and doing so that they can apply it to their design processes.

Our interest in studying metacognitive phenomena in design education is motivated by the fact that metacognition has been recognized as a fundamental ability to promote learning since it plays a crucial role in knowledge acquisition, retention, comprehension, and application (Tamayo, 2006). Likewise, it has been found that metacognitive processes promote self-regulation, creativity, critical thinking, strategic learning, problem-solving, and deep learning (Martí, 1999; Mateos, 1999; Sawyer, 2006; Tamayo, 2007; Tamayo, Zona & Loaiza, 2014). The development of these abilities is also sought by design education since they are central to the designer’s skill set.

Following Seymour Papert’s approach to studying learning processes by understanding first “well-chosen cases and then to worry afterward about how to generalize from this understanding” (1980, p. 10), we decided to start our discovery trip by conducting a literature review that explored interventions in design educational settings in which metacognition played a central role. By reviewing and analysing these interventions, we intended to infer how metacognitive theory and metacognitive processes have been applied in design education, and how the application of these constructs impacted the students’ learning processes and the structure of the learning environments where these interventions took place.

As a consequence, our goal with this review is establishing the current state of the discussion on the topic of metacognition in design education and, specifically, identifying authors, experiences and studies that have explored the topic from an empirical approach through educational interventions and first-hand data collection. Ultimately, we intend to consolidate a knowledge base that stimulates further research and informs educational interventions that leverage metacognitive processes in design learning.

2 Theoretical Background

The first mention to metacognition in literature was in the article Metacognitive Aspects of Problem Solving, written by John H. Flavell, professor of developmental psychology at Stanford University, who defined it as “one’s knowledge concerning one’s own cognitive processes or anything related to them” (Flavell, 1976, p. 232). According to Griffin, Wiley and Salas (2013), in Flavell’s framework, “metacognitive processes are designed to optimize one’s cognitive actions in pursuit of learning goals” (p. 20), through the interaction of four classes of phenomena: metacognitive knowledge, metacognitive experiences, goals, and strategies (Flavell, 1979).

As mentioned in the introduction, metacognition is considered a fundamental ability to promote deep learning and other critical cognitive abilities including problem-solving, creative and critical thinking, and self-regulation. However, despite the importance that this ability has shown, it has been barely studied in the context of design education. In fact, according to numerous authors, there is scarce research that examines the cognitive processes involved in design teaching and learning, and most of the available literature is focused on exploring how designers think and create (Oxman, 1999; 2001; Dym, Agogino, Eris, Frey & Leifer, 2005; Carvalho & Goodyear, 2017). As a response to this lack of literature, Oxman (1999; 2001) highlights the need and value of studying in depth issues related to design teaching and learning. These explorations are especially relevant considering that in traditional design education the teacher replicates his or her learning experience, the student intends to imitate the behaviour of his or her teacher, and in the end the learner is assessed based on the artefact he or she designed, but not necessarily based on his or her learning process.
According to Goel (2001; 2014) and Dym and colleagues (2005), these difficulties in design teaching and learning may be partially caused by the tacit nature of knowledge applied by students in their design processes and embedded in the design artefacts that they create. Additionally, due to the complex, ill-defined, and wicked nature of the problems that design addresses (Rittel & Webber, 1973; Buchanan, 1992; Simon, 1996; Goel, 2001) defining and understanding them require from students an active, design-based approach: "Wicked problems are typically ill-defined and you know their formulation only when you have found the solution. This implies an iterative explorative and generative way of getting to know the problem. Knowledge is built through designing" (Sevaldson, 2010, p. 17).

Besides the complexity of the problems that design addresses, and the fact that knowledge about these problems is constructed through practice, "designers are not used to accounting for what they know or do" (Pedley, 2007, p. 46, in Godin & Zahedi, 2014, p. 10), for which their knowledge "seems less domain-specific and seems largely procedural... [and] is passed down in more subtle, inarticulate ways" (Goel, 2001, pp. 221-222). As a consequence, given the tacit, implicit, subtle, and inarticulate nature of the knowledge produced through the practice of design, it becomes difficult to make it explicit and communicate for both, teachers and students.

To address the difficulties of teaching and learning design due to the tacit nature of the knowledge that it produces and applies, Orrego, Tamayo and Ruiz (2016) propose the use of metacognitive strategies to transform that tacit knowledge into explicit knowledge so that it can be taught and communicated with ease. However, these metacognitive processes are not usually taught by design educators (Azevedo & Hadwin, 2005; Adams et al., 2016; Christensen & Ball, 2017), who, according to Marti (1999), need to reflect on their own thinking (i.e., metacognitive reflection) to become aware about their mental processes and, as a consequence, guide students appropriately through a deep learning experience. Most importantly, Tamayo (2007) highlights the importance that this kind of metacognitive reflection should have for educators to plan and deliver learning experiences that consciously and purposefully teach metacognitive processes and designerly ways of thinking, based on a profound understanding of how students learn. According to the author "no teacher should face a teaching and learning process if he does not know in detail how his students learn what he will teach them" (Tamayo, 2007, in Cadavid & Tamayo, 2013, p. 547).

3 Methodology

Considering that an integrative literature review is a sophisticated form of research that “should be written so that if other researchers attempted to replicate the study” (Torraco, 2005, p. 361), our intention in this section is to present and describe accurately how we conducted this review of studies that reported interventions in design educational settings that involved metacognition. The strategy we followed was comprised of four sequential phases, as follows: search of relevant literature; sampling and selection of the literature; analysis and summary of each source; and synthesis of the body of literature.

3.1 Search of Relevant Literature

To identify relevant studies that addressed metacognition in design education, we started by identifying keywords associated with our research topic and using them to formulate a search statement based on the objective of this review. A search statement is a query used in databases search engines, which connects keywords with Boolean operators in a way that reflects the relationship between the constructs to be researched (University of Illinois Biology Library, 2009). The search statement formulated for this literature review connected the keywords design education and metacognition. Since the latter construct is also addressed as self-regulation by some researchers and research traditions, it was also included in the search statement. The definite statement used to search for publications in online databases was “design education” AND (“metacognition” OR “self-regulation”) as shown in Figure 1.

Using the search statement presented before, we explored the EBSCOhost metasearch engine licensed to the library system of one of the researchers’ institutions. This engine has access to more than 240 databases including Academic Search Complete, ScienceDirect, Scopus, PsycArticles, Web of Science, ERIC, JSTOR, and many others. We conducted the initial search in early December 2018, and it yielded 3168 articles published between 1977 and 2018. Only records written in English were included.
3.2 Sampling and Selection of Literature

Given the scope and limitations of this project, it was not possible nor desirable for us to survey all the 3168 publications found in the initial search. As a consequence, we looked for the most systematic and rigorous way to sample and select relevant studies that addressed metacognition in design education. For this purpose, we applied a series of filters and screening processes that yielded nine selected articles as can be seen in Figure 2.

First, we filtered the publications by type, focusing on peer-reviewed journal articles only. This decision was based on the fact that in our fields, state-of-the-art in educational research in design tends to be published in peer-reviewed journal articles rather than in other forms of publications. Additionally, our universities have access to most of these publications, while access to full-texts of conference papers, electronic books, or book chapters is much lower. This first filter yielded 707 peer-reviewed journal articles.

Second, we filtered the publications by source, focusing on a selection of renowned journals in design and design education. This decision was based on the quality of the contents published in these journals and the fact that a large number of articles included the keyword design education, but used the word design to refer to a variety of situations and phenomena that were neither related to the design disciplines nor to the teaching and learning of design. The selected journals and the number of articles reviewed from them can be seen in Table 1. This second filter yielded 135 peer-reviewed articles.

Third, based on their titles, abstracts and keywords, we screened the articles to check that they included an explicit reference to metacognition or self-regulation and that they presented these concepts as central constructs to study or as essential components of the findings. For studies in which metacognition or self-reflection were not included in the title, abstract or keywords, but were present in the body of the article, we skimmed the full text to verify the centrality of metacognitive aspects in the study. If metacognition was central to the study, we selected it for further review. This screening process yielded 32 articles.

Finally, taking into consideration that this review was intended to explore metacognitive interventions in design educational settings, we did a final screening of the selected articles. For this purpose, we took into consideration the following inclusion criteria: (1) the study reported an intervention in an educational setting; (2) the educational setting
was associated to a program in the design field; and (3) the study explored or applied metacognition as a central construct, or aspects of metacognition were essential findings of the study. This final selection process yielded nine articles that were analysed in depth in this review and whose titles can be seen in Table 2.

Table 1. Number of articles selected per journal after applying the sampling and selection process.

<table>
<thead>
<tr>
<th>Peer-Reviewed Journals in Design and Design Education</th>
<th>Articles found in initial search</th>
<th>Articles filtered by centrality of metacognition</th>
<th>Articles selected for final review</th>
</tr>
</thead>
<tbody>
<tr>
<td>International Journal of Technology and Design Education</td>
<td>54</td>
<td>15</td>
<td>3</td>
</tr>
<tr>
<td>International Journal of Art &amp; Design Education</td>
<td>18</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>The Design Journal</td>
<td>15</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Design Studies</td>
<td>9</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Information Design Journal</td>
<td>9</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Journal of Engineering Education</td>
<td>7</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Design Issues</td>
<td>7</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Art, Design &amp; Communication in Higher Education</td>
<td>5</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Design and Technology Education: An International Journal</td>
<td>4</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>CoDesign</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Design and Culture</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>135</td>
<td>32</td>
<td>9</td>
</tr>
</tbody>
</table>

Table 2. List of articles selected for in-depth analysis after applying the sampling and selection process.

<table>
<thead>
<tr>
<th>Year</th>
<th>Author(s)</th>
<th>Title</th>
<th>Journal</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>Winters, T.</td>
<td>Facilitating meta-learning in art and design education</td>
<td>International Journal of Art and Design</td>
</tr>
<tr>
<td>2013</td>
<td>Hargrove, R.A.</td>
<td>Assessing the long-term impact of a metacognitive approach to creative skill development</td>
<td>International Journal of Technology and Design Education</td>
</tr>
<tr>
<td>2016</td>
<td>Adams, R.S., Forin, T., Chua, M., &amp; Radcliffe, D.</td>
<td>Characterizing the work of coaching during design reviews</td>
<td>Design Studies</td>
</tr>
<tr>
<td>2017</td>
<td>Kurt, M., &amp; Kurt, S.</td>
<td>Improving design understandings and skills through enhanced metacognition: Reflective design journals</td>
<td>International Journal of Art and Design</td>
</tr>
<tr>
<td>2017</td>
<td>Clemente, V., Tschimmel, K., &amp; Vieira, R.</td>
<td>Why a Logbook? A backpack journey as a metaphor for product design education</td>
<td>The Design Journal</td>
</tr>
<tr>
<td>2018</td>
<td>Gelmez, K., &amp; Bagli, H.</td>
<td>Exploring the functions of reflective writing in the design studio: A study from the point of view of students</td>
<td>Art, Design and Communication in Higher Education</td>
</tr>
</tbody>
</table>

### 3.3 Analysis of Selected Literature

The analysis of the selected articles was conducted using the coding scheme presented in Table 3. We developed this scheme with the aim to create a framework that allowed for characterizing, contrasting and comparing the studies and interventions reported in the articles. The coding scheme included six categories and 24 sub-categories that addressed various aspects of the analysed studies such as their context, the role that metacognition played in them, their theoretical framework, the characteristics of the reported intervention, the methodology used to investigate the intervention, and the findings and conclusions presented in the articles. We used these categories and sub-categories to independently code the nine selected articles that were reviewed in depth using MAXQDA Analytics Pro 2018 (Release 18.1.1), a software package for qualitative data analysis. In the context of qualitative research, coding refers to the process by which “we attach labels to segments of data that depict what each segment is about. Coding distils data, sorts them, and gives us a handle for making comparisons with other segments of data” (Charmaz, 2006, p. 3).

An initial phase of coding was completed after organizing and preparing the articles for further analysis. This initial phase was intended to create the categories and sub-categories referred to in the coding scheme. These initial codes were selected, sorted and organized to direct the second phase of coding, in which a focused coding strategy was used. Charmaz defines this type of coding as “using the most significant and/or frequent earlier codes to sift through
large amounts of data” (2006, p. 57). During the coding process, we discussed and compared our preliminary results, refined the categories and sub-categories, and drafted memos that summarized, analysed, and synthesized the information found in the articles. Also, the memos were instrumental in preparing this paper and, especially, in writing the results and conclusions sections.

Table 3. Coding scheme used to analyse the selected articles.

<table>
<thead>
<tr>
<th>Categories</th>
<th>Guiding Question</th>
<th>Sub-Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Context</td>
<td>When and where did the study take place?</td>
<td>Geographic location</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Institution</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Department / Program</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Course / Learning Environment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Year / Duration</td>
</tr>
<tr>
<td>Role of metacognition</td>
<td>How was metacognition addressed in the study?</td>
<td>Research questions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Interest in metacognition</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Interest in design education</td>
</tr>
<tr>
<td>Theoretical framework</td>
<td>What sources were used to inform the study’s theoretical framework?</td>
<td>Referenced authors</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Approach to metacognition</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Approach to design education</td>
</tr>
<tr>
<td>Characteristics of the intervention</td>
<td>How was metacognition operationalized in the study?</td>
<td>Activity / Task / Project given to students</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Type of participants</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Role of the researchers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Duration of intervention</td>
</tr>
<tr>
<td>Methodology</td>
<td>How was metacognition explored in the study?</td>
<td>Research strategy</td>
</tr>
<tr>
<td></td>
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<td>Data collection methods and instruments</td>
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<td>Data analysis methods</td>
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<td>Sampling methods</td>
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<td>Participants</td>
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<tr>
<td>Findings and conclusions</td>
<td>What did researchers find in the study?</td>
<td>Impact of applying metacognition in the intervention</td>
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<td>Impact on participants</td>
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<td>Impact on the learning environment</td>
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<td>Future research directions</td>
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</table>

4 Results

In this section, we characterize the articles that were reviewed and present several overarching themes that we found through the in-depth analysis that was conducted. Since the information presented in the articles was abundant and rich in details, we focused on exploring and presenting the themes and patterns that emerged with clarity and that we judged to be essential for the purpose of our review. These patterns include the roles given to metacognition in the studies, the impacts of introducing this construct in design educational settings, and various other aspects involved in applying metacognition in design education.

4.1 Overview of the Analysed Studies

A total of 3168 publications that matched our search statement were found in the metasearch engine comprising the years 1997-2018. Out of these publications, 707 were peer-reviewed journal articles. Out of these articles, 135 appeared in one of the journals in design and design education that were selected for their relevance and tradition. In 32 of these articles, metacognition played a central role, and just nine of them were empirical studies that reported educational interventions and data collection and analysis. These nine articles were published between 2007 and 2018, with most of them (n=6, 66.6%) being published between 2016 and 2018 (see Figure 3). The studies reported in these articles were conducted in seven different countries (i.e., United States, Portugal, Spain, Cyprus, Turkey, Taiwan and Australia) spanning four continents (i.e., North America, Europe, Asia and Oceania) as seen in Figure 4.
4.2 Roles of Metacognition in Design Education

In the articles that were analysed, we found that metacognition played three main roles: (1) it was pursued as an instructional outcome, (2) it was used as a mechanism to promote other learning outcomes, and (3) it was found as a result of the intervention reported in the articles. As can be seen in Table 4, among the analysed studies, we found three in which the role of metacognition was coded as an instructional outcome; two in which it was coded as metacognition to promote learning; three in which it was coded as metacognition as part of the study findings; and one in which metacognition’s role was coded as both an instructional outcome and an instrument to promote learning.

<table>
<thead>
<tr>
<th>Article</th>
<th>Metacognition as an instructional outcome</th>
<th>Metacognition to promote learning</th>
<th>Metacognition as a study finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adams et al., 2016</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Atman, Kilgore &amp; McKenna, 2008</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Barbero, Pedrosa &amp; Samperio, 2017</td>
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<td>X</td>
<td></td>
</tr>
<tr>
<td>Clemente, Tschimmel &amp; Vieira, 2017</td>
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<tr>
<td>Fan, Yu &amp; Lou, 2018</td>
<td>X</td>
<td></td>
<td></td>
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<tr>
<td>Gelmez &amp; Bagli, 2018</td>
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<td>X</td>
<td></td>
</tr>
<tr>
<td>Hargrove, 2013</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kurt &amp; Kurt, 2017</td>
<td>X</td>
<td></td>
<td></td>
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<tr>
<td>Winters, 2011</td>
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<td>X</td>
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</tbody>
</table>

By **metacognition as an instructional outcome**, we refer to interventions whose intention was to promote the development of metacognitive abilities and metacognitive thinking. For example, Kurt and Kurt (2017) implemented a
reflective design journal with architecture students aiming at enhancing their metacognitive skills and, as a consequence, improving their design skills: “The main aim of this study was to investigate and discover whether the use of reflective design journals (RDJ) enhanced architecture students’ metacognition and whether, according to architecture students, this enhanced metacognition improved their design understandings and abilities” (p. 228).

By metacognition to promote learning, we refer to interventions whose intention was to promote various learning outcomes through metacognitive thinking and processes. For example, Hargrove (2013) implemented two different interventions with students of various design disciplines throughout their freshman and sophomore years in which they were introduced to metacognitive theory and metacognitive activities. However, Hargroves’ goal was to promote the development of creative thinking and problem-solving skills, rather than metacognitive thinking by itself: “The goal of this study was to determine the long-term impact that instructional interventions based on research in metacognition and learning theory would have on design students’ creativity” (Hargrove, 2013, pp. 509-510).

By metacognition as a study finding, we refer to studies in which aspects of metacognition were essential findings of the study. For example, Barbero and colleagues (2017) proposed a teaching methodology to improve the learning process of 3D modelling in mechanical engineering students. Rather than setting metacognition as a learning outcome of the methodology, the authors reported as part of their findings that the exercises proposed as part of their methodology developed metacognitive skills: “A learning methodology has been proposed, in which the different theoretical concepts of CAD and the training in the development of metacognitive skills are learnt through exercises, in which the design rules that are appropriate to each exercise are presented in the form of summaries” (Barbero et al., 2017, p. 496).

4.3 Impacts of Introducing Metacognition in Design Education

In all the analysed studies, the authors report positive impacts as a result of the interventions that were studied. Based on these reports, we identified three main types of impacts of these interventions: (1) improvements in metacognitive skills, (2) improvements in design abilities, and (3) improvements in other abilities and skills. As can be seen in Table 5, among the analysed studies, we found that all of them report enhanced design abilities as a result of their interventions, four articles report improvements in metacognitive skills, and two report gains in other abilities and skills.

<table>
<thead>
<tr>
<th>Article</th>
<th>Improvements in metacognitive skills</th>
<th>Improvements in design abilities</th>
<th>Improvements in other abilities and skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adams et al., 2016</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Atman, Kilgore &amp; McKenna, 2008</td>
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<td>Barbero, Pedrosa &amp; Samperio, 2017</td>
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<tr>
<td>Clemente, Tschimmel &amp; Vieira, 2017</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Fan, Yu &amp; Lou, 2018</td>
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<td>X</td>
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<tr>
<td>Gelmez &amp; Bagli, 2018</td>
<td>X</td>
<td>X</td>
<td></td>
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<tr>
<td>Hargrove, 2013</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Kurt &amp; Kurt, 2017</td>
<td>X</td>
<td>X</td>
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</tr>
<tr>
<td>Winters, 2011</td>
<td>X</td>
<td>X</td>
<td>X</td>
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</tbody>
</table>

In general, the studies show that interventions had positive impact by introducing aspects of metacognition in the design classroom. One of the most notable is that of Hargrove (2013), who in his longitudinal study demonstrates the positive evolution of a group of students who were given and reinforced metacognitive strategies to improve their creative processes. As Table 5 shows, the purpose of all the studies is clearly aimed at including metacognition as a skill that positively affects the appropriation of design skills. Four of the interventions aimed at improving metacognitive skills and, finally, two focused on other skills such as the meta-learning of Winters (2011) and the design pedagogical content knowledge (Design PCK), addressed to the role of the teacher of Adams and colleagues (2016).

For instance, Hargrove (2013) reports that “overall students who participated in one or both interventions finished with significantly higher levels of creative thinking. This is an accomplishment that should not be understated, particularly when compared with students who did not participate in any interventions” (p. 513). Likewise, Kurt and Kurt (2017) report that their intervention “proved to be very effective in activating and enhancing metacognition. The study also revealed that enhanced metacognition improved the understandings and abilities of architecture students. They spent more time and focused more on their design projects, trying to find better options and solutions to their
design related issues” (p. 235). In the same vein, Winters (2012) argues that “facilitating art and design students to engage in metacognitive thinking about learning supports one of our most valued graduate attributes – that our students become reflective, self-reliant and independent learners” (p. 98). Finally, Clemente, Tschimmel and Vieira (2017) argue that their intervention “requires each student to select the cognitive style(s) he has felt the need to activate during a certain project week. By this means, students are guided on the reflection on their own thinking process throughout the project, being explicitly inducing to engage in metacognitive activities” (p. S1536).

5 Conclusions

The goal of this review, as the beginning of our discovery trip, was identifying authors, experiences and studies that have applied metacognition in design education by exploring interventions in which metacognition played a central role. This initial exploration allowed us to reach the following conclusions:

- Metacognition was addressed as an instructional outcome of the reported interventions, as a mechanism to promote other learning outcomes, and as a result of an educational intervention that had purposes different to develop metacognitive abilities. In the analysed studies, these findings are coherent with current literature in which it has been reported that metacognition in educational settings “was part of the study goals or questions... [and] was a component or an outcome of a deliberate instructional practice, instructional intervention or experimental manipulation” (Zohar & Barzilai, 2013, p. 131).
- All the studies that were analysed report positive results in the students’ learning processes and in the structure of the learning environments where metacognitive strategies were implemented. However, it is important to notice that most interventions were limited in the number of participants, and in the duration of the intervention. As a consequence, these positive findings cannot be generalized and need to be verified with further research studies with larger samples and longer or more pervasive interventions.
- Other aspects to take into consideration when implementing metacognitive interventions in design educational settings are the central role that verbal communication plays as the main language to develop and hold metacognitive processes, the need for intentional and conscious teaching to promote metacognitive thinking in students, and the importance of educators who put in place metacognitive learning experiences as the most important strategy to develop metacognitive thinking in students.
- Most studies highlighted the lack of formal preparation of design educators to put in place metacognitive strategies in the classroom, the lack of programs’ large-scale initiatives that offered students instruction on basic aspects of metacognition, and the lack of students’ understanding of their cognitive processes.

Additionally, this literature review allowed us to identify metacognition in design education as an opportunity for further research. We see great potential in this field given the positive impact that metacognitive interventions have on students and learning environments, the small number of researchers that investigate design education and learning, and the even smaller body of research that has explored metacognitive processes in this field.

To continue our discovery trip into the wilderness of the mind that learns to design, and designs to learn, we envision to conduct a more extensive literature review based on the publications identified but not analysed in this study, as well as other types of investigations that explore the intersection between metacognition and design education. We also envision to propose and conduct metacognitive interventions in the design educational settings where we teach, in order to apply what we have learned from others’ experiences and in order to conduct empirical research in these settings. Finally, we intend to continue collaborating with researchers from different disciplines, institutions, and academic traditions in order to pursue a long-term research plan to discover and explore metacognitive phenomena that take place in design educational settings.

References


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Abstract: Studies on the history of industrial design education in Turkey suggest that the emergence of industrial design education was mainly a result of government policies and academy, rather than a demand by industries in Turkey. Along with foreign scholars, Turkish academics who were educated abroad played essential roles in department foundations. Until the late 1990s, the number of industrial design bachelor programs in Turkey was not more than five. However, as of 2018, there are almost 30 bachelor programs in Turkey. This study aims to explore the motives behind the rapid increase in the number of industrial design departments in Turkey. The paper explores the initial grounds for the emergence of industrial design departments through the literature review. In order to explore the motivations behind the recently established industrial design departments, interviews were conducted with five heads of departments. Four of them are the founders of their departments. The main motivations, missions, and strategies of these departments were questioned, along with the logic behind the curricula of the departments. The results indicate that regional environment, and the actions taken within available facilities and sources mainly define the missions of recently established industrial design departments.

Keywords: industrial design education; newly-industrializing countries; industrial design departments

1 Introduction

Industrial design education in Turkey has started in the early 1970s. Four state universities provided design education at the bachelor level for the first 25 years. Since the establishment of the first industrial design program in a private university in 1996, there has been a rapid increase in the number of departments in Turkey. Foreign schools influenced the foundation of the initial industrial design departments. Schools in Germany and the USA were among the ones that have affected the programs and curricula (Şatır, 2006; Bayazıt, 2009). Similar to other developing countries, academic institutions, rather than the industry, introduced industrial design discipline into Turkey (Tezel, 2011).
The discussions about the role of design education and design in general, began to address a more integrative function of design in business (Owen, 1990; Boyarski, 1998; Buchanan, 2004). Buchanan (1998) states that design has evolved from being a follower of the industry to be an equal partner of it. Nowadays, design is considered more like a managerial means in business; although the idea goes way back in time (Archer, 2013), the inclusion of design in business education is rather recent (Dunne & Martin, 2006; Nielsen & Stovang, 2015). On the other hand, academicians brought a managerial perspective to design disciplines, together with the recent trends that mainly evolve along with the design thinking approach (Boyarski, 1998; Liebenberg & Mathews, 2012). The more contemporary views also can be observed in the curricula of the design schools (Özcan, 2011). As there has been a rapid increase in the number of undergraduate programs in Turkey for the last 20 years, it can be questioned if these recently established departments and their strategies appear as a result of recent developments, or whether the motives are the result of regional necessities.

To explore the missions and visions of the recently established industrial design departments, interviews are conducted with five heads of departments about the factors and targets that determine the strategies and curricula of these design departments. Since this study focuses on the intended strategies of these new departments, the views of the founders are the main elements of research. The motives and actions of the departments were evaluated along with the department heads’ idealization of the design departments in general.

2 Initiation of Industrial Design Education in Turkey

Although academic studies on design have started earlier within the architecture education, industrial design education in Turkey began in the early 1970s (Bayazıt, 2009). Unlike the pattern described by Buchanan (1998), industrial design education in Turkey did not start as a server of the industry, mainly due to the lack of competition in the local market and the protection of domestic production (Er, 1997). Like the other peripheral countries, the initiation of industrial design in Turkey was evaluated through the Modernist Development Paradigm (Bonsiepe & Cullars, 1991), and the educational model was derived from the examples located in countries such as the USA and Germany (Flores, 2000; Er, Korkut & Er, 2003; Er & Er, 2006).

Until the late 1990s, there were four state universities that provided industrial design education: The State Academy of Fine Arts (Devlet Güzel Sanatlar Akademisi, DGSA, today called Mimar Sinan Fine Arts University, Istanbul), Middle East Technical University (METU, Ankara), the State Higher School of Applied Arts (Tatbiki Güzel Sanatlar Yükse Okulu, TGSYO, today part of Marmara University, Istanbul), and Istanbul Technical University (ITÜ, Istanbul). DGSA established an industrial design department in 1971; its founding scholars mainly had interior architecture and architecture backgrounds (Küçükerman, 2006). The industrial design undergraduate education of DGSA has started in 1972 (Şatır, 2006). This department set a pioneering example for others; it mainly improved through co-operation with industry and design competitions (Küçükerman, 2006). Although the educational roots of DGSA are based on French schools (Bayazıt, 2009), mainly examples in countries such as the USA and Germany influenced the industrial design division (Şatır, 2006).

TGSYO was initiated in 1957 with five departments including textile, graphic arts, ceramics, interior architecture and decorative arts (Celbiş, 2006; Şatır, 2006). The motives behind the launch of this school were educators and bureaucrats of the Ministry of National Education, who had been examining missions of similar schools abroad, especially the ones in Germany (Celbiş, 2006). Some of the graduates were sent to universities abroad to carry on with their education, in order to be employed in the intended industrial design department; one of the reasons behind this choice was the role of Ulm School of Design in the design world (Alyanak, 1998; Celbiş, 2006). At the initial phase, German Werkkunstschules profoundly influenced the department’s education (Şatır, 2006). Although there were educational activities that could be considered in line with industrial design discipline within the interior architecture department, an independent industrial design department opened in 1985 (Alyanak, 1998). The first academicians of the industrial design department were mainly interior architects who continued their education after graduation at various schools located in Germany, Britain, Italy, Japan and Canada (Celbiş, 2006).

Unlike TGSYO and DGSA, the initiation of the industrial design department at METU was affected by the curricula in the US, rather than Europe (Bayazıt, 2006). METU and its industrial design department were included in ICA program; a team of American industrial designers visited the university to evaluate the opportunities for industrial design education; however, their efforts were unsuccessful at the time (Er et al., 2003). An American designer, David K. Munro, led the first studies to form an industrial design education curriculum; he worked with government organizations, multinational organizations and local industries to form a program suitable for Turkey (Asatekin, 2006). Munro formed two elective courses on industrial design within the Department of Architecture in 1969 (Er et al., 2003). Later, documents gained from ICSID’s “Education of Industrial Designers” seminars helped the curriculum
development for the department; three major course groups were formed as knowledge courses, communication courses and design courses (Asatekin, 2006). The undergraduate education has started in 1979 (Er et al., 2003). There were four academicians in the department at the initiation stage (Erbug, 1998).

The formation of industrial design education at ITU was led by lecturers with a background in architecture (Bayazit, 2006). At the beginning of the 1980s, global developments and integration with Europe were listed among the motives behind the initiation of the department (Gunal Ertaş, 2011). Programs of foreign design departments led the researches for a curriculum, and drafts of YÖK (Council of Higher Education); also, an interdisciplinary approach was adopted in order to benefit from university’s opportunities (Gunal Ertaş, 2011). The primary curriculum included many engineering oriented technical courses, which is mentioned as a distinctive element of ITU’s curriculum (Bayazit, 1998; Bayazit, 2006; Gunal Ertaş; 2011).

To sum up, it can be said that the emergence of industrial design education in Turkey is mainly due to academic initiatives by scholars and institutions, as suggested in the literature (Tezel, 2011). It is also stated that there was not a significant demand in the industry at the initiation stage and design was promoted through collaboration with industry, competitions and conferences (Kucukerman, 2006).

3 Recent Developments in Design Education in Turkey

Industrial design schools were intended to meet the foreseen demands, which were expected to arise from the import substitution strategies followed in the 60s and 70s (Er & Er, 2006). It is stated that, following the enforcement of the global regulations, an increase of the need for industrial design practices may appear in newly industrializing economies (Kumar, 2003). This increase is related mainly to intellectual property rights, which call for differentiation of product designs (Glass & Saggi, 2002). In line with the assumptions on newly industrializing economies, the number of departments has significantly increased after 1994 (Figure 1). Considering the regulations on intellectual property rights, increases in both demands for design practice and the number of departments are understandable; but there is a lack of evidence in the literature about the actual motives behind this increase.

The number of industrial design departments in Turkey showed significant growths after 1995 and 2004 (Dogo, Timur Oğüt & Er, 2015). As stated before, from 1971 till 1994, there were only four state universities in Turkey with industrial design departments (Dogo et al., 2015). The number of universities with design departments became 25 at the end of 2014, which addressed a significant growth since 1995 (Dogo et al., 2015). As of 2018, there are 29 universities with 4-year undergraduate programs in industrial product design and three universities with departments of industrial design engineering (ÖSYM, 2018). The rapid increase in the number of departments may be due to increasing awareness in the industry, possibly triggered by enforcement of intellectual property rights.

When the curricula of departments are evaluated through the demands of the industry, it may be thought that the curricula are not shaped according to expectancies of the industries from designers. A relatively early study by Korkut and Hasdogan (1998) suggests that Turkish industries expect designers to be equipped with better technical, managerial and communicational skills. This study also notes that the managers demanded computer-aided design skills, and there had been significant improvements in the curricula recently. A more current study by Erkarslan, Kaya and Dilek (2013) suggests an incompatibility between curricula and industries’ expectations, as industries tend to employ designers that are equipped with more design skills and contextual understanding. Erkarslan (2013) states that departments do not update their curricula according to industries’ pace and the level of co-operation between departments and industry is still quite low. This referred lack in co-operation is also linked with the low productivity level of these studies (Erkarslan, 2013). Tunali and Toprak (2017) state that, regarding the university and industry cooperation and innovative production, Turkey fails to produce projects that can be actualized to create value in the market. A study by Hasdogan and Şener (2014) states that, Turkish organizations cannot industrialize the projects that are conducted in the studio courses. Büyükhati and Sarsilmaz (2011) did a prior study through interviews with academicians, which also suggests that many of the collaborations done within industrial design departments do not result with products that are manufactured. Therefore, the motives of the Turkish firms are rather conceptual, such as gaining new perspectives, on contrary to the industrial outcomes that are mentioned in the literature (Hasdogan and Şener, 2014).
When the developments in the Turkish industrial design education are considered, it can be said that although there is an increase in the need for both design and number of industrial design departments in Turkey, the literature states a gap between academy’s supply and industry’s demand (Ilhan & Er, 2016). Also, earlier studies suggest an incompatibility between industries’ and departments’ expectations from designers, and there is a lack of more current studies about the grounds of the increasing number of design departments. Therefore, it may be essential to investigate the missions and motives of recently established design departments in Turkey.

4 The Research

This research aims to find answer to the following main research question:

• What are the missions and motives of newly established industrial design departments in Turkey?

To answer this question, the following sub-questions are formed:

• How do the founders of newly established industrial design departments define an ideal design education?
• What are the strategic goals of recently established departments?
• How do the recently launched departments define their curricula?

To answer these questions, five heads of departments were interviewed. Four of them were the founders of departments. One interview was conducted through e-mail, while others were recorded and transcribed. The selected departments have undergraduate education backgrounds with no more than six years. Three of these departments are at state universities, while the other two are at private universities. Private universities are located in metropolises, while others are in relatively smaller cities. The methodology of this paper falls into the phenomenological research category, as the department founders are actively involved in the formation of the answers of our questions (Groenewald, 2004); purposeful sampling was done for interviewees accordingly (Merriam, 2009). Semi-structured interviews were conducted to receive answers for the following open-ended questions (Merriam, 2009):

• What do you think are the critical factors in determining the mission of a design department?
Exploring the Motives behind the Formations of Recently Established Industrial Design Programs in Turkey

- Are there design schools (abroad) that you consider successful in terms of strategy? Why do you find them successful?
- Are there any industrial design/industrial product design departments that acted as an example in Turkey or abroad during the establishment of the department?
- How was the decision made to set up an industrial design/industrial product design department at your university?
- Does the established industrial design department have a specific purpose?
- How was the departmental curriculum and staffing structured during the department establishment?
- Were the infrastructure needs fulfilled during the establishment of the department? How were these needs determined?
- What are the changes planned in the curriculum in the long or short term? Why are these changes necessary?

The questions listed above are asked to understand interviewees’ perceptions of an ideal design education, along with their current and possible future education practices. These questions may reveal the industrial and academic forces behind the formation of an industrial design department in Turkey. The open-ended questions are subjected to thematic coding (Braun & Clarke, 2006). The themes are evaluated under three sections as visions of founders, motives behind visions of the departments, and motives for actions. The summary of the themes and frequencies are shown in Table 1.

### Table 1. The summary of themes and frequencies.

<table>
<thead>
<tr>
<th>THEMES</th>
<th>SUB - THEMES</th>
<th>U1</th>
<th>U2</th>
<th>U3</th>
<th>U4</th>
<th>U5</th>
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<tbody>
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<td>Industry</td>
<td>Academy as a mentor for industries</td>
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<td>X</td>
<td>X</td>
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<tr>
<td></td>
<td>Co-operation with industries</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
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<td></td>
<td>Integration with the industry</td>
<td>X</td>
<td></td>
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<tr>
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<td>X</td>
<td>X</td>
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<td></td>
<td>Being multidisciplinary</td>
<td>X</td>
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<td>The expertise of the instructors</td>
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<td></td>
<td>University’s identity</td>
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<td></td>
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<td></td>
<td>University’s structure</td>
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<tr>
<td>Nation</td>
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<td>Local leadership</td>
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<td>Academic concerns</td>
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<td>X</td>
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<td>University</td>
<td>The popularity of the profession</td>
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<td>Part-time instructors</td>
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<td>Flexibility through elective courses</td>
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<td>Other departments</td>
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### 4.1 Visions of Founders

Interviewees mentioned several themes when they were asked about the critical factors for determining the mission of an industrial design department. These themes can be roughly evaluated in three groups; industry, academy, university. In this section, the quotes of the interviewees are given under these three main groups, to be discussed further.
Interviewees frequently mentioned relations with industry. Their perspective varied from integration with industry to mentoring the industry. Interviewees mentioned the importance of the state’s economic and industrial policies, as they are claimed to have an organic connection with educational policies, referring to the "integration with the industry" (U1). It was also stated that the department’s role is crucial in directing industries’ transition to the future, therefore acting as a mentor for industries (U1). Another quote that addresses co-operations with industry can be seen below.

"What I consider more successful are the works that are done with the sector and university-industry collaborations." (U3- co-operation with industries)

Also, three interviewees mentioned missions related to the academy itself. It was stated that it could be necessary to give direction to the mission through the values that are referred to as universal (U2). Being multidisciplinary was mentioned by one interviewee.

"Looking at the current situation, design education is mainly carried out within the framework of its disciplinary resources. From this perspective, for example, having a multi-disciplinary and co-operative educational environment can become one of the department’s missions." (U2- being multidisciplinary)

Initial conditions of the departments are among the university-related factors, such as the facilities and restrictions that evolve from the university or the academicians. Institutional factors of a university, such as being built in an urban area, were also considered as factors that define the identity of the university (U2).

"Therefore, there should be a strategy in line with the opportunities provided by the university and related to the expertise of the instructors.” (U4, expertise of the instructors; university’s structure)

It can be inferred that academicians mentioned the collaboration with industry within their ideal department mission. The focus on industrial relations may hint an inclination towards the more recent understanding of co-operation with industries. However, even when interviewees were asked about a hypothetical department’s mission, they mentioned the conditions of the university. Academic concerns are also mentioned when defining the ideal structure for an industrial design education program.

4.2 Motives behind the Visions of the Departments

Sub-themes related to nation, region, academy and university are mentioned in answers that covered the questions about the initiations of the departments. Interviewees mentioned local factors addressing region and nation. These concerns were mentioned by providing examples such as Erasmus agreements, where national understandings about design education were revisited (U2). Regional development and local leadership were also mentioned.

"...(our city) is a place that is unjustified on many issues. Generally, investments have been made to the Eastern (region). In this context, bringing an action to (our city) and (our region) is one of the aims of our department. Science and technology are our other focuses on regional development.” (U1- regional development)

"We have set our goal to become the best of the new departments established in Anatolia, in addition to the universities that have hosted industrial design for 35-40 years.” (U3- local leadership)

Corporate factors related to the university are among the other motives in this section. Benefiting from facilities that are provided by other departments was mentioned as a factor that is related to the university’s structure (U4). The interviewees also reviewed the curricula of other departments (U1). Industrial design is perceived as a profession that will be significant in the future; therefore, the existence of industrial design departments is supported by strategy makers regarding the prospective aims of the university (U3). Two interviewees also declared the popularity of the profession.

“Design is also obviously considered as a popular department.” (U2- popularity of the profession)

Academic concerns were mentioned again by two interviewees.

“The curriculum of the department is based on the sound foundations of a theoretical infrastructure supported with an application-oriented structure. Regarding the scope of the main courses, a wide range of projects is carried
out. All the theoretical and practical knowledge that is needed to carry out the project courses are provided through other courses.” (U5- academic concerns)

Although the industry theme appears within the ideal strategic factors, it is not mentioned as a factor that is considered in the initiation of the departments. Local factors such as regional development aim and national development strategies appear in this section, along with the academy factor that addresses core academic concerns, which are also mentioned as factors in the previous section. It can be said that environmental factors such as local sources and the university’s corporate structure are more effective on the determination of the department strategy.

4.3 Motives for Actions

Within motives for actions, sub-themes related to experiences, external environment, region and university can be detected. Interviewees frequently mentioned experiences gained from existent structures, founders, scholars coming from other disciplines and other examples. Founding academicians were claimed to play a role in initial curricula formations, their backgrounds affecting the overall structures of curricula that sometimes derived from another university’s practices (U3). Therefore, even academicians coming from other departments’ backgrounds, such as architecture, may influence a curriculum (U2). Sometimes a founding scholar may play a dominant role, leading to a subjective process in curricula formation (U3). Previous experiences are also effective motives for the departments’ actions.

“...and (formed) through experiences we gained from industrial design workshops.” (U1- previous experiences)

Among the effects of external factors, an increasing number of students is mentioned, as student quotas are mostly defined by YÖK (U5). The availability and expertise of part-time instructors are also mentioned by interviewees (U4). Lack of academicians with post-graduate educations was also referred to as a factor.

“We need a lot of staff who are trained in this field and have completed their doctorate.” (U3- lack of academicians)

The region theme is mentioned again in this section.

“We have changed according to (our city’s) facilities and internal dynamics.” (U3- regional development)

Other sub-themes are mainly about determinants that arise from the university. Some departments seek flexibility in their curricula through elective courses, which help them to maintain the core structure (U4). However, frequent curricula updates are required in some of the others; a reason for this tendency was defined as the structure of the university (U2). The structure of the university is also solely mentioned as a factor; some universities encourage departments to define generic courses and support them with differing contents every semester (U4). Other departments also seem to be among motives for actions.

“There are common core courses that we can call more like an American model.” (U2- other departments)

It can be understood that the formation of curricula is mostly affected by internal and external factors such as facilities in the university, available sources, and regulations. Interviewees frequently mentioned previous experiences on design department curricula and initiating academicians seem to have played important roles. The reappearing themes from previous sections are university and regional development.

5 Discussions

When the distributions of the themes are evaluated, it can be said that most of the themes that are related to the visions idealized by the interviewees are not transferred to departments’ actions in the short term. The only theme that has been mentioned in the three sections is university. The interviewees declared that an industrial design department should be integrated with the industry and provide mentorship. This view seems to be in line with Buchanan’s (1998) projection. Also, factors related to universities and founders are also mentioned, which reflect a relationship with the initiation of industrial design in Turkey. Even though interviewees mention more idealistic missions, they consider factors that are related to the university.

Regarding missions of the newly established departments, the interviewees stressed the effects of the environment; such as the region, university and national factors. While the external factors related to the country and region were
not mentioned in the previous questions, they frequently appeared in motives of the initiation of the departments. Even though universities that are in small cities, most mention regional development. Other universities also have similar concerns about their location, which were expressed through the identity of the university. Factors related to universities were also frequently mentioned; however, co-operation with industries was not stressed here.

Finally, actions taken by the departments are affected mostly by the factors available, such as facilities of the university, student quotas defined by YÖK, availability of the instructors, and academicians that take role in the constitution of the department. Again, co-operation with industries is not mentioned in this section. Focus on regional development was mentioned; however, it was not emphasized as strongly as the answers that were related to the strategies of the departments.

To sum up, it can be said that while interviewees described a more idealistic mission definition for industrial design departments in general, the missions of recently established departments are mainly defined by their environment and actions are taken within available facilities and sources. Interviewees are aware of the necessity of industry-university collaborations; however, while defining the primary missions of the departments, they focus more on local factors such as regional development. The identity of the university was always emphasized as a concern for the interviewees, but it was stressed more in missions of the departments and curriculum foundation.

6 Conclusion

In Turkey, industrial design education has started with initiatives of academicians and influences from the universities abroad. There was a lack of demand from the industry, and the academy took action to promote the profession within the industry. Today, the profession is somewhat known, and department founders mention a possible collaboration with the industry where departments should act as mentors that lead the industry to more ideal design practices. Within this prospected co-operation, local factors are stressed more than before, as industrial design departments in Turkey now appear in locations where the industry is somewhat underdeveloped.

When the initiation of the education practice is concerned, in the beginning industrial design lacked a demand from the industry and educated academicians in the field. Schools in the USA and Germany were examined to build a curriculum suitable for Turkey, and academic concerns were the main priority. The first scholars had backgrounds from other departments and were sent abroad for industrial design education. The first industrial departments in Turkey played crucial roles in the empowerment of the profession.

Today, the pioneer departments have academicians that have been educated in post-graduate programs of industrial design. These academicians seem knowledgeable on the recent thoughts on design education’s relations with industry. However, their awareness is not reflected strongly on missions and curricula of the recently established departments. This may be due to rather underdeveloped industrial structures in smaller cities and a high number of established design departments in metropolises. The recently formed departments seem to focus mostly on regional and local factors in order to differentiate themselves from other universities. Although there are post-graduate programs in Turkey, newly established universities (both state and private) lack academicians that are educated in the field. This results with a tendency of benefiting from available resources while forming and altering the curriculum. Along with available resources, the departments also seem to utilize the education models that are provided from other universities, domestic and abroad, while both internal and external environmental factors may have a more significant effect.

Today’s newly established industrial design departments resemble pioneers in terms of curricula foundation, the effect of initiating instructors and the lack of academicians educated in the field of industrial design. They also seem to aim for an increase in industries’ demand for the profession; however, this time the scope is more regional than national. The universities in smaller cities focus on local industries, while the departments in metropolises emphasize the location of the university as a strategic factor. Interviewees also stress that the university is a significant factor for strategy formation.

It can be said that industrial design education in Turkey still shows characteristics that are attributed to newly industrializing countries. The primary difference seems to be the transition from a national focus to the regional focus. The increase in the number of academicians with industrial design education at post-graduate level and the establishment of sustainable local industries can lead to a more developed education model for these newly founded departments.
References


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About the Authors
Abstract: Systemic design is an emergent field demanded by the complexity and the scale of 21st-century problems. Its objective is to provide a holistic vision over fragmented entities to design responsibly for incremental change. For addressing the complexity of societal and environmental problems, it is important to equip future designers with a broad systemic design skill set. Industrial design education needs to be restructured and regularly updated to transfer required competencies compatible with the nature of contemporary issues. The Competency Domain Model (CDM) proposed in this paper, lists and categorises the essential designer competencies in four different domains. This classification could serve as a framework for educational reforms in the near future, and facilitate meaningful communication between different design programs. The model is applied to 15 industrial design departments in Turkey in order to understand the current status of design education in the national context and to present its potentials for others. Research results are shared within the context of insider knowledge.

Keywords: systemic design; design education; competency model; orders of design

1 Introduction

The purpose of this paper is to present potential contributions of the systemic design approach to industrial design education. Systemic design is concerned with higher-order complex systems rather than designing commercial products, therefore it contains a broader skill-set and requires a wider perspective. In order to educate future designers who can address contemporary social and environmental problems, it is important to integrate these skills into industrial design education. The Competency Domain Model (CDM) is proposed in this paper for organizing and classifying essential designer competencies in four different domains. It works as a diagnostic tool for investigating which competencies are taught in design departments. It is applied to 15 industrial design departments in Turkey, and research results are shared within the context of insider knowledge.

The first section of this paper presents a definition of systemic design, its principles, and emergence as a new design field. The following section explains the contribution of a systemic design approach to design education. Then, the CDM is presented with brief information about the industrial design education in Turkey. In the fourth section results
of the survey conducted with 15 industrial design departments are shared. Finally, insights obtained from the research results and implications are shared.

2 Systemic Design

Systemic design is an emergent field coming from the integration of two diverse interdisciplinary praxis: design thinking and systems thinking. It is demanded by the complexity and scale of 21st-century problems and aims to provide a holistic vision over fragmented entities to design responsibly for an incremental change. Global problems cannot be approached by conventional linear methods and specialized mind-set. For this reason, systemic design merges the knowledge of systems thinking and with the social, practical, economic capabilities of design thinking.

System thinking comprehend the world as interdependent systems. Every system is a part of a larger one (expansionism) and can be understood with synthesis (explaining the role of the system in the larger system of which it is a part) rather than analysis (explaining the role of the system in the larger system of which it is a part) (Ackhoff, 1999). It was explored just before WWII while engineers were struggling with communication and administration problems. Its philosophy is evolved from General System Theory, which is firstly reported by Austrian biologist Karl Ludwig von Bertalanffy (1956), and Norbert Wiener in cybernetics (1948). Since then it has been adopted by many different approaches such as living systems theory, system engineering, hard & soft system principles, complexity theory, emancipatory systems etc. In order to grasp system theories and its principles; it is necessary to understand several key concepts listed below:

- **System**: An organized entity made up of interrelated and interdependent parts.
- **Boundaries**: Barriers that define a system and distinguish it from other systems in the environment.
- **Homeostasis**: The tendency of a system to resist change and maintain status quo.
- **Adaptation**: The tendency of a system to make the changes needed to protect itself and grow to accomplish its goal.
- **Reciprocal Transactions**: Circular interactions that systems engage in such that they influence one another.
- **Feedback Loop**: The process by which systems self-correct based on reactions from other systems in the environment.
- **Throughput**: Rate of energy transfer between the system and its environment during the time it is functioning.
- **Microsystem**: The system closest to the client.
- **Mesosystem**: Relationships among the systems in an environment.
- **Exosystem**: A relationship between two systems that has an indirect effect on a third system.
- **Macrosystem**: A larger system that influences clients, such as policies, administration of entitlement programs, and culture.
- **Chronosystem**: A system composed of significant life events that can affect adaptation.

(Bronfenbrenner, 1979; Germain & Bloom, 1999; Gitterman & Germain, 2008; Langer & Lietz, 2015)

These terms are present in every system from the smallest to the largest scale. When we take the minibus (dolmuş) transportation system in Istanbul as an example; a specific route can be an example of boundaries; the dolmuş system’s resistance to using card payment method is homeostasis; the average number of passengers per day is an example of throughput data... Examples can be replicated for other contexts too. Wherever these three are present: parts, relationships, and a purpose, there exist a system and its entities can include people, hardware, software, facilities, policies, and documents (Long & Scott, 2015). The most important thing to notice here is systems thinking is more about “relationships (rather than unrelated objects), connectedness, process (rather than structure), the whole (rather than just its parts), the patterns (rather than the contents) of a system, and context” (Meadow, 2008, p. 6).

Design thinking on the other hand; does not embrace complexity and shifting boundaries of socio-technical systems. It is on a quest for the market differentiation rather than overall equilibrium and integration. Its boundaries are mostly determined by the material or immaterial subjects that designers focus on such as: communication design, industrial design, interior design, organizational design, interface design, service design, etc. Design thinking term is also relatively recent when compared to systems thinking. It first appeared in the 60s with the foundation of Design Research Society (DRS) and the design methods movement. Principles of systems science is introduced to the design field by the members of DRS, especially by Horst Rittel and others from Ulm. Although, there were some counter views on integrating system science and design and rejections to scientise design; with the introduction of second-generation methods this integration continued its validity.
Industrial design discipline, which was established to conform to the mass production standards of the industry in the first place, is searching for different perspectives in order to keep its serviceability in today’s conditions. Horst Rittel’s provocative and longsighted article Dilemmas in a General Theory of Planning (Horst & Webber, 1973) summarizes these conditions. He uses the term wicked problem to describe the complex and contradictory nature of social problems such as political, economic, environmental issues. Wicked problems require completely new mind-set and philosophy to be approached. While we naively design for any perceived problem, which we may be very convinced and sure about from our diagnosis, solving that problem may reveal or create many others. There is no stopping rule, no solution formula, no true/false, no trial-and-error opportunity, no immediate/ultimate test, no brief — you cannot start with understanding the problem as in every method textbook. First generation system designers were therefore commonly seen as universal problem-solvers with arrogant confidence, who believed that they could approach and solve every problem analytically (Horst & Webber, 1973). Being aware of the wickedness of our contemporary problems; how we can educate future designers with a mind-set beyond the first generations is an important question. It is a futile effort to continue teaching design with its traditional analytical, linear, canonical logical structure. It is even hazardous when we consider time pressured super wicked problems (Levin et al., 2012) like global climate change.

3 Systemic Design and Competencies for Design Education

Classical industrial design is a form of applied art, requiring deep knowledge of forms and materials and skills in sketching, drawing, and rendering (Norman, 2014). Traditionally, design practice and design education have focused on giving form to physical things - apparel, buildings, messages, tools, and vehicles- the artefacts that constitute material culture (Dubberly, 2018). However, since the mid-20th-century design it has followed a trajectory of increasing abstraction, migrating from the design of objects to the design of services, identities, interfaces, networks, projects, and discourses (Ryan & Leung, 2014). This immaterial turn has broadened the design field and made it more welcoming and more connected to interdisciplinary collaboration. Through these collaborations new design fields have emerged: design management, product service system design, interaction design, systemic design, design for social innovation, etc.

It is hard to monitor and catch up with the velocity of these changes. Skills learned today become invalid or insufficient tomorrow. Design departments and design schools are having difficulty to update their curriculums regularly to keep up with these changes. Currently, universities are largely educating designers in similar ways as they have done in the past decades (if not almost a century ago) (Valtonen, 2016). When a curriculum is to be renewed at a university, this is usually done “with a narrow view of specialist knowledge and research”, and in practice “most university curricula are never developed on a strategic scale, but tend to evolve one course at a time ... for reasons related to department survival or institutional prestige” (Toohey, 2002, p. 21). In order to close the ever-widening gap between recent massive changes of society and the unchanging design of education; a systems view needs to be applied which is “simultaneous, all-over, whole-system” approach rather than, “incremental-piecemeal, disjointed, part-oriented, inside-focused” approach (Banathy, 1995, p. 13). A systems perspective is practical for different scales of design education. Where it can be applied for restructuring universities or redesigning a department’s curriculum; it can also be used as an intellectual tool, a skill-set in design studio projects.

Designers, previously working on physical, one-off product design projects, mostly needed hard skills, like craftsmanship skills. Today, with the expansion of the design field and the fact that many of the design problems have become more complex and abstract; soft skills such as inter-personal skills became more important. Organisations such as NASAD, AIGA, and IDSA periodically updates and assesses information about which competencies are required for industrial designers. At the AIGA Designer 2025 conference in October 2017; a summary draft document was shared outlining 7 trends which have significance for the future of design. These trends include embracing complexity, being resilient, making sense in the data economy, bridging digital and physical experiences, taking responsibility of design outcomes. All of these trends indicate that in the very near future designers and design companies will need to have more systemic capabilities in order to survive in the global context. NASAD also regularly lists competencies for industrial design programs. In its 2017/2018 handbook, it defines industrial design discipline as:

Industrial designers create and develop concepts and specifications that optimize the function, value, and aesthetics of products, environments, systems, and services for the benefit of user, industry, and society. Industrial design involves combinations of the visual arts disciplines, sciences, and technology, and requires problem-solving and communication skills... The titles product design, process design, and systems design normally refer to areas encompassed by the profession of industrial design.” (NASAD, 2017)
NASAD standards and guidelines specific for industrial design programs summarized below:

1. **Curricular Structure:** design courses 30-35%, supportive courses 25-30%, design theory & history 10-15%, and general studies 25-30%

2. **General Study Recommendations:** Students should be able to make connections with the physical and natural sciences, the social and behavioural sciences, quantitative reasoning, and the humanities.

3. **Essential Competencies:** Ability to design products and systems, understanding how they are related to environmental and social issues, ability to use representation tools and technologies, design history knowledge, ability to research-define-conceptualize-evaluate-test design solutions, user experience (UX) knowledge, professional practice knowledge, communication skills, basic business practices knowledge, collaborative skills, working in inter-trans-disciplinary teams.

Essential Competencies in NASAD’s last report for industrial designers involves designing for social and environmental problems and systemic design skills such as working in transdisciplinary team projects. Social and environmental problems are among the priorities of designers today. These problems are inherently beyond the individual designer’s intervention area; it requires a transdisciplinary approach. Within the framework a cause people from different disciplines, and also the ones who are not involved in any discipline; collaborate to perform beyond the limits of their knowledge. This new way of working requires different modes of understanding and behaviour than individual design.

Along with the evolution of design trends and core competencies for industrial design education; design methods also have been advanced to more meta-design approaches. This progress has been portrayed by Bousbaci (2008) as 3 generations of design methods. Peter Jones (2014) added the fourth (generative) generation to his description and illustrated the 4 generations of design methods as in Table 1:

<table>
<thead>
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<th>Generation</th>
<th>First</th>
<th>Second</th>
<th>Third</th>
<th>Fourth</th>
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<tr>
<td>Methods</td>
<td>Movement from craft to standardized methods</td>
<td>Instrumentality, Methods customized to context</td>
<td>Design research and stakeholder methods Design cognition</td>
<td>Generative, empathic &amp; transdisciplinary</td>
</tr>
<tr>
<td>Systems influences</td>
<td>Sciences, Systems engineering</td>
<td>Natural systems, Hard systems</td>
<td>System dynamics, Social systems, Soft systems</td>
<td>Complexity</td>
</tr>
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From this list, we can see that system theories have a significant influence on the underlying intellectual frameworks of the four generations of design methods. These generations help us to observe evolution in the design field more holistically. Similarly, different four-tier matrices illustrate the expansion of the design field and the whole scene in a more systemic way. One of the first four-tier approaches explaining the evolution of design is Buchanan’s fourth order design matrix (1992). In this matrix, Buchanan sorts design into four broad areas namely; communication (signs & images), construction (physical objects), strategic planning (processes & services) and systemic integration (systems & environment). These orders represent the broad areas in which design is explored in the twentieth century; they are areas where designers continue to focus and reinvent their professions to meet new opportunities and circumstances (Buchanan, 1998). For creating an innovation, a designer must change placements and adopt to the required set of skills and complexity level of each domain.

The NextD Leadership Institute also has a version of the Orders of Design (van Patter, 2009). Ranging from Design 1.0 to Design 4.0; names of these domains are traditional design, product/service design, organizational Transformation design, and social transformation design. As you climb further up the orders, the complexity of the design problem and the skill-set required to interfere with this problem increases. They call their expertise as “other design thinking” and claim that today much of the design community including graduate and post-graduate design education remains focused on design 1.0 and 2.0. Here, each order resembles a system boundary as in the system theory principles.
However, they are not completely isolated from each other. Indeed, they are interconnected, transitional parts of a bigger whole and while going higher, they morph into new expressions and services within an integrated context.

Systemic design is concerned with third and fourth orders including socio-technical, political, environmental, organizational contexts. Merging design thinking skills (human-centred skills, generative methods, visualization techniques) with system thinking perspective; system design can reach higher orders - wicked problems. A systemic perspective enables designers to see situations from multiple angles and levels, to work collaboratively with many people from different disciplines, to identify references/borders and to develop a road-map in complexity. These skills are different from those that are required by a solo designer working on a small project which belongs to the first two orders. First order design projects require product design skills and are mostly about craftsman practices. Second order includes service design and human-centred research methods. Third order involves organisational change, management of sub-systems in an organisational boundary. The last, fourth order projects aim social and environmental change without pre-defined boundaries.

Knowing and differentiating the required competencies in each order; can provide an operational framework for restructuring design curricula and design programs. It can inform design educators about the quality of their lecture and help them to close the gap between their pedagogical practices with the latest trends in the design field. This paper proposes a competency domain model to guide which competencies should be taught in industrial design education. This model can be used for the evaluation of the education given in a specific design program, as well as facilitating communication and comparison between the different design departments.

4 Competency Domain Model and Design Education in Turkey

A competency is the capability to apply or use a set of related knowledge, skills, and abilities required to successfully perform critical work functions or tasks in a defined work setting. A competency model is the collection of competencies that together define successful performance in a particular work setting (DOL, 2015). Competency models can be tailored for specific jobs and professions. They may include general skills such as problem-solving or critical thinking as well as particular technical skills for a specific profession. The competency domain model (CDM) is developed by classifying NASAD’s essential competencies for industrial designers, and latest trends in design; with the help of four order schema proposed by Buchanan (1992) and van Patter (2009). This categorization systematically presents the appropriate design competencies required to undertake design problems in different complexity scales. It has been developed as part of an ongoing doctorate study, in order to diagnose the current status and scope of undergraduate industrial design education programs in Turkey. As a full member of the Bologna process since 2001 (Ehae, 2016), higher institutions in Turkey offer education in accordance with international qualifications and standards. If we consider Turkey as a case, this proposed model can also be applied by other industrial departments offering education in international standards.

In order to pave the way for the reforms in design education, the first step that should be taken is the diagnosis of the current situation. There are 26 industrial design departments in Turkey. We contacted the department heads of these departments and asked them to participate in the online survey. 15 of them returned to the survey, and their answers were evaluated in the next phase. The survey consists of 4 sections in total, and only the designer competencies section is shared in this paper. Part of the survey layout is shared in Figure 1 and the complete list of the designer competencies in that section with four competency domains is shared in Table 2.

![Figure 1. Part of the survey layout](image-url)
First domain competencies are fundamental technical skills constituting industrial design profession from the beginning. The 2nd domain covers behavioural sciences and human factors in design. Systemic design gets involved in the 3rd and 4th domains where design problems become too messy and hard to approach by a linear analytical approach.

### Table 2. Competency Domain Model (CDM) proposed for industrial design education

<table>
<thead>
<tr>
<th>Competency Domain Model (CDM)</th>
<th>Technical &amp; form creating skills (hard-skills)</th>
<th>Service &amp; experience design skills (soft-skills)</th>
<th>Strategic decision making skills (Management skills)</th>
<th>Systemic design skills (Change-making skills)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Technical &amp; form creating skills (hard-skills)</strong></td>
<td>Production techniques &amp; material selection: Proposing appropriate materials, and production, joining, finishing processes</td>
<td>Human-centered design (HCD) research: Familiarity with HCD research methods such as conducting a field research...</td>
<td>Organizational culture &amp; design management: giving managerial design decisions: branding strategies, processes, resources, time &amp; budget planning, etc.</td>
<td>Complexity &amp; interconnected systems: Recognition of the complexity of contemporary problems, understanding web of interconnected socio-economical, environmental and political systems</td>
</tr>
<tr>
<td></td>
<td>Representation tools &amp; technologies: Ability to work with 2D and 3D communication tools</td>
<td>Service system design: Ability to design integrated combination of products, services, experiences, and interactions</td>
<td>Corporate identity &amp; marketing strategies: Designing visual identities in accordance with the corporate values, identifying organizational opportunities and developing real-life marketing strategies, new business models</td>
<td>Sustainability &amp; social impact: Considering social impact and sustainability aspects of their design</td>
</tr>
<tr>
<td></td>
<td>Workshop practice &amp; prototyping: Creating incremental prototypes, sample models for testing design concepts</td>
<td>Participatory design: Designing collectively with different kinds of stakeholders</td>
<td>Meta-design methods: Identifying and visually mapping complex relationship in nested systems, such as giga-mapping</td>
<td>Interdisciplinary collaboration: Experiencing values and modes of working with different disciplines for effectively handling complex design problems</td>
</tr>
</tbody>
</table>

The department heads were asked to evaluate which of these competencies are covered within the design education given in their departments and to mark the appropriate options. Options are presented as: included in compulsory courses/ included in elective courses/ not included in the curriculum/ in the planning process. In the survey, multiple marking options were provided considering some competencies may be covered by compulsory and elective courses at the same time. Elective and compulsory courses are deliberately presented in two separate options. The reason for this is to be able to understand how much attention is given to each skill, and which of them are planned to be taught consciously. Elective courses are generally not offered regularly in every semester, student capacities are also less compared to compulsory courses. Some electives are opened even though they are not intended to be in the curriculum only because that subject is the expertise of an academic in that department or just to be able to offer more electives. Most of the students graduate without attending the elective courses shared in a department list.

Instead of using the 1-5 Likert type scale which is widely used for scaling responses in survey research, four different options are specified for explaining different modes of pedagogic planning. Thus, every option expressing a specific plan and awareness. “In the planning process” option is important for example, since curriculum revisions take time and changes in the design field cannot be immediately implemented to the design education and some competencies may be in the planning process. Even if they are not included in the curriculum right now, this option is the indication of this department is moving towards that direction. Planning to teach a certain competency in the near future reveals that; there is an existing awareness and intention within that domain, and therefore it’s important data to consider.

### 5 Results and Discussion

In order to verify and enrich the data obtained from the survey study; curricula of industrial design departments in Turkey are also examined within this research. The total course load in 4-year design programs in Turkey is 240 ECTS (European Credit System) in total. When the curricula were examined, an average 25% of these courses are elective courses, and 75% are compulsory courses. The majority of compulsory courses are studio projects, while the rest are other professional courses, summer practice, and general studies. Specialization fields of academic staff have an effect on the selection of elective course subjects. Looking at the overall state of design curriculums, except a few elective
Competency Domains for Systemic Design Education

Courses or some design projects conducted with a specific lecturer’s initiative, there is no structured novelty. Competencies at the 3rd and 4th domain, which also covers systemic design principles, and service system design skills in the 2nd domain are taught embedded in different courses.

Competencies in the 1st and 2nd domains involve the rational and pragmatic approaches of the 60s and 70s, which form the basis of industrial design discipline. These competencies, which are the sine qua non of the industrial design discipline as we used to know, are taught within compulsory courses in all departments as seen in Figure 2, and some are also repeated in electives. HCD research and service system design competencies in the 2nd order correspond to the phenomenological approaches of the 1980s. From the results, it is seen that 2nd order competencies are taught by a smaller number of universities in compulsory courses. When the results are compared in Figure 3 with the department curriculums; it is seen that there is at least one compulsory course opened with a similar name for each competency in the first order:

- **Production techniques & material selection**: manufacturing materials, materials & production, computer aided manufacturing, etc.
- **Representation tools & technologies**: design communication, computer literacy in design, computers in design, product visualization, technical drawing, etc.
- **Workshop practice & prototyping**: elementary workshop practice, model making, prototyping etc.

In the second domain, HCD research is being taught as a separate course in most of the departments. On the other hand, when we look at the department curriculums, we see that there is no separate course in service system design subject except for two design departments (Interaction design for products and services: must course, service design project: elective course). This indicates that service system design is not intended to be taught as a priority in design...
education, and is not regarded as important as the competencies in the first domain. Indeed, Service system design principles are mentioned in different courses and embedded in different design projects.

When we come to the 3rd and 4th domains containing systemic design approaches, we see that the answers of ‘included in compulsory courses’ have decreased. The competencies related to design management and corporate identity in the 3rd domain are taught by most of the design departments within compulsory courses. When we review department curricula, we can see that there are special courses such as introduction to marketing and introduction to management related to these competencies. On the other hand, participatory design (also known as co-design) which is an essential tool for effectively working in the 3rd order, is only taught in 3 departments as a compulsory course. This may be due to the difficulty of planning, implementing and monitoring participatory design practice in a formal educational setting. Actively involving different stakeholders to the design process, instead of individual design activity where every design student creates their own ideas, is contradictory to the grading system at the universities in some point.

In the curriculums of these industrial design departments, there is no separate course offered relating to 4th order competencies, except for sustainability & social impact. Sustainability and social impact subjects are taught only in one industrial design department as separate compulsory courses (namely: sustainability in design, social responsibility). Apart from these courses, all of the competencies in the fourth order are taught embedded within the other courses. For instance, interdisciplinary collaboration is carried out within the framework of product design project in collaboration with another department at the same faculty (e.g. furniture design project with interior design department). For interdisciplinary projects outside of the same faculty, the food design project with the food engineering department and yacht design project with naval engineering can be shown as examples. All of the interdisciplinary projects in industrial design programs (except from one special case) are carried out with two disciplines in the frame of the predetermined product concept. In the current university structure planning and conducting a realistic and organic interdisciplinary study (arranging formal procedures, relationships, grading system, assigning and monitoring tasks for different actors) is a wicked problem itself.

6 Conclusion

Systemic design is a significant approach, which provides a holistic perspective to tackle contemporary social problems. It offers a rich variety of tools for educating future designers as agents of change. It’s important to monitor these latest tools and trends in design and to integrate them into design education for updating the instrumentality of the design discipline. The competency domain model proposed in this paper can be used as a guiding tool in this integration. This model systematically categorizes the essential design competencies in four different domains. It can be used to measure the current state of education in a specific design program, as well as to facilitate communication and comparison between different departments. In the scope of insider knowledge, the results of research conducted with 15 design departments in Turkey is shared in this conference paper. This research can enable us to grasp what is the current status of design in the national context, and what are the benefits of implementing the same research in the international design programs.

For professional industrial designers, keeping up with changes and maintaining their competitiveness under changing market conditions is habitual behaviour. In contrast, it appears that the senior faculty members or industrial design educators that have remained with a single university for an entire career make fewer job changes and repeatedly teach fundamental or core content; they have few opportunities to innovate through leading-edge contemporary design problems (Kenneth et al., 2009). This can be seen as the reason why industrial design education continues to be taught almost unchanged since the first years of its establishment. Another issue effecting the quality of design education is the university structure itself and industrial education paradigms. Learning spaces, systems of hierarchy, grading systems, and different actors and systems in and outside of the university have an effect on this condition. To be able to thoroughly teach design competencies in the 3rd and 4th domain, changes in the curriculum will not be enough; fundamental educational paradigms need to change. In the current educational setting; teaching complexity and interconnected relationships, interdisciplinary and transdisciplinary design can just be carried out in an unrealistic simulation manner. It is hoped that assessment frameworks such as competency domain model presented in this paper will contribute to the educational reforms in the design field.

References

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Application of QFD and AHP in Curriculum Planning of Industrial Design Education

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Abstract: Industrial design is to formulate innovation, promote business success, and hence to offer a better life. It is a design activity that applies strategic process of problem solving in the design of products, systems, services and experiences. It is interdisciplinary, and should be coordinated with the needs of the enterprise due to the development of times. However, it lacks a scientific method in the process of curriculum planning, causing professional competencies of graduates failing to meet with company expectations. From industrial and academic perspectives, the requirements for industrial designing talents are listed. By Analytic Hierarchy Process (AHP), we can acquire the ratings of professional competencies, and analyse them into the professional capabilities that should be mostly addressed in curriculum planning. The use of the AHP method establishes decision-making patterns in a reasonable manner, making complex problems systematic, by decomposing into levels. Also, by means of quantification, the weight of importance degree concerning expertise of industrial design is obtained and sequenced, facilitating the process of curriculum planning in terms of identification of expertise favourable to students. Lastly, QFD is applied to the planning of industrial design curriculums that comply with the requirements of enterprise and society development, bringing forward the courses and disciplines which should be strengthened and attached with great importance among students in current industrial design curriculums. Such research is favourable to the promotion of conformance in curriculum planning with actual needs, enabling actual utilization of school lectures, meanwhile offering a scientific technique for education curriculum reforms.

Keywords: industrial design; curriculum planning; quality function deployment (QFD); analytic hierarchy process (AHP); scientificity
1 Preamble
The primary task of design education is to guide learners to establish advanced scientific concepts and values, and to foster creativity, innovation and entrepreneurship. Industrial design is an interdisciplinary subject, which links innovation, technology, business, research and consumers closely, and jointly conducts creativity activities. It visualizes problems and proposals, deconstructing problems, taking it as an opportunity for building better systems, making better products, rendering better services, formulating better experiences and business networks, providing new values and competitive strengths. With the rapid development and diversification of the design industry, the needs for professionals are increasing each year, thus causing the need for colleges and universities to take into consideration the requirements of enterprises when planning the curriculum, making textbook knowledge and expertise more aligned to actual work. The current conceptualization of scientific research in education and the complexity of conducting research in special education settings underlie the development of quality indicators. At each stage, different research questions are relevant, and different research methodologies to address the research questions are needed (Odom & Harris, 2005). During the last 15 years, design education has also evolved from academic focuses to those that are more real-life design project oriented (Pahl & Beitz, 2013). Design education focuses on teaching students how to do the design. The design courses could be offered from freshman to senior year at universities depending on the curriculum requirements. The key point in design education is to learn how to design. On the other hand, industrial focus in design of products and systems is design itself (Tomiyama & Kimura, 2009). The professionals are the core of industry competitiveness which largely depends on the curriculums taken in the course of education. The qualifications for industry design jobs are useful information to students to select courses in order to be prepared for a future professional career. Such information is also useful to design professionals for reviewing their own competencies. Furthermore, it is also useful to employers for hiring or promoting industrial designers (Yeh, 1999). Design educators and professionals are always concerned with the issue of industrial designers’ competencies. However, the quality of industrial design (ID) graduates is not regarded as up to a level expected by employers (Kaufman, 1998), and there seems to exist a gap between what students learn at school and what they are required to do in practice after graduation (Ball, 2002). There is little updated information about the current job market for ID employment, and ID students are not well prepared with the knowledge and skills required for employment when they graduate. The possible reasons for the ID graduates’ lack of relevant qualifications could be as follows. First, the extent and content of industrial designers’ work are currently different from those in the past, but there is little updated information about industrial designer employment in the job market. Therefore, before they graduate, ID students are not well equipped with the knowledge and skills required for employment. Finally, industrial design programs in universities recruit students with diverse backgrounds from senior high schools. As a result, the ID students’ abilities, aptitudes, and career goals may vary considerably (Yang & Chen, 2005). A web-based survey found that practitioners are not as concerned about graduates’ possessing specific technical skills as they are about them possessing a systems view of organizations and value streams (Fiedler & Mathieson, 2009). Therefore, a systematic curriculum planning which centers on company requirements, will ensure the conformity of design education with actual needs in employment, benefiting both the enterprises and the students.

Quality Function Deployment (QFD) is a method for introducing quality right from the design stage to satisfy the customer and to transform customer requirements into design objectives and key points that will be required to ensure quality at the production stage (Akao, 1993). QFD appears to be a methodological tool geared for supporting greater ergonomics consideration in product design because its aims are to safeguard customer needs throughout the design process, to promote communication between design actors (engineers, ergonomists, users, etc.) and to highlight possible contradictions between the various design parameters. QFD approach is based on deploying user expectations (the Whats) in terms of design, and production-related parameters (the Hows) for the new product. This process is represented by a succession of double entryWhats/Hows tables allowing the correlations between entries to be identified and prioritized. The first matrix, also referred to as the house of quality (HOQ), is the most recognized form of QFD. In addition toWhats/Hows correlations, this matrix allows the integration of elements related to analysing product competition and identifying synergies and/or contradictions between different product characteristics. Thus, this matrix offers the twin advantage of facilitating the transition between the world of the user and that of the designer, and of combining in the same document all effective data for decision-making in relation to product development (Marston, 2005). The purpose of QFD is to ensure that the voice of the customer is incorporated into the design and delivery of a product or service. The process ensures that customer requirements, expressed in their own terms, become the basis for the definition of product or service quality. The quality of the study program and of the course as products with value on the competitive educational market, which have to meet the requirements of internal and external customers and stakeholders, QFD is held as the core, for the planning of curriculums and class hours (Crisan & Enache, 2011). Many researches have adopted the integration of QFD with other methods, to explore into the subject of curriculum design and planning. Capabilities and opinions of students
are deemed as requirements, converted into weight in curriculum designing, to acquire a positive outcome of curriculum planning (Koksal & Egitman, 1998).

QFD has been used in a variety of different settings within higher education (Quinn & Johnson, 2009). QFD implementations (mostly in academic/curriculum settings) are seen both in the United States and abroad (Mazur, 1996). The application of QFD in curriculum planning, gathering of opinions from enterprise and students, and their conversion into weight and restrictions in curriculum planning and designing, lead to positive outcomes that conform with expectations.

Analytic Hierarchy Process (AHP) was first proposed by Myers and Alpert (1968) and further developed for application in Wharton School of Business (Saaty, 1980). AHP is basically a measurement theory based on priority values obtained from pairwise comparisons between criteria and alternatives (Yılmaz, 1999). AHP method has ability to process subjective data gathered from user interviews, enabling the users to be placed at the centre of the design process. The reasons for applying these methods in the industrial design process are for increasing the accuracy of decision making (Özsoy & Yılmaz Özsoy, 2018). In AHP, the relation between the decision processes is unidirectional and the overall process is comprised of three steps. For the solution of the problem, first a hierarchical structure is formed (An & Kang, 2007). Then a pairwise comparison matrix which determines the priorities in terms of the relative importance values of the criteria is calculated (Basak, 2002). Saaty’s Eigenvector method is used to calculate the relative importance values (Garcia & Lamata, 2009). Then the consistency of the values in the matrix is checked by calculating the consistency ratio (Chou & Hsu, 2008). If the consistency ratio is between acceptable limits, the process continues with assessing the priorities of the alternatives to see which of the alternative has the highest priority, therefore is the most successful. This research with application of AHP has advantages in group decision-making and existing defects, studying into the topic of how to conduct decision-making among designer professional competencies acquired by sorting. In this research, requirements of enterprises on professionals of industrial design is translated into the goal of curriculums, in line with enterprise requirements, and one systematic curriculum for industrial design is drafted for the reference of enterprises and academic communities.

2 Requirements on Professional Competencies of Industrial Design

With the expansion of the range of industrial design, innovation, technology, business and aesthetics are introduced into industrial design. To clearly locate the definition, nature and functions of industrial design, the definitions from home and abroad are sorted and listed in Table 1.

<table>
<thead>
<tr>
<th>Organization</th>
<th>Definition of Industrial design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial Designers Society of America</td>
<td>Industrial Design is a strategic problem-solving process that drives innovation, builds business success, and leads to a better quality of life through innovative products, systems, services, and experiences. <a href="http://www.idsa.org/news/dblog/what-id">http://www.idsa.org/news/dblog/what-id</a></td>
</tr>
<tr>
<td>The World Design Organization (WDO)</td>
<td>Industrial Design is a strategic problem-solving process that drives innovation, builds business success, and leads to a better quality of life through innovative products, systems, services, and experiences. <a href="https://wdo.org/about/definition/">https://wdo.org/about/definition/</a></td>
</tr>
<tr>
<td>China Industrial Design Association</td>
<td>Design is a creative process, and it is a key factor that enables interaction of culture and business. <a href="https://wenku.baidu.com/view/58e8566729ea81c75f5f61f7b7360b4c2e3f2aae.html">https://wenku.baidu.com/view/58e8566729ea81c75f5f61f7b7360b4c2e3f2aae.html</a></td>
</tr>
<tr>
<td>Ministry of Industry and Information Technology, People’s Republic of China</td>
<td>Industrial design is a creative activity that targets mass production, achieving conformity shape and internal quality to meet with users’ requirements. <a href="http://www.chinatax.gov.cn/n810341/n810765/n812161/n812547/c1084968/content.html">http://www.chinatax.gov.cn/n810341/n810765/n812161/n812547/c1084968/content.html</a></td>
</tr>
<tr>
<td>Chinese Academy of Engineering</td>
<td>Design is assumption and planning towards innovation, it is the key link and pioneer for China creativity. Creative design promotes manufacturing and service, gains trust of users and market advantages and creates values. <a href="http://www.cae.cn/">http://www.cae.cn/</a></td>
</tr>
</tbody>
</table>

Industrial designers should possess basic know-how from front end development, market research, product development process, manufacturing and sales, management and communication skills. In the training process of industrial designers, the essential elements must include: 1. Art, 2. Engineering, 3. Economy, 4. Humanities (Gordon, 1945). Design thinking has received a lot of attention in engineering, architecture, and design majors in universities.
because it can change how people learn and solve problems (Dym & Leifer, 2005). Students are educated to become designers capable of designing products and services on a global level integrating a broad spectrum of disciplines as aesthetics, ergonomics, manufacturability, market considerations and sustainability (DUT-IDE, 2003-2004). In order to become successful future designers, they need to have at their disposal both domain-specific knowledge and general (domain-independent) procedural knowledge of the design process itself (Venselaar & Drunen, 1987). The capabilities mostly needed by industrial designers are: computer-aided industrial design, problem solving, marketing strategies, creativity, proactive and extra care, communication and coordination, foreign language competency, market research and analysis, international vision, designing and molding, structural design, designing conception development, and product planning (Yeh, 2003). The industrial designers focus on developing new product concepts to challenge and complement strategic businesses. The industrial designer should possess the ability of awareness, imagination, creativity, visualization and coordination (Takesue, 2000). Many previous studies have been conducted to identify the required competencies of industrial designers. Most of them are based on such a general or extensive perspective that the amount of required competency sums up from 43 to 60 items. In the recruitment of industrial designers, the top five aspects worthy of attention are: creativity, molding ability, quality, observation, and aesthetic quality literacy (Hsu & Yang, 2007).

3 Research Process

Industrial designers play a key role during the new product design and development stages of enterprises, and are a key human resource (Baxter 1995). Therefore, professional competency in industrial design is of key importance. This research establishes decision-making pattern by adopting AHP method, making complex problems systematic, composing levels. And by quantification, weight of importance degree concerning competency of industrial design is obtained and sequenced, facilitating identification of expertise favourable to students the process of curriculum planning. Furthermore, QFD is applied to draw out curriculums that are more in line with requirements of social and corporate development, setting out those which shall be attached with emphasis and great efforts.

3.1 Gathering of Documents and QFD Application

Sort a large amount of industrial design-related literature at home and abroad, and develop the professional competence indicators of industrial design based on domestic publications, including the disciplinary knowledge about industrial design, professional ability and basic attitude.

3.2 Setting the Professional Competency Index

From above, the following eight aspects and 21 indices regarding industrial designing competencies are derived and listed in Table 2.

<table>
<thead>
<tr>
<th>Competency aspect</th>
<th>Professional competency index</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Aesthetic literacy</td>
<td>1.1 Plane and 3D appearance, molding ability</td>
</tr>
<tr>
<td></td>
<td>1.2 Grasp on trends of fashion</td>
</tr>
<tr>
<td></td>
<td>1.3 Acuity on visual analysis</td>
</tr>
<tr>
<td>2. Designing Expression</td>
<td>2.1 Embodiment of abstract concept</td>
</tr>
<tr>
<td></td>
<td>2.2 Envision from multi-dimensional perspective</td>
</tr>
<tr>
<td>3. Creativity</td>
<td>3.1 Creative thinking</td>
</tr>
<tr>
<td></td>
<td>3.2 Proactivity and optimism</td>
</tr>
<tr>
<td></td>
<td>3.3 Team work</td>
</tr>
<tr>
<td>4. System Integration</td>
<td>4.1 Systematic organization</td>
</tr>
<tr>
<td></td>
<td>4.2 Problem-solving</td>
</tr>
<tr>
<td></td>
<td>4.3 Communication skills</td>
</tr>
<tr>
<td></td>
<td>4.4 Inter-disciplinary knowledge</td>
</tr>
<tr>
<td>5. Engineering Competency</td>
<td>5.1 Knowledge of manufacturing process</td>
</tr>
<tr>
<td></td>
<td>5.2 Application of materials</td>
</tr>
<tr>
<td></td>
<td>5.3 Structure designing and principle</td>
</tr>
<tr>
<td>6. Computer Skills</td>
<td>6.1 2D Computer program skills</td>
</tr>
<tr>
<td></td>
<td>6.2 3D Computer program skills</td>
</tr>
<tr>
<td>7. Human Machine Knowledge</td>
<td>7.1 Human-machine knowledge</td>
</tr>
<tr>
<td></td>
<td>7.2 Five senses analysis</td>
</tr>
<tr>
<td></td>
<td>7.3 Culture factor</td>
</tr>
<tr>
<td>8. Language</td>
<td>8.1 Foreign Language Acquisition</td>
</tr>
</tbody>
</table>
3.3 Expert Evaluation for Weighing Competency Indexes Using AHP Method

The goal of AHP development is to make complex problems systematic, decomposing it into varied levels, making it easy for comparative and quality reviews. Furthermore, with determination through quantification, it offers proper options to decision makers and reduces risks of wrong decisions.

Framing of target problems

Framing the scope of research matters. Mainly it is two steps in this phase, information collection and confirmation of research matters. In the former part, literature reviews by professional industrial designers are carried out, brain storming methods of professionals are applied, together with the collection of problem nature, range, and influence. The latter is to determine the purpose of the problem and analysis, and to formulate alternative plans.

Formulating architecture

Firstly, evaluation criteria, sub-criteria, and an alternative plan are identified through three instruction committee members of higher education. Secondly, through group decision-making, the preliminary architecture undergoes additions and omissions, group members determine the binary relations among per each two elements, the architecture of the whole research is formulated.

Forming a pairwise comparison matrix, calculating weight of each element

In order to establish the paired comparison matrix, the importance of the relative elements should be known. In the determination of relative importance degree of each sub-element, scale of 1-9 is applied, elements of sub-level are compared with each one (Ej= 1, ...,n), by comparison of Ei and Ej, we acquire aij, and pairwise comparison matrix A=[aij], value of which is n×n, i,j= 1,....,n;

\[
A = \begin{bmatrix}
1 & a_{12} & \cdots & a_{1n} \\
1/a_{12} & 1 & \cdots & a_{2n} \\
\vdots & \vdots & \ddots & \vdots \\
1/a_{1n} & 1/a_{2n} & \cdots & 1
\end{bmatrix}
\]

After the comparison matrix is established, the eigenvalue can be solved by the geometric mean value standardization method of column vectors commonly used in numerical analysis to obtain the eigenvector value, and then the weight of elements at each level can be obtained, as shown in the formula:

\[
W_i = \left( \prod_{j=1}^{n} a_{ij} \right)^{1/n} \quad i, \quad j=1,2, \ldots, n \quad (1)
\]

Testing of hierarchical consistency

After completion of each pairwise comparison matrix, consistency is to be met (X>Y, Y>Z, then X>Z). Due to the various elements and hierarchies, it is hard to reach consistency in two-two comparison for decision makers. Therefore, consistency testing among numeric values is required to test consistency index. After calculation of vector, to find out consistency prior and post determination, calculation of C.I. value is required; the formula is as follows:

\[
C.I. = \frac{\lambda - n}{n-1} \quad (2)
\]

From the formula we conclude, \( \lambda \) value is the precondition for CI (Consistency Index). Therefore \( w \), as acquired from above is applied to obtain consistency vector (symbolized by \( y \)), and \( \lambda \) value; the formula is as follows:

\[
y_i = \left( \sum_{j=1}^{n} w_j a_{ij} \right) / w_i \quad i, \quad j=1,2, \ldots, n \quad (3)
\]
After obtaining consistency vector, arithmetic mean of $\gamma$ is calculated to obtain $\lambda$ value, the formula of which is:

$$\lambda = \frac{\sum_{i=1}^{n} \gamma_i}{n} \quad \cdots \cdots \quad i = 1, 2, \cdots, n$$

(4)

Lastly, from $\lambda$ value, value of CI is captured; $\text{CI} = 0$, meaning absolute consistency between prior and post determination. Saaty (1980) suggests that in the case of $\text{RI} < 0.1$, a favourable consistency is manifested. From positive reciprocal matrix derived from evaluation 1-9, under varied levels, different CI values are generated, and are named as Random Index (R.I.). The ratio of CI values to RI is named as Consistency Ratio; CR, i.e:

$$\text{C.R.} = \frac{\text{CI}}{\text{RI}}$$

(5)

In the case of CR value being less than 0.1, the consistency level of matrix is high, the random index value is as follows (Table 3):

<table>
<thead>
<tr>
<th>Order</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>RI</td>
<td>0</td>
<td>0</td>
<td>0.58</td>
<td>0.90</td>
<td>1.12</td>
<td>1.24</td>
<td>1.32</td>
<td>1.41</td>
<td>1.45</td>
<td>1.51</td>
<td>1.48</td>
<td>1.56</td>
<td>1.57</td>
<td>1.58</td>
<td></td>
</tr>
</tbody>
</table>

After gaining of weight of each hierarchy, the most bottom alternatives apply the sequence set forth above to get the weight and CI and CR value for determination of consistency. The final evaluation calculation is set out as below:

$$S_i = \sum_{j=1}^{r} w_j a_{ij} \quad \cdots \cdots \quad i = 1, 2, \cdots, n; \quad j = 1, 2, \cdots, r$$

(6)

In the second reviewing sequence (X1, X2, …, Xr), weight is acquired and is represented by $W$; in the third alternative (P1, P2, …, Pn), the relative importance level of each scheme is acquired and represented by $\alpha$; therefore, if there are $n$ alternative solutions, and $j$ evaluation items under each solution, with the weight of each item represented by $w_j$ (j is subscript), then the total evaluation score $S$ of each solution is equal to the weight of each item multiplied by the evaluation value of each solution, as shown in the formula 6.

3.4 Research Implementation and Results

3.4.1 Expert Interviews

This research invites three experts from Ministry of Education of the People's Republic of China's subordinate unit (http://www.moe.gov.cn/). Its name is Steering Committee on Design and Teaching in Colleges and Universities. The research evaluates industrial design expertise as a team of experts.
Interview time is November 28th, 2018; the location of interview is Hangzhou City, and the form of interview is expert questionnaires (Figure 1). According to the results derived from discussions over documents, it is concluded that industrial designers should possess eight aspects of skills including aesthetic literacy, design representation, creativity, systematic integration, engineering competency, computer skills, human-machine knowledge and language proficiency, and 21 indexes for these. Structural plane and indicator are adopted into the questionnaire, presenting to experts for selection through Likert scale method. Also, questionnaires of three experts are collected for statistical data. Professional competency aspects and weight of index are calculated by AHP method.

3.4.2 Weight of Professional Competency Index of Industrial Designers
From the questionnaire of experts, comparison matrix is formulated, then the eigenvector and eigenvalue of the matrix is computed for the determination of consistency degree of matrix of each expert. Through consistency examination, the CR value is separately 0.05, 0.032, 0.044<0.1, conforming to consistency examination. The calculated weights are given in Table 4.

<table>
<thead>
<tr>
<th>Professional Competency aspects</th>
<th>Weight</th>
<th>Professional Competency Index</th>
<th>Sub-Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Aesthetic Literacy</td>
<td>0.146</td>
<td>1.1 Plane and 3D appearance molding ability</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.2 Grasp on trends of fashion</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.3 Acuity on visual analysis</td>
<td>0.05</td>
</tr>
<tr>
<td>2. Designing Expression</td>
<td>0.158</td>
<td>2.1 Embodiment of abstract concept</td>
<td>0.08</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.2 Envision from multi-dimensional perspective</td>
<td>0.08</td>
</tr>
<tr>
<td>3. Creativity</td>
<td>0.095</td>
<td>3.1 Creative thinking</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.2 Proactivity and optimism</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.3 Team work</td>
<td>0.03</td>
</tr>
<tr>
<td>4. Systematic Integration</td>
<td>0.193</td>
<td>4.1 Systematic organization</td>
<td>0.07</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.2 Problem-solving</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.3 Communication skills</td>
<td>0.03</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.4 Inter-disciplinary knowledge</td>
<td>0.04</td>
</tr>
<tr>
<td>5. Engineering Competency</td>
<td>0.097</td>
<td>5.1 Knowledge of manufacturing process</td>
<td>0.03</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.2 Application of materials</td>
<td>0.03</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.3 Structure designing and principle</td>
<td>0.03</td>
</tr>
<tr>
<td>6. Computer Skills</td>
<td>0.123</td>
<td>6.1 2D Computer program skills</td>
<td>0.03</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.2 3D Computer program skills</td>
<td>0.09</td>
</tr>
<tr>
<td>7. Human-Machine Knowledge</td>
<td>0.134</td>
<td>7.1 Human-machine interface knowledge</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7.2 Five senses analysis</td>
<td>0.03</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7.3 Culture factor</td>
<td>0.03</td>
</tr>
<tr>
<td>8. Language</td>
<td>0.054</td>
<td>8.1 Foreign Language Acquisition</td>
<td>0.05</td>
</tr>
</tbody>
</table>

From the statistics above, systematic integration ability, designing expression, and aesthetic literacy are the top three. These are followed by computer skills, human-machine knowledge, engineering competencies, language, and creativity. In systematic integration, system organizing is rather important. In terms of design representation, abstraction of specific concept is the same as multi-dimensional perspective. In terms of aesthetic literacy, vision analysis acuity and plane and 3D appearance are relevantly more important. To improve aesthetic accomplishment,
quality of the curriculums should be improved. In terms of computer skills, 3D application is more important. In terms of human-machine knowledge, the human-machine interface knowledge score is high, and the human-machine interface emphasizes interaction and user-centeredness. In terms of engineering competency, the structure designing and principle is the most important. Language ability is an indicator of independence. In terms of creativity, weight of creative thinking is higher than the other indicators. To improve the creativity of students, more related courses need to be opened.

3.5 Curriculums of Industrial Design

The professional competence of designers was summarised, and the domestic authoritative higher education industrial design education curriculum system was referred to (RCU, 2013). Three industrial designers with designing experience of five years, all of whom are senior university lecturers are invited in discussion. Courses of the respective universities are collected and summarized in combination with courses and books published by the state. A total of 32 curriculums that are correlated directly to designing expertise are listed, as shown in Table 5.

Table 5. Weight of industrial design curriculum, importance level sorting

<table>
<thead>
<tr>
<th>Aspects</th>
<th>Curriculum</th>
<th>Importance level of curriculum</th>
<th>Importance level sorting</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Integration</td>
<td>Marketing &amp; Planning</td>
<td>1.51</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Specific Design</td>
<td>1.75</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Design Research</td>
<td>1.45</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Internship with Companies</td>
<td>1.27</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Graduation Thesis</td>
<td>1.93</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Works Portfolio</td>
<td>1.31</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Product Design</td>
<td>1.13</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>System Design</td>
<td>1.28</td>
<td>10</td>
</tr>
<tr>
<td>Design Expression</td>
<td>Sketch</td>
<td>1.48</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Constructive Design</td>
<td>1.01</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Expression Technique</td>
<td>1.39</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Layout Design</td>
<td>0.88</td>
<td>19</td>
</tr>
<tr>
<td>Aesthetic Attainment</td>
<td>Brand Aesthetics</td>
<td>1.62</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Chromatics</td>
<td>0.56</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>Art Review</td>
<td>0.61</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>History of Art</td>
<td>1.09</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Introduction to Design</td>
<td>0.82</td>
<td>20</td>
</tr>
<tr>
<td>Computer Application</td>
<td>Computer Graphics</td>
<td>1.89</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Interaction Design</td>
<td>0.59</td>
<td>25</td>
</tr>
<tr>
<td>Human-Factors</td>
<td>human factors engineering</td>
<td>0.96</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Sensory Design</td>
<td>0.79</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Culture and Creativity Design</td>
<td>0.89</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Cognitive Psychology</td>
<td>0.19</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Usability Design</td>
<td>1.07</td>
<td>15</td>
</tr>
<tr>
<td>Engineering Competency</td>
<td>Mechanical Graphics</td>
<td>0.68</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>Applied Electronics</td>
<td>0.13</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>Materials and Crafts</td>
<td>0.46</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>Physics</td>
<td>0.36</td>
<td>30</td>
</tr>
<tr>
<td>Language</td>
<td>English</td>
<td>0.58</td>
<td>26</td>
</tr>
<tr>
<td>Creativity</td>
<td>Creativity Development</td>
<td>0.50</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Designing Mindset</td>
<td>0.81</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Designing Methods</td>
<td>1.21</td>
<td>12</td>
</tr>
</tbody>
</table>
3.6 Relation Matrix in House of Quality

The relation matrix in this study is completed by three doctoral students. Relation matrix in house of quality is designated to illustrate the relevance degree between designing expertise and responding curriculums. In formation of quality house, professional competency of designers are spread out level by level, furthermore, importance degree \( k(i=1,2, \ldots, m) \) of relevant courses are viewed, the relation degree of the two relation matrices is shown by \( r_{ij} \). The relevance appraisal of this matrix is indicated as 9, 3, and 1 to reach a clear discrimination. Moreover, to distinguish relevance more easily, symbols are applied to indicate relevance, of which 9 means strong correlation, represented by symbol ●; 3 means medium correlation, represented by symbol ○; and 1 means weak correlation, represented by symbol △. A panel of QFD experts completed correlation matrix between professional competencies and corresponding curriculums by means of quantification and grading method. The importance degree \( h_i \) of the quality characteristics of relevant courses was calculated, and the importance degree of the quality characteristics of relevant courses was determined after being weighted as:

\[
h_j = \sum_{i=1}^{m} k_i r_{ij}
\] (7)

If the \( j \) item professional course is closely related to multiple design professional abilities, and these design professional abilities are relatively important \((k_i \) is larger), then the value of \( h_j \) is larger, and then the professional course is relatively important. The weight calculation results are shown in Figure 2. For instance:

\[
h(1.47)=0.07\times9+0.04\times1+0.03\times9+0.04\times3+0.04\times3+0.05\times3+0.05\times1+0.05\times1+0.04\times1+0.02\times1+0.03\times1.
\]

Figure 2. House of quality in curriculum planning of industrial design

3.7 Calculation of Curriculum Importance Level

The importance level of curriculum is the sum of matrix value multiples by importance level of competency aspect, listed in accordance with the values given in Table 4. The top 10 curriculums are as follows: 1) graduation thesis, 2) computer graphics, 3) specific design, 4) band aesthetics, 5) marketing and planning, 6) sketch, 7) designing research, 8) expression technique, 9) works portfolio, and 10) system design.

4 Conclusion

Through the above research process, centring the QFD method together with experts’ interviews using AHP, we learned about the company competency requirements, and the curriculums are therefore finalized. It concludes as follows: (1) In professional competency index of industrial design, through experts’ appraisals and AHP, the abilities
mostly required from the design students are: system integration, design expression, and aesthetics attainment. The other aspects are also of great importance, yet these three aspects are the factors that influence the work the most. In the field of training of students' professional competencies, these three aspects shall be attached with emphasis. Students of industrial design should put efforts in cultivating their capabilities of 3D computer programs, systematic thinking, materialization of abstract concept, and constantly improve their aesthetic literacy and ability to communicate with the society.

(2) This research applies the QFD method to locate the ten curriculums that conform to the needs of companies. Suggestions for college and university curriculum planning are: to increase the ratio of courses of graduation thesis, computer graphics, marketing and planning, works portfolio, orienting school teaching towards social needs, increasing conformance of curriculum with the market, enabling students to utilize school learning, and offering scientific techniques to curriculum reforms.

References

Application of QFD and AHP in Curriculum Planning of Industrial Design Education


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Qualities of Design Briefs for Studio Learning

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Abstract: The design brief is considered a pivotal component in studio-based learning, yet there is a paucity of studies on the student brief genre in design education research. This work seeks to contribute by examining brief qualities from a variety of relevant sources that can help tertiary educators name, define, frame, evaluate, and present student briefs. The paper draws from the scant but growing academic literature on this topic, as well as from textbooks and publications on professional practice and design competitions. A dozen qualities are articulated from the literature that shape the purpose, content and context of briefs. Of special interest are the affective qualities of briefs, the interplay between project outcomes, learning objectives and assessment criteria, and the degree to which student briefs are execution dependent. A research agenda concludes the paper to comprehensively study the effects of design briefs in studio-based learning.

Keywords: problem space; design projects; design tasks; reflective practice

1 The Brief Genre

Design briefs are used in multiple contexts and for a range of purposes, thus making it difficult to narrow down a cohesive definition. Briefs broadly refer to a type of memoranda used for establishing goals, principles, or rules of engagement and are especially relevant in the planning and management of projects ranging from advertising to construction. Creative briefs are used as a communicative tool between stakeholders to express basic information for creative projects including all areas of design. In design education at the tertiary level, the student brief refers to the document or hand-out prepared by teachers to operationalise the learning objectives typically in studio learning environments. Student briefs in design share some elements with those used in professional practice as well as with competition briefs and design tasks used in experimental studies of design activity. As this paper will illustrate, student briefs vary widely in nature, function, elements, formats, and usage in design education. However, it is broadly believed that design briefs play a pivotal component given that they are an instrument that shapes relationships and the learning experience in the studio.

Design briefs are deemed necessary in a range of project-oriented and practice-based pedagogies, including studio-based learning (Öztürk & Türkkan, 2006; Lee, 2009; Basa, 2010; Demirbaş & Öğüt, 2018). In such settings, the brief establishes a structuring of the process (Öztürk & Türkkan, 2006). The crafting of briefs is viewed as strategic in traditions such as Problem-Based Learning where efforts to identify suitable problem formulations for learning are still sparse (Jonassen & Hung, 2008; Hung, 2016). Design educators draw from intuition as well as from professional and
personal experiences to define and frame student briefs (Heller & Talarico, 2009). The brief genre remains largely under-theorised and is receiving increased attention from researchers (Hocking, 2014; Vasconcelos, Neroni & Crilly, 2018) as well as from professional practitioners (Barrett, Goulding & Qualter, 2013) and design educators (Heller & Talarico, 2009). Despite their widely assumed importance and general consensus over a few main characteristics (Sadowska & Laffy, 2017), significant variances are visible between disciplinary and individual styles (Bassett, 2014). In experimental studies of design ideation, the creation of briefs or tasks also varies significantly motivating efforts to better understand their effects and increase the validity of such studies (Sosa, 2018).

The work in this paper emerges from a dissatisfaction with the current ad-hoc usage of design briefs by educators and the paucity of research in this area that prevents informed dialogue and improvement strategies. Design educators are often left to replicate the practices and conventions that they were exposed to as students. Thus, limited opportunities exist to critically reflect, build and share knowledge about the nature and properties of student briefs. The paper presents a set of qualities for student briefs extracted from a variety of relevant sources including textbooks, professional practice and design competitions. The purpose behind eliciting these qualities is to help educators and researchers define, frame, evaluate and present briefs in more explicit, sophisticated, shareable and accountable ways. The paper closes with a tentative formulation of a comprehensive research agenda to advance our understanding and practice in this important area of design education.

2 Brief Qualities

This section presents a critical examination of current practices, guidelines, and, to a lesser degree, research findings, that provide evidence of the functions and characteristics of student briefs in tertiary education. This comprehensive examination applies an inductive lens to the topic given the lack of theoretical foundations in the academic literature. The voices of prominent design practitioners and design educators are instrumental to unfold the basic qualities of design briefs. Sources are quoted to inductively define these qualities and to tentatively explore the entailments, nuances, and in some cases the tensions and paradoxes that manifest. These sources were carefully selected for their diverse origins, professional credibility and academic rigour. The overlaps show agreement between various design actors, whilst the gaps, contradictions and questions inform research proposals in this area. The first five qualities capture the purpose or functions of student briefs (staging, interpretation, authenticity, learning, and affective); the next six qualities address formal and content dimensions (orientation, prescription, information, representation, outcomes, and assessment); the final quality directs attention to the contextual realities of student briefs by characterising their dependency on execution.

2.1 Stage

The student brief sets a shared baseline formulation for all learners in a cohort, yet their responses are expected to all differ from each other and even from the results expected by the brief’s creators. Moreover, the assessment criteria are also common for all projects, thus creating a paradox between the divergent and convergent forces of the “the staging of students’ design activities” (Hocking, 2014, p. 60). Experts refer to this quality with expressions like "clarity of purpose” Frank Gehry (2:30) in (Bassett, 2014), “the brief sparks something” John C. Kay (21:19) in (Bassett, 2014), and “the brief as a catalyst for creative activity” (Hocking, 2014, p. 52). Criteria for staging include that outcomes are emergent rather than dictated: “hopefully what starts to emerge is something that grows out of the brief but not directly, linearly from it” David Rockwell (23:26) in (Bassett, 2014). Design competitions show a tension in staging in that “the competition should be predictable. No surprise grounds for judging should ever appear afterwards. However, the quality judgement of the entries should lead to new insights into the task at hand. The entry should clarify the problems of the competition” (Rönn, 2009, p. 62). Two cases that illustrate radically different staging qualities are the Dyson Award (Dyson, 2017) and the Braun Prize (Braun, 2015). Staging is critical but not exclusive to the early phases of a project since briefs serve as reference points throughout, i.e., “the brief keeps changing” John Boiler (2:52) in (Bassett, 2014).

2.2 Interpretation

The student brief enables flexibility by supporting multiple interpretations, so its creators “must anticipate the response while allowing license so that students can interpret or reinterpret the brief” (Heller & Talarico, 2009, p. 12). Briefs seek to balance clarity and ambiguity by being “intentionally unspecific, ambiguous, imperfectly formed and ill-defined” (Hocking, 2014, p. 60) in alignment with design problems (Goel & Pirolli, 1992; Jonassen & Hung, 2008). Briefs amplify the sensibilities for interpretation: “When you’re an architecture student, the brief is God. But I’ve learned about the brief whether it’s verbal or written, it’s our job to challenge it” David Rockwell (19:53) in (Bassett, 2014). Interpretation is a continuing process as the problem-solution coevolve: “We’ll literally rewrite a brief like six
times in the course of making the stuff” John Boiler (20:03) in (Bassett, 2014). The degree of interpretability enables new understandings and the re-staging of projects, so that: “A central function of the brief is that it encourages multiple interpretation so that ultimately each student, or group of students, generates a distinctly individual solution” (Hocking, 2014, p. 60). This provides a mechanism to resolve the apparent paradox of common assessment criteria by revealing how each project can meet (exceed in exceptional cases) those criteria in their own unique ways.

“An aversion to vagueness and partial specifications” is not exclusive of brief-writing guides (Hocking, 2014, p. 68), and manifests in education where time and resources are limited, and where class sizes, timetable, and learning outcomes are prescribed. In professional practice, re-interpretation of the brief can take years since early ideas that are deemed promising can be later abandoned for solutions that reframe the problem (Kocienda, 2018).

2.3 Authenticity

The student brief has a far-from-straightforward relation to professional briefs. Real-world in design education is often invoked as if a congruous approach to professional practice existed out-there, yet the variance in beliefs and practices around briefs across professional areas and individual styles is marked (Bassett, 2014). The quality of authenticity brings forth trade-offs and tensions, inasmuch as professional briefs bring increased complexity, an emphasis on outcome rather than process, successful results as the main driver rather than failing and learning, and a removal of student agency (Maturana, 2010, p. 161). Authenticity can be interpreted in other ways such as via “a more meaningful understanding of the activities associated with art and design learning [which] can result if students are encouraged to collaboratively undertake the activities that are traditionally the responsibility of the tutors, such as writing the brief” (Hocking, 2014, p. 61) - including students performing designer and client roles to collaboratively define the brief (Bohemia, Harman & McDowell, 2009, p. 129).

2.4 Learning

The student brief has strong instructional qualities that shape the studio experience, and suggest ways of practising design and ways of being a designer (Nelson & Stolterman, 2012). In this sense, briefs “provide enough unanswered questions that students are learning something new by doing something new” (Heller & Talarico, 2009, p. 11). A balance is preferred between student-led learning and prescribed curricular and instructional goals: “The most important questions are How will the project encourage learning? and What lessons are essential to learn?” (Heller & Talarico, 2009, p. 12). Whilst professional briefs may also generate significant learning (Kocienda, 2018), the core outcomes in professional projects are the designed artefacts, whilst student briefs are primarily driven by the evidence of learning. Learning is not exclusive to students, briefs can trigger reflection and new understandings from their creators: “The learning experience comes both from the solutions for the assignment and the jury’s quality assessment of them” (Rönn, 2009, p. 63). Guidelines for competition briefs recognise that “flexibility is helpful and build it into the process, with an interim review or workshop during the competition stage to allow the client to update the briefing requirements” (RIBA, 2014, p. 9). Student briefs can support a range of learning experiences including individualised, learning with others and learning from others by witnessing their unique journeys.

2.5 Affectivity

The student brief embodies affective qualities of the relationship between learners, instructors and others who may be explicitly included or not in the brief. Briefs can inspire by reinforcing existing connections to personal interests or developing new awareness. Briefs can do this via a range of effects including positive (“makes you gasp with delight” Maria Kalman (1:25) in (Bassett, 2014); “it has to inspire’ John C. Kay (2:44) in (Bassett, 2014)) as well as negative (“Students overwhelmingly agree that the best class projects are those that force them to develop in the most personal ways” (Heller & Talarico, 2009, p. 19); “I want a class project to make me scared. I need to go beyond my safety zone” Irina Lee in (Heller & Talarico, 2009, p. 25)). To maximise the affective dimensions of student briefs, the experience and facilitation skills of instructors can be critical: “It’s the teacher’s job to promote the project with fervency and passion” (Heller & Talarico, 2009, p. 18). However, “placing all bets on facilitators is risky” since strong presence and leadership can remove agency from students (Hung, 2016, p. 2). Hence a balance between brief content and delivery seems preferable in studio for student briefs to capture affective qualities to “communicate the passion and conviction” John Boiler (2:30) in (Bassett, 2014). In this sense, briefs are “combustible, the fuel that powers the creative engine” (Heller & Talarico, 2009, p. 12). Professional design projects are marked by intense positive and negative emotions too (Kocienda, 2018).

2.6 Orientation

The student brief orients the project and provides focus in different ways: by defining a desired scenario or outcome (“to design a playground for a fictitious neighbourhood” (Atman, Cardella, Turms & Adams, 2005, p. 329)); by referring to a concrete situation (“a concept for a litter disposal system in a new Netherlands train” (Dorst & Cross, 2001, p.
by naming a theme for problem setting (“think about how human transportation will be like in 2050” (Vasconcelos, Neroni, Cardoso & Crilly, 2018, p. 105)); by selecting a target user with a specific condition (“eliminate the need to have multiple bikes as people grow up” (Vasconcelos, Cardoso, Sääksjärvi, Chen & Crilly, 2017, p. 4)) or by instructing discovery (“each team must interact with the client/sponsor to define their needs” (Jain & Sobek II, 2006, p. 61)). Brief orientation starts to shape the type of relationship in the learning environment: “I don’t believe in briefs, I believe in relationships” Yves Béhar (3:39) in (Bassett, 2014); “the relationship with the client can be very exciting” Frank Gehry (6:23) in (Bassett, 2014). Brief orientation can also give emphasis of process, towards collaboration: “If well planned, a project will also encourage interaction and collaboration” (Heller & Talarico, 2009, p. 12); or towards the use of particular materials, media, or resources. Some briefs use a seminal idea to orient the project: “Sport is war, minus the killing. So, that was the brief and that set the tone. Now, that was backed up by a summer long of interviews” John C. Kay (21:19) in (Bassett, 2014). Whilst some orientations are straightforward (“redesign a shopping trolley”), other orientations can be deceptive: “This project is a real Trojan horse; it challenges designers to solve a relatively unsolvable problem” Allan Chochinov in (Heller & Talarico, 2009, p. 13). The length of time for a project determines many brief qualities, and particularly its orientation, which varies from a one-session activity to several weeks or months (Lee, 2009; Sosa, 2018). In industry, briefs can also range from hours up to a year or two (Kocienda, 2018).

2.7 Prescription

The student brief integrates instruction and inspiration for learners to tackle problems that are ill-defined and ill-structured (Goel & Pirolli, 1992; Jonassen & Hung, 2008): “The participation of architectural teams [in competitions] involves a choice of reading the competition brief for instructions, indications or inspirations” (Kreiner, 2009, p. 37). Metaphors abound in the portrayal of how briefs balance constraints with freedom to direct student action: “briefs are no handcuffs or railroad tracks” David Rockwell (1:34) in (Bassett, 2014); “you have to be given a lot of runway so you can take off” John C. Kay (2:59) in (Bassett, 2014); “the brief is a deadline and a dream” Maria Kalman (9:45) in (Bassett, 2014). The brief orientates by direction (2.6) but also by naming constraints, goals and variables explicitly, whilst leaving others implicit. Briefs are often “negotiable” (Goel & Pirolli, 1992), but considerable skill is required to identify the restrictions and challenge them creatively: “the brief in my world is... both extremely pragmatic and concrete. There is a product... And then the brief is fantastically elusive and completely romantic” Maria Kalman (11:20) in (Bassett, 2014); “Those ideas would not have come about without a brief that had limitations, and an invitation” David Rockwell (14:47) in (Bassett, 2014). Briefs that provide instructions with a why give opportunities for learners to grasp the rationale. Prescription is ongoing during a project through instructor feedback and the students’ own revealing of information and insights. “At least give us the choice of whether we want to use a paint brush or a jack hammer. If you tell us why we’re going to do this thing then we get to use everything” John Boiler (24:13) in (Bassett, 2014). A tension is visible between how students value freedom and guidance: “While educators try to provide just enough details to leave room for the exploration of the design space, students prefer a more articulated and structured problem definition” (Sas & Dix, 2009, p. 176). Brief prescription is a key quality to provide support for students to “fail fast and often” via the information provided, the type and timing of deliverables, etc.

2.8 Information

The student brief is shaped by the volume of information provided; its type or nature; whether it is given, requested by, or revealed by students; its timing throughout the project; and the ability of learners to meaningfully, creatively and productively question it to ground their insights, validate their findings, and justify their design decisions. “Design problems cannot be comprehensively formulated at the outset because certain components of the problem only emerge through the actual process of generating solutions” (Hocking, 2014, p. 67). Brief information shapes learners’ encounter with the project: “Participants unanimously respond that too much information in the brief limits the quality of their creative response” (Hocking, 2014, p. 82). “It’s good to get information. The more information, the better. Don’t get me wrong. I’m not saying I want to start projects in total ignorance. On the contrary, but what I want is much more of the soft side” Yves Béhar (23:45) in (Bassett, 2014). Brief orientation can motivate students to challenge their assumptions and seek new information by themselves to open new regions of the design space (Kocienda, 2018). Briefs can also release information in stages and by demand: “All the necessary information was prepared in advance on information sheets, with one specific topic on each sheet... If a designer wanted to know something, they asked the experimenter, who would then hand over the appropriate sheet.” (Dorst & Cross, 2001, p. 427).

2.9 Representation

The student brief relies heavily on text-based representations, usually as a short memo that conveys contextual background, a type of outcome depending on its orientation, and some sort of evaluation criteria and other
constrains (Braun, 2015; RIBA, 2014). The effects of the lexical and semantic qualities of briefs have only recently and initially been characterised (Hocking, 2014; Vasconcelos & Crilly, 2016; Sosa, 2018): “a good creative brief should be written in a way that stimulates creativity and promotes original ideas” (Hocking, 2014, p. 73). Student briefs can make use of visual imagery and other non-linguistic formats. A variety of approaches exist in regards to the extension of briefs: “the shorter, the better” Yves Béhar (1:42) in (Bassett, 2014), and their intrinsic qualities compared to how instructors introduce and manage the learning experience: “if the presentation of the project is vigorous, it doesn’t matter how routine (or even mundane) the problem is” (Heller & Talarico, 2009, p. 18). Qualities of representation also include what the brief stipulates as outcomes, and whether interim or final deliverables include audio-visual formats, oral presentations, and written journaling reflecting on or documenting the process. Professional briefs can alternate competition and collaboration for example via idea derbies where quick working prototypes are assessed (Kocienda, 2018).

2.10 Outcomes

The student brief defines deliverables and may distinguish these by stages or contribution (individual/team or disciplinary). Briefs emphasise learning by providing “just enough structure which should enable a strong focus on the design process and students’ reflection on it, rather than on the design outcomes” (Sas & Dix, 2009, p. 177). Defining outcomes entails a degree of prescription and anticipation, yet “students [should] surprise both their teacher and themselves” (Heller & Talarico, 2009, p. 11). Outcomes in studio include two main types: design outcomes in the form of artefacts that respond to the brief, and learning outcomes in the form of evidence of proficiency: “A project can propel students in two opposing directions -either through success or failure. While the former is obvious, the latter way might seem perplexing. Often, however, only through failure can a student get the best critique and truly absorb the right lessons” (Heller & Talarico, 2009, p. 11). The combination of these two types of outcomes entails that new understandings of the brief, the process, and one self are more meaningful results rather than seemingly creative design solutions. This is in tension with the pressure on design students to build strong portfolios from their studio projects. Whilst professional and competition briefs require one concept or solution from each participant, in learning environments students usually demonstrate fluency abilities to generate and develop multiple ideas (Cardoso & Badke-Schaub, 2011).

2.11 Assessment

The student brief communicates outcomes and an accompanying set of criteria for their assessment or evaluation. Briefs define what, when and how is assessed, and who does the assessment and its mapping onto the learning objectives of the studio. Interim feedback and feedforward in the tradition of crit sessions can accompany formative assessments as well as peer and self-assessments. Evaluation criteria should distinguish between satisfactory outcomes and those that exceed the brief: “The best brief... have always been the most audacious and seemingly impossible” John Boiler (7:43) in (Bassett, 2014). Research in this area is scarce: “there is a dearth of research that studies the relationship between the requirements (or assessment criteria) as set out in the student brief and the correlation these have with the creative processes of students and the perceived success of their final creative outcomes” (Hocking, 2014, p. 71). Design instructors face the complexities of making conclusive quantifiable evaluations of open-ended projects (Goel & Pirolli, 1992; Jonassen & Hung, 2008), so briefs that include student evaluations can help address issues of perceived fairness. The tensions are visible in competition briefs: “The competition programme should be formulated in such a way that there is a balance between being as clear as possible about the requirements and yet leave as much latitude as possible for the competitors to operate and without locking them in more than necessary” (Rönn, 2009, p. 61). Outcomes can also shape the rubric: “Based on the knowledge acquired during the competition promoters may, for very good reasons, reconsider their position and let the new evidence influence their choice of winner” (Rönn, 2009, p. 63). One approach to assess the unexpected is to designate a bonus score: “for outstanding performance of up to 10% of the maximum test score. This is to reward teams that do more than what is needed to solely score points in a test but show innovative and general approaches” (RoboCup, 2016, p. 40).

2.12 Execution Dependency

The student brief has a strong situational quality of fitness, i.e., there is no such thing as a perfect brief (Phillips, 2012). The merit of a student brief is in how well they fit a learning environment, the characteristics of actors (“was the wrong project for the person responding” David Rockwell (3:33) in (Bassett, 2014)), and the type of projects used in studio pedagogies (Lee, 2009). In this sense, student briefs vary along a continuum of execution dependency (ED) (Kocienda, 2018), a quality borrowed from the analysis of early ideas in the movie industry (Luo, 2011). A student brief that is highly dependent on execution affords significant re-framings (Sosa, Connor & Corson, 2017), such as “Trojan horse” briefs (Heller & Talarico, 2009, p. 13). In projects with briefs of high-ED value, the quality of outcomes strongly
depends on students’ execution and are more *allographic* (Goodman, 1976). In projects with briefs of low-ED value, the quality of outcomes strongly depends on students’ concepts and are more *autographic* (Goodman, 1976). High-ED briefs seem better suited for students with more advanced design skills, industry projects, projects that emphasise problem exploration, projects where crafting of outcomes is expected to be superior, team projects including inter-disciplinary, and projects where working prototypes are more appropriate. This type of briefs may require longer extensions (Braun, 2015; RoboCup, 2016). Low-ED briefs seem better suited for novice design students, competition projects, projects that emphasise solution exploration, projects where originality of concept is a priority, individual projects, and projects where appearance or conceptual prototypes are more appropriate. This type of briefs may be of shorter extension (Dyson, 2017; RoboCupJunior, 2016). Instructors can critically assess and reflect upon the deployment of student briefs to identify the qualities of relevance for the next instantiation: “The answer to what makes for an interesting class project will always vary because every teacher and every student addresses a different set of agendas and priorities” (Heller & Talarico, 2009, p. 20).

### 3 A Research Agenda on Briefs

The twelve qualities of briefs tentatively presented here point to a rich and complex landscape that justifies a comprehensive, multi-method research agenda on the framing, deployment, and effects of student briefs in studio education at the tertiary level. A key goal in examining these qualities is to assist in the structuring of research questions for such programme of inquiry. The current paucity of literature in this area has been addressed elsewhere (Hocking, 2014, p. 60; Vasconcelos et al., 2018) including in the formulation of methods to select design tasks in experimental studies (Sosa, 2018). Given the different research and pedagogical approaches in design, we aspire to encourage varied dialogues on how our briefs shape the learning experiences of future designers, and how we can improve them and learn from each other rather than the current ad-hoc and largely intuitive, accidental nature of design briefs in studio projects (Frascara & Noel, 2012).

Within quantitative approaches, research on student briefs may include the measurement of the effects of different values and types of the twelve qualities examined here. These include brief phrasings that shape the staging, prescription, information and orientation of the brief. Experimental and control groups can be studied to identify the effects of the affective quality of briefs, or to what degree authenticity shapes the learning experience. Dependent variables in such studies could serve as indicators of the range of interpretations and the variances in outcomes along with the performance in achieving the learning outcomes. Surveys could also be useful to gather affective responses to brief variations, and effects on learners’ engagement and achievement could be assessed via student satisfaction surveys and grades. Readability scores and metrics of complexity as well as the effects of different media formats to convey information can be assessed via Likert-scale questionnaires. Priming and fixation scores can be established via laboratory studies in connection to one or more of the qualities examined here.

Within qualitative approaches, research on student briefs can include in-depth interviews, observations in the studio, learners and teachers journaling, and generative sessions with seasoned design educators and professionals. Creative research methods could be very appropriate to role-play and interrogate current practices (Elsbach & Kramer, 2003). These studies could lead to better grasping of the tensions, trade-offs, and opportunities for innovative ideas for one or more of the qualities analysed in this paper. Questions that address deep beliefs and intuitive decision-making in the crafting of briefs and in their deployment in studio projects can reveal new ideas on how authenticity and orientation of brief shape the learning experience. Participants in these studies can be encouraged to reflect upon their practices and the ways in which briefs may shape their own beliefs and behaviours around teaching design. How may studio instructors reorient or shift the staging of their own briefs if invited to re-purpose them to different learners, learning outcomes, or learning environments? Can educators identify the political and ethical issues in their briefs? How are the learners’ perceptions of briefs shaped by gender or cultural characteristics? What are the studio or school ethos and cultural practices? How do novice and casual teachers who combine professional practice with teaching inherit assumptions and traditions that shape their student briefs in the studio?

Mixed methods and practice-led approaches can combine and introduce new methods to study briefs via multidimensional approaches (Kara, 2015). Repositories or databases of student briefs could assist both research and teaching practices, and they could include metrics empirically derived from quantitative research as well as commentaries and explanations from qualitative research. Many important and complex issues are likely to arise from the connections between the brief qualities examined here, and will require imaginative methodological approaches. Creativity is also required in the crafting of future student briefs not only in studio education, but also throughout the design curriculum and other fields. Student briefs could be *reverse-engineered* from recent prominent solutions in the market, or specific omissions or provocations could be purposefully inserted to test their effects, briefs could be
authored by teaching teams or by students, and innovative non-textual formats could be experimented to represent briefs.

Future work will apply the brief qualities inductively proposed here to structure and guide inquiry into the ways in which educators frame, deploy, assess and reflect upon the briefs they use to educate future designers. Connections to brief qualities and more general studio pedagogies also deserve further attention, as these twelve qualities transcend the domain of briefs and more generally shape learning experiences in design education.

**References**


**About the Author**

**Ricardo Sosa** is a Mexican industrial designer interested in the study of creativity and innovation principles through multi-agent social systems. He also studies new methods and support systems for the fuzzy front-end of the design and innovation process. He is an Associate Professor at Auckland University of Technology in Aotearoa New Zealand and Adjunct Associate Professor at Monash University in Australia.
Motivation Intended to Inform Design Teaching Practice

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Abstract: Academic success is a difficult task that often involves struggles and mistakes, requiring effort and engagement on the part of students. As the literature is vast and complex, this work focuses on motivation with the intention of informing teaching practice. Design pedagogy is also affected by these aspects, which can influence student success, mastery and autonomy. Although the theme deserves attention, there are not many research reports on the impact of these factors in design teaching and learning. This work is a qualitative study based on subjective evaluation of specific aspects of motivation science regarding learning. The research design was developed with the intention of understanding the impact of non-cognitive factors in design education, by compared perspectives. Twenty-one professors of diverse design (studio) courses and 49 design students, also of different institutions, answered a survey containing twelve questions under three themes: the development of self-determination basic characteristics; the utilization of grades, rewards and praise; and seven statements regarding rewards and praise to ensure motivation, presented to collect subjective perceptions. The results show that students have a much more positive perception of self-developed skills regarding self-determination elements compared to their colleagues. A finding is related to the different perception of the subjects about the utilization of praise. The discrepancy can be a symptom of instructional problems, lack of information by educational professionals or even indicates a poor communication channel in the classroom. Another finding refers to the two groups’ opposite views regarding three statements on the usage of rewards and praise for motivation. Apparently, professors utilize grades vastly, which is a clear opposition to the best practices signalized by scientists in the field. Students, also, do not seem to understand that the praise used is sincere and deserved, which could be an indication of lack of trust. Finally, although professors seem to agree that the emphasis of praise and rewards are associated to process and effort, students tend to feel that skill is the key point.

Keywords: motivation; design education; perception; self-determination; praise

1 Introduction

The study of motivation encompasses a scientific area dedicated to understanding human behaviour and factors that can change it. Among these factors, commitment, will and self-determination are some of the main ones. The focus of
this research relies on motivation and will be intended to inform teaching practice. This work is a qualitative study based on subjective evaluation of specific aspects of motivation science regarding learning. This research design was developed with the intention of understanding the impact of non-cognitive factors in design education, by compared perspectives.

The motivation, according to the theory of self-determination, is composed of intrinsic and extrinsic aspects and both make up a constellation of supposedly invisible factors that regulate human behaviour. This theory gained strength in the twentieth century mainly due to the contributions of Deci, Koestner and Ryan, (1999, p. 658), who observe that “intrinsic motivation supports and energizes activities through spontaneous satisfactions inherent in effectively volitional actions. It is manifest in behaviours such as playing, exploring, and competing for external rewards, as people often do.” In this study we will bring to the fore, important aspects related to the self-determination of design students, as well as professors’ perception, specifically linked to the following four factors: interpersonal connection, competence and mastery, independence and autonomy, purpose and meaning.

In addition to its complexity and variability, these behaviours can change from individual to individual according to the area, age and gender, among other factors. Conceived and defined scientifically, motivation is understood as "the attribute that implies us to do something or not" (Gredler, Broussard & Garrison, 2004, p. 106). Guay et al. (2010), on the other hand, point out that motivation refers to the underlying reasons for behaviour. Even more interesting for this work approach, Gottfried (1990, p. 525) defines academic motivation as "the pleasure of academic learning characterized by mastery orientation, curiosity, persistence, and learning challenges, difficulties and tasks". Turner (1995, p. 413) considers academic motivation as synonymous with cognitive engagement, which is defined by the author as "voluntary uses of self-regulated, high-level learning strategies such as dedicated attention, connection, planning and monitoring."

Much of the theory regarding motivational studies is associated with individual goals and values. They have a direct link to the extrinsic aspects of motivation. According to Stipek (1996), initial approaches to the study of motivation were structured on the basis of extrinsic reinforcement literature. In these parameters, all behaviour, including the sense of personal fulfilment, would be governed by reinforcement contingencies. Positive reinforcements or rewards are understood as consequences that increase the likelihood of a given behaviour by the removal or reduction of some negative external stimuli.

Stipek (1996) points out that this approach becomes limited because rewards or punishments do not have the same effects on all students, and some desirable academic behaviours, such as paying attention for example, are not easily reinforced. Further, the author states that the effects of rewards usage tend to be less effective over time, and that individual goals and objectives are stronger reasons for engaging tasks and activities. Also, goals can be divided into mastery goals (intrinsic values) and performance goals (extrinsic values) (Broussard & Garrison, 2004).

Research such as that by Gottfried (1990), proves the aspects of variation linked to motivation and also presents evidence that behaviours can be manipulated from certain instructional practices. When applied well, these practices can increase motivation and consequently improve student performance. When poorly applied, however, they can generate negative impacts. Thus, it is understood that well directed instructional practices, according to these scientific findings can positively manipulate the motivation and behaviour of students to support the learning process.

The studies show that from the educational point of view, especially when coming from the teachers’ view, the intrinsic aspect of the motivation would be beneficial or at least it is the most valued (Deci et al., 1999). However, research in the field of social psychology shows that extrinsic rewards can positively affect motivation, also increase the interest, commitment, and willingness of individuals in relation to a given task.

Use of rewards and praise is an important topic for understanding motivation in learning situations. Recent findings from neuroscience and cognitive science respond that we can rather use both rewards and praise to improve the non-cognitive aspects of learning, among them, motivation. Studies such as that of Murayama and Kitagami (2014) in addition to Howard-Jones and Jay (2016) present results consistent with the above statements and confirm the response to reward stimuli by the brain. But as mentioned earlier, the use of rewards does not always have a positive impact. A phenomenon called the undermining effect or over justification effect (Lepper, Greene & Nisbett, 1973; Deci et al., 1999) suggests that extrinsic rewards are not always beneficial to learning. That is, in specific cases extrinsic rewards could decrease intrinsic motivation.
Briefly, this whole range of findings presented a scenario that confirms the hypothesis that rewards would facilitate learning. The use of rewards has a positive effect on motivation and improves academic performance as evidenced by neural linkage studies linking motivation (reward) and memory systems in the brain (Murayama & Kuhbandner, 2011). But in some conditions, such as when a task is intrinsically interesting and rewards could decrease motivation, it could not bring benefits to learning (McGillivray, Murayama & Castel, 2015).

Praise is also a powerful motivational tool. Research shows that praise is underused and under-estimated by teachers (Brophy, 1981; Kern, 2007; Hawkins & Heflin, 2011). Some recommendations can facilitate the use of praise to maximize the positive impacts on student learning and are basically constituted of two elements: the description of the academic performance or behaviour that one wishes to emphasize, and a sign of approval by the teacher.

Studies show that the power of praise to shape positive student behaviours is linked to the ability to indicate exactly what kind of behaviour or academic performance is being valued and how it fits into the teacher’s expectations (Burnett, 2001). Also, in the use of rewards, the use of praise will only have positive effects on academic behaviour and motivation in situations where students are encouraged (Akin-Little, Eckert, Lovett & Little, 2004).

A compliment that does not point exactly to a description of the behaviour being rewarded, for example, will not have a positive effect on student motivation (Hawkins & Heflin, 2011). The authors’ work demonstrates that what behaviour is being praised should be clearly described to the student. Literature also runs counter to the praise of skills. Instead, teachers should focus on compliments on effort, and as evidenced (Burnett, 2001), vague praise for ability can reduce students’ interest in risk taking. When properly employed, praise helps students see a direct link between effort dedicated to a task and improvement in academic performance or behaviour.

The third and final aspect concerns the manner and context of how praise is provided to the student. There are several ways to approach the subject, and research indicates that the teacher should tailor the praising situation to the student’s preference. For example, students who are predisposed to feel uncomfortable with compliments given in public, should be addressed individually, or even in writing, in the tests and papers given to the teacher. To summarize the main points related to the literature review (Dweck & Molden, 2005; Farrington et al., 2012; Dweck 2015) of the work’s theme, a table was crafted to organize the main guidelines for the use of praise and rewards (Table 1).

<table>
<thead>
<tr>
<th>USING REWARDS AND PRAISE FOR MOTIVATION GUIDELINES</th>
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<tbody>
<tr>
<td>USING REWARDS</td>
</tr>
<tr>
<td>1. rewards usually have short-term effect</td>
</tr>
<tr>
<td>2. constant use of rewards can demotivate</td>
</tr>
<tr>
<td>3. rewards should be used only for dull tasks</td>
</tr>
<tr>
<td>4. teachers should seek other alternatives</td>
</tr>
</tbody>
</table>

Since motivation characteristics linked to self-determination are important skills for professionals in many fields including design, the purpose of this study is to investigate the perception of teachers and students of design on aspects related to the motivation and findings of applied science to academic behaviour. This collection of subjective impressions, linked to non-cognitive factors of the science of learning in design, can present important points of improvement both in the instructional practice of design teachers and in the students’ learning strategies. Understanding the impact of emotional factors on design pedagogy through the perception of students and teachers can be a determining task. With this data, one can identify critical areas in the teaching-learning relationship in order to structure strategies based on instructional models and improved processes.

2 Methods

The focus of this research relies on motivation and will be intended to inform teaching practice. This work is a qualitative study based on subjective evaluation of specific aspects of motivation science regarding learning. Twenty-one professors of six diverse studio design courses and forty-nine undergraduate design students from three studio courses answered a survey containing twelve questions regarding three main areas or themes: the first is the development of self-determination basic characteristics, the second, the utilization of grades, rewards and praise.
Finally, seven statements regarding rewards and praise to ensure motivation in learning were presented to collect subjective perceptions (Table 2).

### Table 2. Basic research design.

<table>
<thead>
<tr>
<th>THEME</th>
<th>QUESTIONS</th>
<th>MEASUREMENT / SCALE</th>
</tr>
</thead>
</table>
| Development of SELF-DETERMINATION aspects during course; | 1. During my course, I have developed;  
2. During my course, I noticed that most of the students and colleagues developed;  
3. During course, my students develop;  | 1. No Development  
2. Unsatisfactory Development  
3. Satisfactory Development  
4. Full Development |
| Utilization of GRADES, REWARDS and PRAISE  | 1. Rewards and grades: are / were used:  
2. Praises are / were used: | 1. Never Used  
2. Rarely Used  
3. Frequently Used  
4. Always Used |
| Perception on statements regarding REWARDS and PRAISE | 1. For me, the effects of stimuli attached to grades are short-term;  
2. Grades may cause / cause demotivation;  
3. Grades are / were used on "minor" tasks;  
4. Teachers seek / sought to avoid application of grades and seek to find other alternatives;  
5. Praises are / were always sincere and deserved;  
6. Controlling language is / was avoided in compliments;  
7. Process and effort are / were emphasized, not skill; | 1. I Totally Agree  
2. I Agree  
3. Neutral  
4. I Disagree  
5. I Totally Disagree |

**TOTAL: 12 QUESTIONS**

This research design was developed with the intention of understanding the impact of non-cognitive factors in design education, by compared perspectives. To ensure clarity and maintain scientific rigor appropriate to the selected research method, all the questionnaires used were totally identical. The questions were always executed in the same order and with the same values and criteria. All participants participated voluntarily in the research and signed the informed consent that presented the structure and objectives of the research. There was no risk associated with participation in the research; on the contrary, participation only gives the volunteer a chance to learn about the topics covered. Regarding the applicability of the same research project to other schools and universities, this study becomes fully feasible since the form can be used in a simple and direct way, both in the version directed to students of design, as in the version that investigates the positioning of teachers.

Two types of graphs were selected for the analysis of the obtained data: one of them was dedicated to the presentation of the answers of the themes 1 and 2 of the research (Figure 1 to Figure 5). In these charts, we have the visualization of the answers related to the development of abilities (without development, unsatisfactory, satisfactory and full development) and also the use of rewards and praise (never, rarely, often and always). The second type of chart was used to visualize the answers related to the agreement or disagreement regarding the use of rewards and praises. In these charts, the answers of teachers and design students on the same theme are presented in a comparative way on the same charts (Figure 6 to Figure 12).

### 3 Results and Discussion

The premise of this research is to present motivation science and theory elements, intended to inform design teaching practice. In order to do that, this paper confronts design students and professors to the science of motivation in education, to understand their perspective on those themes in a comparative approach.

#### 3.1. Development of Self-Determination Aspects during Course

As shown in the methodological part of this work, the goal of these particular questions is to uncover discrepancies amongst the perception of professors and students regarding the four basic elements of self-determination:

- Competence and mastery
- Independence and autonomy
- Purpose and meaning
- Interpersonal connection

Professors answered on their perception of students’ levels of development of those qualities during the course, students also were questioned on the matter, but twofold: first regarding themselves, and secondly, regarding their
colleagues. Responses of students were much more optimistic and positive regarding their own accomplishments, than compared to their peers (Figures 1 and 2). Interpersonal connection is the most developed quality according to students’ experiences of their courses, in opposition to competence and mastery, which is the less developed of the characteristics in the two initial questions directed to them.

![Figure 1](image1.png)

**Figure 1. Students’ perception of self-determination aspects, self-development: The self-assessment of design students about themselves is far more positive than the assessment they make of fellow students of the same course. Competence and mastery are the most satisfactorily developed characteristics.**

![Figure 2](image2.png)

**Figure 2. Students’ perception of self-determination aspects, development of colleagues: Besides interpersonal connection, which is practically unchanged, the students’ perception of the other three topics was much worse, with a perception of poor development, with an average of close to 50%.**

When assessed, students rated competence and mastery as the most well-developed trait in their ongoing design experiences. In this evaluation it is noticed that the four topics evaluated reach about 75% of opinions with full or satisfactory development. Competence and mastery, which is related to the domain of technical aspects of the course content, is the only element that was never perceived as “never developed” by the subjects.

Used as a technical resource, which helps prevent perceptual study results from being driven only by the subjectivity and self-perception of the subjects involved, questions directed at peer evaluation can be used as a way of understanding students’ real performance. When the students evaluate themselves, they give an opinion about their experience and also about an egocentric approach. When evaluating colleagues, in turn, it is evaluating a larger number of individuals and establishes a much more relevant average for the study in question. Thus, we can perceive that it is necessary to improve the communication of important values for the group in question, regarding the understanding of the purpose and meaning of the activities and knowledge passed in the evaluated design courses.

Professors’ perception of the development of those characteristics did not differ much to students’ self-evaluation responses, as all of them were mostly evaluated as satisfactorily developed. Yet, none of the elements were indicated as “never developed” in this group of subjects (Figure 3).
Figure 3. Professors’ perception of self-determination aspects, development of students: With very positive results, none of the topics was assessed as undeveloped. In spite of this, it is necessary to emphasize that a question directed to the work of other teachers, or the evaluation of own practices compared to that of departmental colleagues, for example, was not carried out.

3.2. Rewards and Praise for Motivation

The usage of rewards, grades and praise in education is a crucial matter in motivation. As discussed earlier, there are parameters and guidelines that can determine success or failure regarding the utilization of those topics in the classroom. Regarding rewards and grades, almost 75% of the students claimed that it was always or frequently utilized. Amongst professors more than 75% of subjects affirmed using these resources in their practice (Figure 4).

Figure 4. Usage of rewards and grades in design disciplines: Teachers and students similarly perceive the use of rewards and grades.

Figure 5: Usage of praise in design discipline: Teachers and students perceive the use of praise very differently.
In contrast, the utilization of praise is differently perceived by the groups. Almost 90% of professors declared the constant usage of praise, but only 40% of the students noticed it in that way (Figure 5). The high difference in the perception of the use of praise is a matter of concern, since the literature dedicated to the subject points to empirical findings that indicate that this resource is extremely impactful on the motivation and construction of the academic mindset of students. With these results, it is possible to establish that the optimization of this topic would be crucial for the improvement of non-cognitive aspects related to the learning of design in these courses. Still, the correct use of praise could directly improve the indexes of purpose and meaning, which were deficient in previous issues.

### 3.3. Perception on Statements Regarding Rewards and Praise

Subjects of this study have been presented with seven statements regarding rewards and praise, which are:

1. For me, the effects of stimuli attached to grades are short-term;
2. Grades may cause / cause demotivation;
3. Grades are / were used on minor tasks;
4. Teachers seek / sought to avoid application of grades and seek to find other alternatives;
5. Praises are / were always sincere and deserved;
6. Controlling language is / was avoided in compliments;
7. Process and effort are / were emphasized, not skill;

From these assertions, all the individuals participating in the research, students and teachers, were invited to stand in agreement or against, one next time. For each of the statements, the subjects could agree totally, only agree, demonstrate neutrality, disagree or totally disagree. Figures 6 to 12 show the results of these comparative analyses. The graphs used for the presentation of the data were selected to demonstrate two lines opposing each other in an area that goes from total agreement, passes through neutrality and arrives at total disagreement. The highest points of the lines, which represent the largest number of positions between the subjects surveyed for the two groups, students and teachers, were then compared.

Three of those statements’ perception were extremely diverse regarding professors and students’ points of view, they are related to the usage of grades for minor tasks (Figure 8), to the sincerity and deservedness of praises (Figure 10), and the emphasis on effort and process and not skill (Figure 12). Results regarding the perception of subjects on the other statements did not differ much for each group and are presented in figures 6, 7, 9 and 11.

![Figure 6. Perception regarding stimuli of grades: The perception of teachers and students are similar about this item.](image)

Teachers and design students evaluated in the research tend to agree that the use of grades tend to serve as short-term stimuli, in agreement with the literature of the area. Although both groups of subjects demonstrated agreement with the statement that the scores cause or can cause demotivation, it is possible to notice that the students presented a position much more in line with the literature. Teachers, on the other hand, presented a position of concordance that approaches neutrality (Figure 7).

On the claim that grades were used in minor tasks, for example (Figure 8), the majority of professors disagreed with the statement, but differently, students had a divided opinion with a much more neutral opinion. In this topic we find a key point of investigation, since both groups position themselves differently to the newest findings of cognitive
science and the science of learning. The use of grades in smaller tasks has shown to be positive, for building a growth mindset, keeping students on repetitive tasks, or gaining skills.

On the search for other alternatives to grades, teachers and students tended to disagree (Figure 9). This may not only reveal an ignorance of the literature devoted to learning science but may also indicate a deficiency in continuing teacher education.

Figure 7. Perception on grades and demotivation: Although both groups were in agreement, teachers tended more towards neutrality.

Figure 8. Perception on grades usage for minor tasks: Both groups were negatively positioned, with more students being neutral. However, the use of grades in smaller activities has been studied and presents very positive results in relation to the construction of a growth mindset.

Figure 9. Perception on application of other alternatives to grades: The two groups evaluated disagree that teachers seek alternatives to evaluation other than grades.
Motivation Intended to Inform Design Teaching Practice

Figure 10. Perception on sincerity of praises: While professors agree that they praise in a sincere and deserved way, the students apparently cannot understand the praise in the same way.

Figure 11. Perception on controlling language in compliments: In this item specifically, both groups were positioned in a neutral way.

Figure 12. Perception on emphasis of compliments and feedbacks: Although teachers agree with the statement, students, differently, tend to be neutral or disagree.

On the statement that affirms the usage of praise as sincere and deserved, professors had a positive agreement response to the matter, but students have, once again, taken a neutral posture towards the topic (Figure 10).

As can be seen in the literature dedicated to motivation and non-cognitive aspects related to learning, the correct use of praise can positively contribute to a better student performance. In addition to making clear which attitudes, behaviours, and practices are considered appropriate in the learning process, praise, when well placed, can help the
student feel embedded in the group context, feel empowered and engaged, and foster mentality for personal development. Because of all that has been presented, this finding of research becomes extremely relevant. Regarding the usage of controlling language in compliments, both groups were positioned in a neutral way. It can be inferred that there is a lack of knowledge among the researched ones about the subject. Still, it is important to point out that the literature presents important research results that show that the use of controlling language should be avoided when teachers are praising students.

Finally, the third critical finding is related to the emphasis in process and effort on the praising. Although the majority of participant professors agreed with the statement, most of the students tended to be neutral towards or disagree with the matter (Figure 12). Again, as seen in previous topics, there seems to be a flaw in the clarity of communication between teachers and design students. To praise correctly, as the literature proposes, is a crucial factor in positively affecting the non-cognitive factors that impact learning. However, as seen in the results of this research, it is possible that there is a lack of communication between teachers and students. Besides the clarity of the praises and clear establishment of purpose for the subjects studied, teacher training can be an important factor to correct these topics.

4 Conclusion

This research is important to reveal the perceptions of design students and professors regarding motivation and self-determination. The results can be used for comparative analysis in other courses and areas, establish guidelines for teaching practice or even set directions to the development of educational technologies. In addition, as future studies, one can cite the possibility of using this information to adjust curriculum, to select other related courses and to target complementary teacher training and, also, to adapt teaching methods and correct use of educational technologies.

The first important finding of the research concerns the comparative perception of design students about themselves and their colleagues. In this phase of the research they were invited to evaluate the development of four important aspects related to self-determination. The self-assessment of design students about themselves is far more positive than the assessment they make of fellow students of the same course. Competence and mastery are the most satisfactory developed characteristic. Besides interpersonal connection, which is practically unchanged, the students' perception of the other three topics was much worse, with a perception of poor development, with an average of close to 50%. Also, we can perceive that it is necessary to improve the communication of important values for the group in question, regarding the understanding of the purpose and meaning of the activities and knowledge passed in the evaluated design courses. With very positive results, none of the topics was assessed as undeveloped by the professors. In spite of this, it is necessary to emphasize that a question directed to the work of other teachers, or the evaluation of own practices compared to that of departmental colleagues, for example, was not carried out.

Another important finding is related to the different perception of students and teachers about the utilization of praise. This discrepancy can be a symptom of instructional problems, and lack of information by educational professionals, or even indicate a poor communication channel through the peers in the classroom. With these results, it is possible to establish that the optimization of this topic would be crucial for the improvement of non-cognitive aspects related to the learning of design in these courses.

Also, very relevant findings, refer to the two groups’ opposite views regarding three statements on the usage of rewards and praise for motivation. Apparently, professors utilize grades vastly, which is a clear opposition to the best practices signalized by scientists on the field. Students, also, do not seem to understand that used praise is always sincere and deserved, which could be an indication of untrustworthy parameters. Finally, although professors seem to agree that the emphasis of praise and rewards are associated to process and effort, students tend to feel that skill is the key point. Another clear violation of guidelines regarding the matter on motivation science. To praise correctly, as the literature proposes, is a crucial factor in positively affecting the non-cognitive factors that impact learning. However, as seen in the results of this research, it is possible that there is a lack of communication between teachers and students. In the matter of the perception on grades usage for minor tasks, both groups were negatively positioned. With more students being neutral, however, the use of grades in smaller activities has been studied and presents very positive results in relation to the construction of a growth mindset.

Based on these findings, these design courses and professors can establish ways to diminish the most critical discrepancies related to the motivational aspects of design pedagogy and teaching. The clearest limitation of the study is due to low sampling. However, since the applicability of questionnaires in other schools, courses and universities does not present great obstacles and difficulties, new applications may be made in the near future, and other courses
can assess these motivational topics and decide whether any measure should be taken to improve some aspects of design teaching practice.

References


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Interactive Imagery and Shared Mental Models in Design Learning

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Abstract: This study explores the relationship between interactive imagery and shared mental models in a design learning environment. The study focuses on design, design learning, and the cognitive components of design. In this research, conceptual project development processes of third year architecture students, in a design studio where four instructors gave desk critiques on a rotational basis, are examined. Within the scope of the study, interviews were conducted with four students and four studio instructors. The process was analysed and interpreted based on the collected data and interviews. It is argued that interactive imagery and shared mental models, which are shaped in the studio's desk critiques, juries and panel reviews, affect students' conceptual project development. It is possible to conclude that if there is more than one studio instructor giving desk critiques on a rotational basis, students may have both advantages and disadvantages.

Keywords: design learning; design cognition; reasoning; representation; imagery

1 Introduction

It is a challenge to learn and teach the design process because design has a complex structure often escaping any exhaustive definition. Some have argued that learning in design is primarily based on learning-by-doing (Schön & Wiggins, 1992). Finke and his colleagues (1992) have claimed that one of the most important aims of design education is the acquisition to realize cognitive behaviours. Design learning consists of getting acquainted with these behaviours (Oxman, 2001). In studies of design learning, Schön (1983) and Goldschmidt (2005) explain design learning through three main components. Especially in the studies on design studios, these components are defined as instructor, student, and representation (tool). According to these studies, the interaction of the three components shapes the design learning process together with cognitive abilities.

Schön (1985) and Goldschmidt (2007) have separately touched upon the interactions between these three components, cognitive abilities, and the design learning process. These and other similar studies have focused mainly on short moments of interactions between an instructor and a student and a momentary exposure to instructor's
mental models. However, in design studios, the conceptual project development process is elongated. The aim of this study is to examine this interaction along an elongated process.

Schön (1985) describes how students learn through communication facilitated through verbal and graphical language used by students and instructors. According to Uluoğlu (1990), these verbal and graphical expressions complement each other in communication through expressions and grammar. Goldschmidt (2005) argues that people have acquired a body of knowledge in their previous education and life experiences and any field-specific knowledge and skills are based on this body of knowledge. Moreover, each person has his or her own cognitive and personal characteristics (Goldschmidt, 2005). When faced with a design task, the designer solves the design problem by using this knowledge and characteristics. Therefore, each person creates a unique conceptual space in the design process. If this process is experienced in the context of an instructor-student desk critique in the studio, this process is shaped through students' and instructors' knowledge and personal-cognitive characteristics (Goldschmidt, 2005). These two components, i.e., instructor and student, are important factors affecting the design learning process. The third component of design learning process is representation.

According to Akin (1986), representation is an important part of design synthesis and there are two types of representation. One of them is external representation as stimulus. The other is internal representation that occurs in mind as the result of external and internal representations. Therefore, representation is a tool for shaping thought (Akin, 1986). According to Goldschmidt (1997), internal representations are the basis of cognition. Internal representation is the visual state of the image of an idea or object in memory. Internal representations can be seen with the mind's eye (Goldschmidt, 2017). When mental representations are organized in such a structured way that identify and predict objects, conditions, phenomenon, and people, they are called mental models (Goldschmidt & Surasky, 2011). Mental models are systems that interact and develop with the environment or the mental models of others. These mental models are shaped by experiences and knowledge (Goldschmidt & Surasky, 2011).

In many disciplines, language is the dominant medium in the transmission of mental models and construction of shared mental models among different individuals. In the design studio environment, the interactive communication between a student and an instructor facilitated through verbal and visual representations targets at achieving a shared mental model. In design learning, different from learning in other fields, visual images are irreplaceable to create a shared mental model (Goldschmidt, 2017). In the design process, the interaction of representations and shared mental models brings new knowledge and creative results (Rouse & Morris, 1986). Therefore, it is possible to say that in design learning environment, representation has an important role and it is one of the main components in the design learning process. The interaction of the three components shapes the design learning process together with cognitive abilities such as thinking, reasoning, mental and interactive imagery. In this study, the role of these abilities in the process is investigated. Our main argument is that studio learning environment is a loosely structured collaborative learning environment supported through external representations facilitating the construction and sustainment of shared mental models. This learning environment is a cognitive system including students, multiple instructors, external representations and internal representations.

The study examines four case studies in a design studio with more than one instructor to understand the construction of shared mental models through visual and verbal communication throughout the whole semester. It especially focuses on how a student's mental model of a design situation keeps changing or remains unchanged in a design studio where students take critiques from different instructors. The students selected for this study are third-year students in the architecture department at İzmir Institute of Technology. They were selected based on their accessibility, availability of data, and volunteering.

The study focuses on the conceptual development process of students’ projects and is based on students’ and instructors’ retrospective accounts of desk critiques, panel reviews and midterm juries. The research carried out in this study is of qualitative nature, using qualitative data collection strategies to examine an elongated design learning process. In this study, data gathering began at the end of the project development. The cases were investigated after the phenomenon. During the research process, semi-structured interviews were used to collect students’ and instructors’ accounts of the design process for each studied student. In these interviews, open ended questions were used to ensure that the accounts would provide rich and detailed data. In the interviews, visual and verbal documents related to students’ projects produced by students and instructors during panel and desk critiques were collected. The collected data and documents were analysed and interpreted in the light of literature studies.
2 Design and Design Learning

Designing and learning are closely related styles of interrogation. At the beginning of the design learning process, design students start to learn how to design as a novice. However, they do not have any conceptual or procedural knowledge about design (Schön, 1983). They do not know the specific meanings of the esoteric conditions of both the operational movements and the related design word knowledge (Schön & Wiggins, 1992). This body of knowledge is used during the practice of the profession. This knowledge is referred to as procedural knowledge (Crowder, 1993). According to Eastman (2001), studio instructors present this tacit knowledge generally in design studios.

Goldschmidt (2005) argues that two types of learning take place in the design studio. These learning types are conceptual learning and professional learning. According to Goldschmidt (2005), the design process, after determining the problem, is shaped by designers through interpreting the problem based on the background knowledge that people have had in their previous education and life experiences. Moreover, each person has his or her own notes with their own cognitive and personal characteristics. These notes and knowledge shape the design process. Conceptual learning is concerned with concept identification and shaping. Professional learning is concerned with using field-specific knowledge to solve a design proposal or concept (Goldschmidt, 2005). Professional learning as described by Goldschmidt (2005) is about the ability to use procedural knowledge (Crowder, 1993). Therefore, design is not just about doing an action. Design activity is based on cognitive abilities. In the design process, cognitive abilities guide the process. These abilities, which include competences such as reasoning, thinking and learning, can be different in each person.

3 Cognitive Components of Design

Design involves different mental stages (Akin, 1986). Designers learn these mental stages by experimenting, thinking, intuiting, and doing. Designers work in a process that proceeds from abstract and ill-defined problems (Dunbar, 1998). The human cognitive system has extraordinary abilities to deal with ill-defined problems such as design (Goldschmidt, 2017). Representation is the basic component of this process both as a mental activity and as an externalization of this activity (Goldschmidt, 2007). According to Goldschmidt (2017), the design process contains certain stages. These stages are acquisition of knowledge, selection of appropriate knowledge, association or transformation, production of alternative synthesis and formation of new design ideas (Goldschmidt, 2017). As in the actual design environment, the design studio has similar stages in the design process (Suwa & Tversky, 1997). While seeking solutions to design problems at hand, students are transforming their knowledge and experiences they have learned in combination with other interactions in the process (Goldschmidt, 2017). A synthesis of existing knowledge and new learned knowledge emerges in instructor-student critiques in the design studio. The resulting product is an example of interactions within the process. The design feedback that is carried out to transfer the mental models of the instructor and the student to each other usually takes place with visual representations.

3.1 Representation

Designers re-represent their mental representations through externalizations, and images that are externalized become internalized again in the mind of the designer. The designer needs representations to describe the image of the design in his/her mind and to communicate with himself/herself and others. They use representations to both solve these problems and create a language (Oxman, 2001). According to Akin (1986), representation is an important part of a physical intuition and design synthesis. Representational activity has an important role in design problem solving and it is used externally in graphic domain or internally in imagery domain (Akin, 1986). Representation is the tool of shaping thought (Akin, 1986). In other words, representation is not only a passive mechanism that externally displays what the mind contains, but it is actively guiding design (Akin & Moustapha, 2004). The relationship between external and internal representations should be examined to understand the importance of representations in the design process (Johnson, 1998). Internal representations and external representations are coupled and enable a complementary cognitive system. External representations are either externalized versions of internal representations or modifications of already existing representations. Everything we perceive with our sense organs, such as visual images, speeches and writings, is an external representation. In general, external representations in the field of design are plan, section, elevation, 3D or 2D images, models, diagrams, graphics, digital representations, or sketches. Unlike internal representations that occur in the mind during design, external representations also allow interaction with other persons and teams involved in the design process (Brereton, 1999).

In design, the most common type of representation is sketch. The reason for this is that the nature of the sketch overlaps with the image as they are both blurred and vague. In the design process, the image is uncertain, blurred and undefined. For this reason, it takes time for the image to become visible. The vague nature of sketch is very suitable
for this situation. Sketching is fast enough that it does not interrupt the flow of thinking. Goldschmidt (2017) argues that sketch is a laboratory where the designer can test solutions. According to Goel (1995), the sources, which are used in the serial sketch process, are obtained from either long-term memory or previous solutions. Each drawing in the sketch process includes both a syntactic source and a semantic source. Sketching enables changes in design along lateral and vertical transformations. The lateral transformation implies a differentiation of thought. Vertical transformation suggests a change of an idea by way of detailing. In these transformations, the freehand sketches facilitate creativity and exploration through their dense and ambiguous structures (Goel, 1995). Thus, lateral transformation reduces the risk of fixations that may occur at the beginning of the design (Goel, 1995). In the design process, serial sketch activity aims to provide new options. This repetition comes with continuous feedback. This process is basically the stage that Goel (1995) refers to as a vertical transformation. In the design process, internal representations and external representations influence each other. At the same time, it is possible to say that they are part of a system where they are constantly changing into one another. Following this line of argument, this study questions how external representations support and/or enable the process of design thinking and learning in the studio environment during interactions among a student and multiple instructors.

### 3.2 Reasoning

Reasoning is one of the cognitive components that determine the response of people to conditions or events (Rittel, 1987). According to Rittel (1987), reasoning is in the essence of design process and design thinking. In design, reasoning is theorized as abductive, deductive and inductive reasoning (Dorst, 2011). When looking for a solution to a design problem, designers transform their knowledge and experience they have learned and continue to learn by combining it with other interactions in the process. In the design process, visual images or representations are a very effective component for some reasoning types such as analogical reasoning (Gentner & Stevens, 1983), case-based reasoning (Kolodner, 1993), pictorial reasoning (Gero, Tham & Lee, 1991) and visual reasoning, which includes mental imagery and visual representations, (Oxman, 2001). According to Oxman (2001), representation which is used in visual reasoning, can be an external representation that can be matched to an internal representation. Studies on visual reasoning show that visual reasoning interacts with external representation in the perceptual process (Schön & Wiggins, 1992). According to Goldschmidt (1991), it is possible to directly access the knowledge contained in the images through pictorial reasoning. However, it is also possible to access knowledge that they do not expressly disclose (Goldschmidt, 1991). Goldschmidt (1991) argues that in the design process, pictorial reasoning takes place in two different ways. The first is seeing that and the other is seeing as. Seeing that is reasoning by perceiving the image as is. In other words, it is a reasoning that does not invoke different associations than its initial and immediate signifier. Seeing as, in contrast, is the result of interaction with association of ideas (Goldschmidt, 1991). Sketching is a process that involves both seeing as and seeing that. Goldschmidt (1991) argues that sketch is a systematic dialectic between seeing as and seeing that.

In the design process, any stimulus recalls knowledge from memory. The recalled knowledge and existing knowledge come together by way of reasoning and a new idea/product is created. This transformation allows the designer to produce an alternative solution. So, reasoning and knowledge transformation is important in the design process. Especially, in design teams like instructor-student, sharing knowledge between team members is important to create alternative solutions. So, sharing knowledge allows knowledge transformation in this process. In design, sharing knowledge is sharing mental models. Shared mental models are created by way of interactive imagery. Images in interactive imagery are not taken directly from memory. A person can take an image of a previously perceived image in this process. According to Goldschmidt (1991), imagery is the essence of seeing something as something else. If this happens in the sketch process or with any external representation, it is “interactive imagery” in words of Goldschmidt (1991, p. 131). The interactive imagery allows the designer to communicate with the materials (Goldschmidt, 2001).

### 4 Case Studies

Four students’ project developments were investigated in this study. These were analysed specifically with a focus on their conceptual phase. The project development continued for fourteen weeks and in some cases the conceptual phase continued till after the tenth week when the third midterm of the semester was scheduled. The students were asked to design a work place that will foster creativity and collaboration among the workers as an alternative to office plaza work environments. In each case study, the relationship between design learning and interactive imagery facilitated through shared mental models are examined. Lateral and vertical transformations in students’ representations are examined based on Goel’s study (1995). In addition to this, episodes of seeing as and seeing that, as defined in the work of Goldschmidt (1991), are identified in each design process. Each student’s process is broken into steps according to the nature of transformations in their schemes accompanied with the determination of the kind of pictorial reasoning, i.e., seeing that or seeing as, used by the student.
4.1 Student 1

The student began the project with the idea of “creating connections between high buildings” but quickly after changed his concept as “work-game”. During the conceptual development process of his project, he tried to reflect the concept requirements on his design scheme. His project was transformed mostly through lateral transformations instigated by instructors’ contributions and his willingness to pursue them at every step. After each communication with instructors, the student managed to conceptually shift his proposal throughout the conceptual phase. It is possible to interpret that the student took into consideration the instructors’ proposals and he tried to use them and expand on them. Therefore, his attitude is determined to be closer to that of an explorer. The process of the student is summarized graphically in consecutive steps: Step 1 (Figure 1), Step 2 (Figure 2), Step 3 (Figure 3), Step 4 (Figure 4), and Step 5 (Figure 5); and the types of reasoning and transformations are tabulated (Table 1, Table 2, Table 3, Table 4, and Table 5) as follows:

Step 1: Panel Review

<table>
<thead>
<tr>
<th>Step 1</th>
<th>Type of Reasoning</th>
<th>Type of Transformation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student</td>
<td>seeing as</td>
<td>lateral transformation</td>
</tr>
<tr>
<td>Instructor 1</td>
<td>seeing as</td>
<td>lateral transformation</td>
</tr>
<tr>
<td>Instructor 3</td>
<td>seeing as</td>
<td>x</td>
</tr>
</tbody>
</table>

Figure 1. Step 1 of Student 1

Step 2: Desk Critique with Instructor 1

<table>
<thead>
<tr>
<th>Step 2</th>
<th>Type of Reasoning</th>
<th>Type of Transformation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student</td>
<td>seeing as</td>
<td>lateral transformation</td>
</tr>
<tr>
<td>Instructor 1</td>
<td>seeing as</td>
<td>lateral transformation</td>
</tr>
</tbody>
</table>

Figure 2. Step 2 of Student 1
Step 3: First Midterm Jury

Table 3. Step 3 of Student 1

<table>
<thead>
<tr>
<th>Step 3</th>
<th>Type of Reasoning</th>
<th>Type of Transformation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student</td>
<td>seeing that</td>
<td>vertical transformation</td>
</tr>
<tr>
<td>Instructor 2</td>
<td>seeing as</td>
<td>lateral transformation</td>
</tr>
<tr>
<td>Instructor 3</td>
<td>seeing as</td>
<td>x</td>
</tr>
</tbody>
</table>

Figure 3. Step 3 of Student 1

Step 4: Desk Critique with Instructor 4

Table 4. Step 4 of Student 1

<table>
<thead>
<tr>
<th>Step 4</th>
<th>Type of Reasoning</th>
<th>Type of Transformation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student</td>
<td>seeing as</td>
<td>lateral transformation</td>
</tr>
<tr>
<td>Instructor 4</td>
<td>seeing as</td>
<td>lateral transformation</td>
</tr>
</tbody>
</table>

Figure 4. Step 4 of Student 1

Step 5: Desk Critique with Instructor 1

Table 5. Step 5 of Student 1

<table>
<thead>
<tr>
<th>Step 5</th>
<th>Type of Reasoning</th>
<th>Type of Transformation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student</td>
<td>seeing as</td>
<td>lateral transformation</td>
</tr>
<tr>
<td>Instructor 1</td>
<td>seeing as</td>
<td>lateral transformation</td>
</tr>
</tbody>
</table>
Discussion

In this case, the student achieved a final scheme mostly with lateral transformations (in Step 1, Step 2, Step 4, and Step 5) in the conceptual development process (Figure 6). And also, in the conceptual phase of this student, pictorial reasoning is mostly “seeing as” (in Step 1, Step 2, Step 4, and Step 5) (Figure 7). It is possible to say that the student used the conceptual and procedural knowledge which is given by the instructors (Figure 8).
4.2 Student 2

The student’s concept was “ant colony”. During the conceptual development process of his project, he did not make many changes to the form and the concept of the project. He did not want to change his project radically. Therefore, his attitude is labelled as scrutinizer. At this point, it is possible to interpret that the student did not take into consideration the instructors’ proposals closely at the jury, panel review and desk critiques. In this case, interactive imagery remained limited with the initial image proposed by the student. During the project process, he made little changes in both conceptual and technical aspects of his project. The process of the student is summarized graphically in Step 1 (Figure 9), Step 2 (Figure 10), Step 3 (Figure 11), Step 4 (Figure 12), and Step 5 (Figure 13) and the types of reasoning and transformations are tabulated (Table 6, Table 7, Table 8, Table 9, and Table 10).

**Step 1: Panel Review**

<table>
<thead>
<tr>
<th>Step 1</th>
<th>Type of Reasoning</th>
<th>Type of Transformation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Instructor 1</td>
<td>seeing as</td>
<td>x</td>
</tr>
</tbody>
</table>

**Step 2: Desk Critique with Instructor 1**

<table>
<thead>
<tr>
<th>Step 2</th>
<th>Type of Reasoning</th>
<th>Type of Transformation</th>
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</thead>
<tbody>
<tr>
<td>Student</td>
<td>seeing that</td>
<td>lateral transformation</td>
</tr>
<tr>
<td>Instructor 1</td>
<td>seeing as</td>
<td>lateral transformation</td>
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</tbody>
</table>
Step 3: Desk Critique with Instructor 2

Table 8. Step 3 of Student 2

<table>
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</tr>
</thead>
<tbody>
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<td>seeing as</td>
<td>lateral transformation</td>
</tr>
<tr>
<td>Instructor 2</td>
<td>seeing that</td>
<td>vertical transformation</td>
</tr>
</tbody>
</table>

Step 4: First Midterm Jury

Table 9. Step 4 of Student 2

<table>
<thead>
<tr>
<th>Step 4</th>
<th>Type of Reasoning</th>
<th>Type of Transformation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student</td>
<td>seeing that</td>
<td>vertical transformation</td>
</tr>
<tr>
<td>Instructor 1</td>
<td>seeing as</td>
<td>x</td>
</tr>
<tr>
<td>Instructor 2</td>
<td>seeing as</td>
<td>vertical transformation</td>
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</tbody>
</table>
Step 5: Desk Critique with Instructor 1

**Table 10. Step 5 of Student 2**

<table>
<thead>
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<th>Step 5</th>
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<th>Type of Transformation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student</td>
<td>seeing that</td>
<td>vertical transformation</td>
</tr>
<tr>
<td>Instructor 1</td>
<td>seeing that</td>
<td>vertical transformation</td>
</tr>
</tbody>
</table>

Discussion

The student achieved a final product through both lateral transformation (in Step 2, and Step 3) and vertical transformation (in Step 4, and Step 5) in the project development process (Figure 14). It is possible to say that in the middle of the process, the student had a conceptual shift triggered by critiques. Student’s pictorial reasoning is mostly seeing that (in Step 2, Step 4, and Step 5) (Figure 15). It is possible to say that the student did not make conceptual changes during the majority of the process (Figure 16).
Interactive Imagery and Shared Mental Models in Design Learning

Figure 14. Transformation process of Student 2

Figure 15. Pictorial reasoning process of Student 2

Figure 16. Design path of Student 2
4.3 Student 3

This student began the project with “creating a pedestrian axis” but he continued with a different concept. This concept emerged from the valley metaphor which was proposed by Instructor 1. During the conceptual development process of his project, he could not reflect properly on the metaphor. At some points the student directly copied some proposals which were offered by the instructors. Therefore, his attitude is described as a follower. He did not make an extra effort in adapting the suggestions to the project. In other words, he did not mix the instructors’ suggestions with his own ideas. Perhaps, at the beginning of the project process, he did not have the knowledge or ability to represent these changes. However, during desk critiques, jury, and panel review, he conceptually developed his project through applying the instructors’ proposals. The process of the student is summarized graphically in consecutive steps: Step 1 (Figure 17), Step 2 (Figure 18), Step 3 (Figure 19), Step 4 (Figure 20), and Step 5 (Figure 21); and the types of reasoning and transformations are tabulated (Table 11, Table 12, Table 13, Table 14, and Table 15).

**Step 1: Desk Critique with Instructor 4**

<table>
<thead>
<tr>
<th>Step 1</th>
<th>Type of Reasoning</th>
<th>Type of Transformation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Instructor 4</td>
<td>seeing as</td>
<td>x</td>
</tr>
</tbody>
</table>

Figure 17. Step 1 of Student 3

**Step 2: Desk Critique with Instructor 1**

<table>
<thead>
<tr>
<th>Step 2</th>
<th>Type of Reasoning</th>
<th>Type of Transformation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student</td>
<td>seeing that</td>
<td>lateral transformation</td>
</tr>
<tr>
<td>Instructor 1</td>
<td>seeing as</td>
<td>lateral transformation</td>
</tr>
</tbody>
</table>

Figure 18. Step 2 of Student 3
Step 3: First Midterm Jury

Table 13. Step 3 of Student 3

<table>
<thead>
<tr>
<th>Step 3</th>
<th>Type of Reasoning</th>
<th>Type of Transformation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student</td>
<td>seeing that</td>
<td>vertical transformation</td>
</tr>
<tr>
<td>Instructor 2</td>
<td>seeing as</td>
<td>lateral transformation</td>
</tr>
<tr>
<td>Instructor 4</td>
<td>seeing that</td>
<td>x</td>
</tr>
</tbody>
</table>

Figure 19. Step 3 of Student 3

Step 4: Desk Critique with Instructor 3

Table 14. Step 4 of Student 3

<table>
<thead>
<tr>
<th>Step 4</th>
<th>Type of Reasoning</th>
<th>Type of Transformation</th>
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<tbody>
<tr>
<td>Student</td>
<td>seeing that</td>
<td>lateral transformation</td>
</tr>
<tr>
<td>Instructor 3</td>
<td>seeing as</td>
<td>lateral transformation</td>
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</table>

Figure 20. Step 4 of Student 3

Step 5: Desk Critique with Instructor 1

Table 15. Step 5 of Student 3

<table>
<thead>
<tr>
<th>Step 5</th>
<th>Type of Reasoning</th>
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</thead>
<tbody>
<tr>
<td>Student</td>
<td>seeing that</td>
<td>lateral transformation</td>
</tr>
<tr>
<td>Instructor 1</td>
<td>seeing as</td>
<td>lateral transformation</td>
</tr>
</tbody>
</table>
The student achieved a final product mostly with lateral transformations (in Step 2, Step 4, and Step 5) in the project development process (Figure 22). It is possible to say that the student produced a new scheme mostly with conceptual shifts from the knowledge which was obtained from critiques and juries. But his pictorial reasoning is seeing that at all steps (Figure 23). It is possible to say that the student did not add any interpretations on instructors’ proposals which were given at the critiques (Figure 24).
4.4 Student 4

The student’s concept was “cross pollination”. During the conceptual development process of her project, she could not adequately reflect her concept and metaphor. Instructors proposed different perspectives to develop her project at the jury, panel review and desk critiques. However, the student could not grasp the different perspectives. Thus, she developed her project with only minor changes, but she managed to keep her initial concept until the end of her project. She made efforts to reflect the concept to the project. She took into consideration the instructors’ suggestions during the project development process. Although she was not very successful while adapting the instructors’ suggestions to the project, she was eager to develop it. Therefore, her attitude is characterized as a struggler. The process of the student is summarized graphically in consecutive steps: Step 1 (Figure 25), Step 2 (Figure 26), Step 3 (Figure 27), Step 4 (Figure 28), and Step 5 (Figure 29); and the types of reasoning and transformations are tabulated (Table 16, Table 17, Table 18, Table 19, and Table 20).

**Step 1: Panel Review**

<table>
<thead>
<tr>
<th>Step 1</th>
<th>Type of Reasoning</th>
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<tbody>
<tr>
<td>Student</td>
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<td>vertical transformation</td>
</tr>
<tr>
<td>Instructor 1</td>
<td>seeing as</td>
<td>x</td>
</tr>
<tr>
<td>Instructor 2</td>
<td>seeing as</td>
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</tr>
<tr>
<td>Instructor 4</td>
<td>seeing as</td>
<td>x</td>
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</table>

![Figure 25. Step 1 of Student 4](image)
**Step 2: Desk Critique with Instructor 1**

**Table 17. Step 2 of Student 4**

<table>
<thead>
<tr>
<th>Step 2</th>
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<tbody>
<tr>
<td>Student</td>
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<td>lateral transformation</td>
</tr>
<tr>
<td>Instructor 1</td>
<td>seeing as</td>
<td>lateral transformation</td>
</tr>
</tbody>
</table>

**Figure 26. Step 2 of Student 4**

**Step 3: First Midterm Jury**

**Table 18. Step 3 of Student 4**

<table>
<thead>
<tr>
<th>Step 3</th>
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<tbody>
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<td>vertical transformation</td>
</tr>
<tr>
<td>Instructor 1</td>
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<td>x</td>
</tr>
<tr>
<td>Instructor 2</td>
<td>seeing as</td>
<td>lateral transformation</td>
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</table>

**Figure 27. Step 3 of Student 4**

**Step 4: Desk Critique with Instructor 2**

**Table 19. Step 4 of Student 4**

<table>
<thead>
<tr>
<th>Step 4</th>
<th>Type of Reasoning</th>
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<td>Instructor 2</td>
<td>seeing as</td>
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</tbody>
</table>
Interactive Imagery and Shared Mental Models in Design Learning

Figure 28. Step 4 of Student 4

Step 5: Desk Critique with Instructor 1

Table 20. Step 5 of Student 4

<table>
<thead>
<tr>
<th>Step 5</th>
<th>Type of Reasoning</th>
<th>Type of Transformation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student</td>
<td>seeing that</td>
<td>vertical transformation</td>
</tr>
<tr>
<td>Instructor 1</td>
<td>seeing as</td>
<td>lateral transformation</td>
</tr>
</tbody>
</table>

Figure 29. Step 5 of Student 4

Discussion
The student achieved a final scheme mostly with “vertical transformations” (in Step 1, Step 3, Step 4, and Step 5). At this point, it is possible to say that the student produced a new scheme mostly with changes concerning detailing (Figure 30). The student created a new scheme with conceptual knowledge during the reasoning process. In the project process of this student, pictorial reasoning is mostly seeing that (in Step 1, Step 3, Step 4, and Step 5) (Figure 31). At this point, it is possible to state that the student could not add new conceptual approaches to her scheme after desk critique or juries (Figure 32).
4.5 Results

In this study, four cases were discussed and analysed. In each case, conceptual development processes of students’ projects were analysed in terms of visual reasoning strategies, i.e., seeing as and seeing that, used by instructors and students and of shifts in design ideas, i.e., lateral and vertical transformations. When four cases are compared, it is possible to say that each case illustrates a different process. Both students and instructors during the interactive
imagery sessions of design critiques created new images with externalized mental models through external representations facilitated by interactions between different media, the instructors, and the students.

In these cases, the initial schemes are conceptually and/or formally transformed. These transformations took place differently in each case (Figure 33). At panel reviews, midterm juries, and desk critiques, instructors provided conceptual and procedural knowledge to the students. Students, in turn, designed new schemes with conceptual and procedural knowledge during the pictorial reasoning process. However, each student developed a product with different pictorial reasoning. When the pictorial reasoning processes of the students are examined, it is possible to say that each student follows a different process (Figure 34). Transformations (lateral-conceptual, vertical-detail) and pictorial reasoning styles (seeing as, seeing that) occurred with different frequencies and followed different paths in the process of each student. The reasons for these differences could vary from case to case (Figure 35).

![Figure 33. Transformation process of students](image1)

![Figure 34. Pictorial reasoning process of students](image2)
According to Goldschmidt (2005) and Schön (1985), one of the reasons is the personal interpretation of the design situation in hand by each designer. The design process is shaped by designers through interpretations of the problem. However, the designer is not objective in this interpretation process. The reason for this could be related to background knowledge that people have had in their previous education, their life experiences and their own notes with their own cognitive and personal characteristics. These notes and knowledge shape the design process. Furthermore, in the design studio environment, instructor-student as a design team work together. A synthesis of existing knowledge and new learned knowledge emerges during instructor-student interactions. In other words, a new mental model emerges with shared mental models and this can be different in each team. Especially, in these cases, the final schemes emerge through synthesizing four different instructors’ personal and cognitive characteristics in addition to the students’ own personal and cognitive characteristics.

Briefly, in this study, different processes were observed due to the nature of the design process and the cognitive characteristics of the individuals. Although the processes of students were different from each other, it is possible to state that interactive imagery and shared mental models contributed to the students’ design learning process through the learning of conceptual development.

5 Conclusion

The aim of this study was to investigate two questions: how interactive imagery facilitates construction of shared mental models in a design learning environment and how interactive imagery that occurs in the desk critique process performed by more than one instructor through the rotation method affects the student’s conceptual space (solution space). Within the scope of the study, two cognitive components of design were explained to answer the research questions. These cognitive components are representation and reasoning. The effects of these components on design learning and design were examined. According to Uluoğlu (2000), design can be taught and learned through interaction between designers. Design activity is based on cognitive abilities that foster reflection on action and on other reflections. This approach explains why design cannot be taught with existing knowledge and skills (Uluoğlu 2000). When faced with a design task, the designer solves the design problem by using his/her knowledge and characteristics. Therefore, each person can create a different conceptual space in the design process.

In this study, the interactive imagery that takes place during the design process allows many different mental models. In a teamwork of instructor-student, mental models shape the process giving way to a synthesis of mental models. Therefore, each design process is unique and also is not linear. Being aware of cognitive activities, sharing mental models, and understanding the role of representations in guiding the process can contribute to design learning and teaching processes. In the design studio environment, the realization of the interactive imagery and shared mental models can affect the conceptual space of the students. It is possible that being exposed to different instructors would enhance interactive imagery.

When the rotational critique method applied in these cases is examined, it can be said that there are positive and negative aspects. As a positive aspect, students’ designs benefit from four different instructors’ personal and cognitive characteristics in addition to their own personal and cognitive characteristics. This method has the potential to expand the conceptual space (solution space) of students and to avoid early fixations or strict and utmost control of a single instructor over students’ projects. However, sometimes this situation may be different. In the process, the student or
instructor may be the dominant one. When the student is dominant, he or she can be fixated, stubborn, or a scrutinizer. When the instructor is dominant, students can become explorers, followers or submissive. These possibilities may cause or block divergence in the process. However, in the learning process, lack of convergence is not a failure because this possibility provides more opportunities for the students to try out new ideas. If it is considered that studio learning is a process rather than a product, this could be beneficial. On the other hand, this method can create confusion in the mind of the students and prevent them from arriving at a solution at all. However, when everything is taken into consideration, instructors’ awareness of the relationship between the cognitive activity and the design process can lead to more successful results in design learning.

References


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Material Education in Design: From Literature Review to Rethinking

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Abstract: The world of materials for design is continually changing and evolving, not only thanks to technological advancements, but also thanks to the continuous original applications by designers, as well as the reinterpretation and understanding by design researchers that reveal new ideas, suggestions and unconventional paths. It is essential and fundamental for design educators to understand how to educate students and let them be autonomous and prepared for the choice or creation of materials and processes to complete their projects nowadays. The material is not only the object but also the tool or media around which most of the design education shapes: transferring the knowledge of materials’ technical properties or experiential qualities to design students is essential, and in the process on materialising the design projects, students are also being educated by their hands-on experiences. This paper provides a literature review to interpret the nature of material education in design and lists significant aspects. It is structured into four parts: the role of material in design education; learning through practice with materials; considerations on material in design; and the highlighted aspects in material teaching and learning processes. This paper lays the foundation for future material education research.

Keywords: material education; material experience; design education; material literacy

1 Material in Design and Design Education

The material, as we are using here, refers to the substance of everything we see and touch. Designers have always appreciated materials because the design practice can also be interpreted as a process that allows shaping a better world thanks to materials and their qualities. The material is an essential element for transforming a design concept into reality, and furthermore, it can drive innovation, give inspirations and meaning to the project. All designers use materials and can express their judgments or formulate their thoughts about their relationship with that matter (Manzini, 1986; Ashby & Johnson, 2013). In the end, the understanding of design cannot be separate from the materials and processes that are useful in shaping it.

Nowadays, in design education, students are required to materialise their concepts with correct materials and more and more, they are encouraged to explore materials actively through practical activities as well. Based on the existing
literature and our experience as researchers and instructors, we believe that materials education is an essential part of design education as a whole.

This paper will provide a holistic view of materials and design education, and lead to a thorough inquiry on the past and present conditions of material education in the contest of design.

1.1 Design Education Background

We are discussing materials within the discipline of design, for which it is relatively difficult to propose a satisfactory and shared definition (Redström, 2017). However, this does not mean that scholars cease their efforts to formulate an adequate design definition. On the contrary, as a broad subject where people’s diverse experiences as well as their cultural backgrounds are involved, design, as a term, has been given too much explanation (Findeli, 1990). The definition of design contains too much, depending on whether it is observed as a concept, knowledge, project, process, product, or even a way of being. These definitions and contents remind us that design is not a simple matter that can be performed according to a specific model. Regardless, the proliferation of theories justifies design itself, and the design education is interwoven with many things, for example: the combination and interaction of art and science, technology, the particularity and universality in different cultural contexts, and the diverse methods with which knowledge and experiences are acquired.

We want to start considering the theories related to design education beginning from what was formulated by John Dewey who proposed that the principal meaning of education is a matter of the ability to act intelligently, constantly cultivating the capability for a person to proceed in a changing world (Dewey, 1916; 1938; 1946). The psychological aspects of education emphasised that the personal intrinsic and inherent abilities provide a starting point for all educational activities. Learning is a process of understanding and improving personal skills, and teachers are asked to provide an environment and the guidance for that process. Besides, the social background gives an interpretation of individual capabilities in terms of social activity. Dewey emphasised the concept of experience—he believed that the teaching method should consider experience not only as the goal of education but as the method and process of achieving education as well (Cross, 1983).

The exploration and reflection of design education began with Bauhaus, universally considered the first school of design, where the issues related to design education were also addressed theoretically for the first time (Wick, 2000). The Bauhaus’s educational approach was a dynamic and growing process with constant improvement to the professors’ teaching curriculum (Cross, 1983), considering one’s own sensations and expressions as the foundation (Itten, 1963). Here, the importance of experience and practice, and materials and processes were highlighted as vital components of the education approach. According to the Bauhaus Educative Scheme, the basic course was structured by “study of materials and tools”, “study of nature”, “study of materials”, “space study - colour study - composition study”, and in the third shell in which the centre of the circle is the material (clay, stone, wood, metal, glass), textiles, and colour. The principal aim was to encourage students to explore primary and unique material characteristics based on hands-on exploration (Rognoli & Levi, 2004).

Bauhaus was influenced by Dewey’s philosophy of epistemology and constructed the practice-based knowledge generation within the courses accordingly (Moholy-Nagy, 1947; Fiedler & Feierabend, 1999). We can outline two main categories, one being the plastic elements such as line, shape, colour, texture and so forth, and another category being the materials and specific tools (Findeli, 1990). It had a clear purpose: offer “a test of students’ abilities, ...help[] shorten the road of self-experience, ...[and] give [the students] ample opportunities to make a careful choice of his field of specialisation later” (Educational Program, 1937-38). According to the methodological structure of this introductory course, the material is a tool and a media in design education. The practical process with materials and effective processing of materials helped the students understand their design methods and gain design capabilities.

1.2 Material as Design Knowledge

The characteristic of design knowledge is defined considering both the feature of knowledge and the design activities. It is a mix of designers’ experience and contextual information about the production and use of products. Explicit knowledge refers to knowledge that is transmittable in formal and systematic language (Nonaka & Takeushi, 1995). In design activities, analytical and synthetic methods are the driving forces to promote the development of a design solution through formal structures (Jones 1970; Papanek, 1972; Woodham, 1997). Opposite to this, tacit knowledge is personal, context-specific and hard to formalize and communicate (Nonaka & Takeushi, 1995). It is embedded in individual experience and involves many personal intangible factors, such as belief, perspective, value system. Tacit
knowledge cannot be articulated easily, it generates through personal intuition and experience. These two types of knowledge interact and interweave to each other in design activities.

Material itself is design knowledge, it has technical attributes which can be transmitted from teacher to students formally. Furthermore, through intuitive experience of materials with the five senses, materials help people achieve tacit knowledge and perceive the world all around.

1.3 Material in Design Curriculum and Pedagogy
From the detailed curriculum in classical design schools we move our sights to the macro perspective of the educational model. There are two opposite poles in design education: content and pedagogy (Findeli, 1990). Some design schools are content-oriented; they emphasize the curriculum and deliver scientific and technical skills to students, while other design schools are pedagogic predominates, they are more humanistic (Read, 1943) and process-oriented. This dualism is intrinsic in design education: curriculum and pedagogy are two aspects that cannot be separated in design education, and effectiveness of education depends on how to achieve balance between them. In design education, besides the outward study and research on science and technology, students should be balanced by inward looking, thinking and spiritual focus (Itten, 1963), which means that students need to understand the necessary theoretical foundations and also establish their own ideological backgrounds for design in practice. Content and processes are equally important in design education.

Thinking through this dialectic dualism, material has two roles in design education. First, it is the content of design education: the knowledge of the materials itself (explicit knowledge) is essential to students —almost all of the design programs have a material mandatory course in the first year. Second, material is a tool and media in the design and design education process: by encouraging students to undertake practical activities and gain materials experience, students increase their design capabilities. In summary, teachers not only transfer explicit material knowledge to students, but also emphasize practice to cultivate students with their individual differences in design learning, engage them tinkering with materials, in order to understand the attributes of materials, select proper materials or create their own materials.

2 Learning through Practice with Materials
How do students learn through practice in design, with materials? John Dewey’s theory of experience (Dewey, 1938) laid a solid foundation for later practice-based educational theory. Influenced by his and other scholars’ (Montessori, Froebel, Pestalozzi, etc.) research, Jean Piaget coined a theory of learning known as “constructivism.” He emphasized that knowledge in one’s mind does not result from receiving information transmitted by others without an internal reprocessing — learners construct knowledge based on their experience (Piaget, 1976). Donald Schön generated more detailed and profound theories called reflective practice for clarifying this re-processing of knowledge, by introducing concepts such as reflection-on-action and reflection-in-action (Schön, 1983). Schön pointed out that, the developmental insight of people is based on paying critical attention to practical values and theories. In other words, “examining practice reflectively and reflexively” (Bolton, 2010). One of the most typical models of reflective practice is the experimental learning (Kolb, 1984), which provides a method where a person’s abilities can be assessed in the same language that can be commensurability measured. It gives us a holistic perspective on learning, including experience, perception, cognition and behaviour — considering the journey on concrete experience, reflective observations, abstract conceptualization and active experimentation as a cyclic learning process.

In essence, these theories clarified how students acquaint design knowledge and acquire design capabilities in design practice; they can also inspire design educators with a large-scale picture of how to guide and engage students in the practice through materials. In the current design education context, two emerging phenomena concerning materials-related practice are highlighted: the emergence and democratization of makerspaces, and the emphasis of material tinkering.

With the development of science and technology and the popularity of fabrication tools, the democratization of individual fabrication brings the relationship between designers, technologies, production processes, and materials to a new dimension (Rognoli et al., 2015). The popularity of makerspaces as fab labs (Gershenfeld, 2007) in schools and universities (Blikstein, 2013; Martinez & Stager, 2013) gives students more access to materials and tools for processing materials, and engages students more with the knowledge of digital crafts and transformation of materials in novel and creative ways (Zhou et al., 2018). Besides, countless websites and social networks where makers share ideas facilitate and engage the learning and creating (Martinez & Stager, 2013).
As a behavioral level of material practice in design, scholars introduced the term of “material tinkering”: the practice of direct, creative, and iterative experimentation on materials (Parisi et al., 2017). Tinkering is a mindset, which refers to a playful way to approach and solve problems through direct experience (Martinez & Stager, 2013; Wilson & Petrich, 2014). Through material tinkering, learners can directly be engaged with physical samples of materials and generate their own sensoriality of materials. Here it’s important to elaborate the transition of the way designers view the material, and the impact it brings.

3 Materials in Design

3.1 Material Selection

From the past to now, the most fundamental consideration of material in design is to materialize the design concepts by selecting the proper materials. There are many tools and guidebooks on helping designers and design students to select the materials they want. The most comprehensive theory about material selection in design is from Ashby and Johnson (2009), in their book “Material and Design”. It mentions that material selection relies on both deductive and inductive reasoning. Deductive reasoning (selection by analysis) is a matter for choosing the best materials that fits the functionality needs with perfect technical attributes, while the inductive method (selected by synthesis) is used on perception and visualization, which relies on the synthesis competence of designers and their previous experiences. Besides these two methods, there are also two other ways of selecting: by similarity or by inspiration. In short, designers use a comprehensive approach in selecting materials.

Materials are multi-dimensional: besides the engineering dimension (the technical attributes), they have a usability dimension related to ergonomics and interfaces, an environmental dimension considering their sustainability, an aesthetics value which elicits people’s senses and set up their material personalities. With such considerations, the theories and methods of material selection are getting constantly enriched as well as going through a transition, which emphasizes the relation between people and materials.

3.2 Materials Experience

Designers also focus on the attributes that describe personality or character, not just the technical attributes of materials: their visual and tactile attributes (an aesthetic perspective), their associations and meanings (an ethical perspective), as well as the emotions they evoke (a humanities perspective). Following Ezio Manzini’s seminal book “Material of Invention” (Manzini, 1986) where for the first time the human interactive and experiential qualities of materials were emphasized, many researches and theories for guiding students to explore and measure the experimental characteristics of materials emerged (e.g. van Kesteren, 2008; Ashby & Johnson, 2009; Karana, 2009; Pedgley, 2009; Rognoli, 2010; Zuo, 2010; Karana, Pedgley & Rognoli, 2014). In design education, students are encouraged to experience materials samples with their senses, to objectivize the samples intellectually and to realize them synthetically.

The experiential activities with materials play an increasingly important part in teaching and learning process of design, and the term of experience-centred materials selection emerged recently. Scholars refer to the experience that people have with and through the materials as materials experience (Karana et al., 2008). This is a concern for the experience of aesthetics, meaning being evoked and emotional being responded by materials. And, with the continuous development of relevant theories and research on this term, materials experience acknowledges the active role of materials “not only in shaping our internal dialogues with artifacts, but also in shaping ways of doing and practices” (Karana et al., 2015, p. 37). Accordingly, four levels of materials experience are being defined: sensorial, interpretative (meanings), affective (emotions), and performative (Giaccardi et al., 2015). All these four components of materials experience are highly intertwined with subject-, object-, context-, and time-dependent attributes (Karana et al., 2015). Related active learning for these components can deliver a good foundation for student appreciation and action on designing for material experiences (Pedgley et al., 2016).

3.3 Gaining Insight and Foresight

The transition from technical attributes of materials to materials experience witnesses the changing perspectives in the current didactic emphasis and approaches in design.

Material opens up our view of design, craftsmanship, history, culture and the future. From a craftsmanship perspective, designers are able to create unique, personal or durable products with the capabilities to feel the passage of time and recognize and rationally apply the imperfection of materials (Rognoli et al., 2015). In terms of a social and environmental perspective, sustainability of materials, revived materials and bio-based materials, are frequently
occurring issues in design programs, which gives a design project multi-levels of meaning and interpretation. Besides, the generation and development of novel materials such as DIY materials (Rognoli et al., 2015; Ayala-Garcia & Rognoli, 2017) and ICS materials (Rognoli et al., 2017; Parisi et al., 2018) are getting into the designer’s and design educator’s eyesight. Students are beginning to actively create new materials to achieve their design expression. These emerging materials are not only able to provide new and unique experiential qualities (Rognoli, 2015), but also appear to open the door to a new form of ethics and a possible aesthetic of the future (Celi et al., 2018).

4 Next Generation of Material Education in Design

In the following section, with respect to the state of the material in design and design education, we define the material education in design and highlight its important aspects.

4.1 Material Education in Design, for Design, through Design

We discuss the material education in design, which refers to the educational process centred on materials in design, or design education activities that consider material as an aspect. As we mentioned before, in design process material itself can be defined as knowledge and simultaneously, as a medium for acquiring design abilities (design-related tacit knowledge). Therefore, material education in design includes both the material knowledge transfer and the usage of materials as aspects or tools to cultivate students’ insight and foresight in design.

Material education and design are multi-beneficial. First, the material education we are talking about starts from a design learning environment, training students to understand and use materials from a designers’ perspective. Moreover, the outcome of material education is directly targeting design students and thereby future designers. Finally, design methods and mindset help investigate and analyse the process, and develop the requisite methodology and tools of material education.

4.2 Four Aspects in Material Education

There are many factors to be considered in the process of material education. Considering the nature of design and design education as well as the current state of materials in design, we can view material education from four aspects: competence, tool, space, and service (Figure 1).

Figure 1. Four aspects of material education in design.

Competence refers to the material abilities designers need to have in design. It is not only a matter of explicit knowledge, but also tacit, experience-based knowledge. Therefore, in addition to direct knowledge transfer, design practice is essential. Students can have an intuitive feeling for the material itself through the encounter with material samples. The competence is also reflected in the proficiency of students in material practice and the mastery of relevant material processing methods.

Research on tools, spaces and services can answer the question of how to enhance material education in design. The tools refer to teachers’ teaching methods, especially how teachers guide and encourage students to explore material experiences in driving their designs. Tools in material education can be a guideline, a touchpoint, or a combination of both. Currently, representative and classic tools in material education have different bias of contribution, some focus
on guiding students to clarify their experience with materials, and some start from technic, market or production perspectives to analyse materials. The significance of the tool is to encourage students to take the initiative to discover, experience and learn on materials or with materials. It starts with the student's personality and inner feelings, with the final aim of improving students' comprehensive design ability.

Material education activities can happen in diverse spaces; besides the classroom, the material library and fab lab can provide hands-on experiences to designers, navigate the materials selection process, considering that many aspects of materials are currently unquantifiable in experimental dimensions (Wilkes & Miodownik, 2018). For instance, a material library can provide access to physical samples of materials, which helps designers and design students translate material database and catalogue information to tangible experiences (Akın & Pedgley, 2016). Of course, such encounter behaviours may occur not only in the materials libraries, because these samples can be also presented during a lecture in front of a class, and students are allowed to touch and feel them.

Services can connect the environment and stakeholders together and enhance the educational process. In the university, the administrative system can provide an important service for students and teachers to share documents and slides, publish information and deliver homework. Besides, there are many material-related online services that can enhance design teaching and learning, such as the CES EduPack, with its comprehensive database of materials and processed information. Services provided by different companies may also help, by engaging transdisciplinary collaboration in design. Following on the material library example, a private company could coordinate the relationship between material researcher, designer and user needs (Wilkes & Miodownik, 2018). Design schools, as important stakeholder, can be also engaged in these kinds of collaborations.

Furthermore, material education should be viewed in a holistic context, and these aspects cannot be analysed in isolation. The material education research needs to be taken into account on the specifics of the competencies, skills, tools, services, and spaces best suited to enhance the concept of materials experience in design education and provide guidance for the future development of materials education.

5 Conclusion

This paper begins with a historical overview of the role of materials in design education and summarizes the state-of-the-art of material education. It provides a literature review, positioning material education in design within the existing knowledge (Figure 2), and highlights the important aspects of this teaching and learning journey. Material in design education is both the content and the pedagogic tool. Material education is not only for the cultivation of students' awareness and competence of materials, but is also for guiding students to actively tinker with materials, to achieve hands-on experience. The way designers view materials is going through a transition: they are starting to focus more on the experiential attributes, rather than the technical attributes.

The form of material education in design can be more diverse with the development of the four principal aspects: competences, tools, spaces, and services. Material education can enhance students' ability in materials and their design capabilities comprehensively from diverse starting points and perspectives. It can also encourage more practical design activities with hands-on experiences. Relevant creative spaces can be developed and applied to this teaching and learning, enabling students’ design works into a more open and collaborative process. Meanwhile, material education can become more transdisciplinary for future designers: more stakeholders could be involved into the educational process and share their knowledge. Material-related services could enter the universities’ classroom, providing students with more resources, connecting their projects to the market, and helping them get closer to their target users. These could be more helpful in opening up students’ minds compared to traditional didactics. Figure 3 shows how these four aspects (competence, tool, space, and service) would enhance future material education.
Research of material education needs to be considered both for design and through design, since material education and design complement each other. Research and development on material education should keep pace with what is happening right now on this issue. Although re-elaborating the relationship between design, materials, and education can provide a theoretical basis for material-related educational process in this changing design world, material education research should contribute to the continued and regular discovery of current educational activities, in order to provide a vision of future materials education as well as design education.
References


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A UX Pedagogy on Multimodal Aspects of Emotions

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Abstract: Everyday products are becoming increasingly complex, at a time when the population is progressively ageing. These trends highlight the importance of teaching future designers to create inclusive and meaningful experiences for ageing users interacting with digital technologies and smart products. This paper presents a pedagogical approach to evaluate and analyse the affective interaction with smart products. Through the development of active problem-solving scenarios, students learn to understand the multidimensional aspects of emotions and cultivate the skills and dispositions needed to empathise with users. The training requires students to capture users’ emotions through mixed methods and visually analyse the data in ways that are adapted from the initial stages of a PhD research project and grounded in the literature. Visualisations seek to enhance students’ knowledge of how these methods can provide complementary information and how to analyse and interpret the collected data. The proposed model seeks to inform design education on effective ways to design with new technologies for more meaningful and positive emotional experiences.

Keywords: user experience; smart products; digital technologies; interaction design

1 Introduction

Products embedded with positive stimuli can create pleasurable user experiences and lead to better interaction (Thoring, Bellermann, Mueller, Badke-Schaub & Desmet, 2016). Demand for user experience designers (UX) in professional practice has increased in recent years. However, academic programs that teach UX remain limited especially in areas of advanced digital technologies such as the design of robots, Internet of Things (IoT), and Artificial Intelligence (AI). This research responds to the need for pedagogical models to design advanced technological products accounting for users’ emotions. The complex nature of smart products calls for studies to investigate more extensively beyond laboratory contexts, mock homes or office environments using multi-method approaches to deeply understand users’ emotions (de Graaf, Allouch & van Dijk, 2017).
The effects of digital technologies on everyday life raise social and ethical concerns (Greenfield, 2017). These concerns accentuate for vulnerable users and technologies under development that we only partially understand today. Everyday products are becoming smarter, they incorporate advanced sensing and information processing capabilities, they communicate with local and remote devices, and they have the capacity to learn and adapt from daily user interaction. On the other hand, a global ageing population with gradually reduced physical and cognitive capacities will be increasingly exposed to these smart devices (Blackler, Popovic & Mahar, 2010). With the population growing older, future UX designers need to learn today how to identify, investigate and design while adopting an inclusive design approach to consider the affective dimensions of user experience with everyday smart products (Goddard & Nicolle, 2012). The emotional behaviour of users interacting with smart products can inform the design of future products that can trigger meaningful experiences, such as social acceptability, product desirability and ethical uses.

Whilst intelligent machines date a long way back (Oh & Park, 2014), smart products have grown rapidly over the last two decades. Smart products are everyday products embedded with computational power, information and sensing capabilities giving them information about themselves, their environment and the users (Lyardet & Aitenbichler, 2007). The ability to interpret their functions and features, the environment and users can enable these objects to interact, cooperate and adapt autonomously. In this paper, everyday products with such capabilities are referred to as smart products. Smart products require users to learn new and multifaceted skills (Barricelli & Valtolina, 2017). This complexity can cause frustrations, particularly among older people that are accustomed to manual and direct control (Yang & Coughlin, 2014).

In the user experience literature, the emotional interaction of users with products is examined (Blythe & Monk, 2018). Such studies reveal opportunities and open challenges for the education of designers to address the emotional experience of interacting with smart products (Jeon, 2017; McStay, 2018; Tonkin et al., 2018). Initial attempts to bridge aesthetic and emotional dimensions of HCI show that the literature offers limited insights into how to apply techniques and theories to the emotional design and implementation of advanced technology (Schiphorst, 2009). Teaching initiatives in HCI tend to be reported in descriptive dimensions without clear theoretical underpinnings (Martin & Roehr, 2010; Martin & Sherman, 2015). Users’ memory, previous interaction with technology, individual differences, aesthetics, and sensory elements of the designs are good examples of the factors that may shape the emotional user experience but remain largely unaddressed in the literature. While the UX field is growing rapidly, educational and academic programs with a focus on the design of advanced technologies remain limited (Vorvoreanu, Gray, Parsons & Rasche, 2017). Consequently, this research seeks to contribute to a better understanding of UX methods for smart products. Our aim here is to provide a grounded model for studio education that accounts for the affective state of vulnerable users of smart products. Building upon the literature, this research will offer a deeper understanding of teaching UX practices through the following activities:

- Interactive problem solving workshops to teach the techniques of measuring emotions proposed by Jacob-Dazarola, Nicolás and Bayona (2016).
- Visualising data that can help compare and understand the value of each technique.
- Co-design with older people to define the project priorities and represent their voices (Walker, 2018).
- Creatively expand the knowledge, attitudes, values and methodologies associated with inclusive UX designs that address the needs of ageing users.

2 User Experience Education

The emotional dimensions of everyday products can elicit a range of experiences for users (Schifferstein & Desmet, 2010). Recent studies identify multidimensional factors shaping user experience and illustrate the reactions in users including physiological and behavioural. The multifaceted nature of emotions demands a systematic and deep level of understanding of user behaviour from attitudes and expectations prior to interaction, through purchasing decision making, initial and long-term usage, and post-usage.

The acquisition and use of smart products are vital to the identities and relationships that connect individuals and determine their behaviours (Solomon, Dahl, White, Zaichkowsky & Polegato, 2017). A user starts to form an opinion about a product from the first-time interaction that is called first impression (O’Shaughnessy & O’Shaughnessess, 2003). This impression grows and changes over time with long-term interaction that will form a conspicuous and lucid story called user experience (Norman, 2013). According to Hassenzahl (2013), the user experience process stimulates various emotional responses which result in positive or negative outcomes. Hence, the emotional aspects of user experience are of especial importance in the design of smart products.
Compared to the growth of UX profession and research, little to scarce scholarship addresses the learning and teaching aspects of UX design (Martin & Sherman, 2015). Given that UX design is an emerging discipline, and the lack of disciplinary programs tailored to familiarise students with different techniques of understanding user emotions, we suggest a pedagogy based on the Unified Theory of Acceptance and Use of Technology (UTAUT) model (Venkatesh, Thong & Xu, 2016). UTAUT recommends users’ acceptance of technologies should be examined from initial introduction to post-adoption, throughout an extended period of time. The model suggests that studies need to focus on active adoption decision-making process. Routinized behaviours may result in retrospective reported individual reactions.

2.1 Research Design

The pedagogical approach is part of an ongoing PhD study that looks at the multidimensional aspects of emotions through conducting prolonged user research. It evaluates users’ emotions by looking through the mental reasoning, changes in physiological, gestural, behavioural and individual responses. The research targets older users’ engagement with smart products. It applies user experience theories to study the emotional responses of an older generation of users. A mixed methods approach to data collection is selected to collect both qualitative and quantitative data of the users, and to understand their emotional needs and experiences deeply (Figure 1). The study extends the traditional lab-based usability tests by going beyond conventional observation methods. There are four main methods of data collection: interviews, multimodal usability observation, solicited extended experience sampling, and co-design session. This approach will combine traditional design tools, such as interviews to identify what participants think and say, with observation of both physiological and behavioural signals. The self-report user experience method monitors users’ responses over the course of the research. Lastly, by conducting a co-design/creative session, reflection and ideation of future design of the smart products will take in place. The creative session will give the opportunity of taking the conversation beyond the lived experience and ideate what can be implemented in the future of designs.

With the growth of older population worldwide, the demand for addressing the needs and expectations of older population will grow too. The capabilities to adapt to new complex technologies can decline with age. By studying user experience of the older people, we can inform the design of new technologies to create safe, inclusive, pleasurable and meaningful experiences. This demands preparing students and future designers with design practices that can understand the user experience of this growing demographic and provide design solutions for them (Razmi, 2018). The Auckland University of Technology (AUT) has established the AUT Centre for Active Ageing (ACAA) that is committed to work with older people for better living. The centre is focused on inclusivity, co-creation, and participation to engage with older people in research and projects that targets this demographic. We propose that a UX pedagogy with similar
aim and priorities of the ACAA centre focused on social inclusion and active ageing can educate and facilitate students in better understanding the needs and demands of the community.

### 2.2 Evaluating Emotions Workshops

The pedagogical model proposed here addresses the multidimensional aspects of emotions and focuses on learning how to evaluate users’ emotions by analysing physiological, gestural, behavioural and verbal responses. Studying all these dimensions of emotions will provide rich data to produce insights for an in-depth understanding of interactive experiences of older users with smart products. Emotions can be analysed based on the understanding of each of these dimensions, suggesting essential techniques for UX students to be familiar with. Jacob-Dazarola et al. (2016) categorise five groups of emotional processes shown in Table 1.

<table>
<thead>
<tr>
<th>Dimensions of Emotions</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subjective</td>
<td>Individual differences, perspectives, values, and responses.</td>
</tr>
<tr>
<td>Physiological</td>
<td>Physiological responses that can be measured into quantitative data.</td>
</tr>
<tr>
<td>Thought-action</td>
<td>Gestures and expressions that can be categorised into emotional expressions.</td>
</tr>
<tr>
<td>Behavioural</td>
<td>Prolonged activities for learning functions in naturalistic environments.</td>
</tr>
<tr>
<td>Cognitive</td>
<td>Individual’s evaluation, classification and ratings of products.</td>
</tr>
</tbody>
</table>

This studio pedagogy integrates five sessions to learn a set of methods for data collection and five sessions to interpret and apply these data in experience prototyping exercises. Starting from understanding subjective user values and how similar or varied different users’ perception and needs might be. Based on these findings, learners conduct ideation activities and early prototyping. The second method involves physiological measuring techniques and how to visualise and use the data collected from techniques such as electrocardiograms (ECG). The second round of ideation and concept development starts with the focus on physiological data. The third process includes thought-action tendencies that takes the students to learn gestural and other non-verbal assessments. The last two stages address behavioural and cognitive processes. These techniques are appropriate for late stages of the design and prototyping process. They allow learners to study and capture users’ emotional feedback and interaction in more depth and iterate their designs. Based on a critical review of the literature, each of these dimensions is discussed in detail in the following subsections to teach students the process of evaluating emotions.

#### 2.2.1 Subjective Emotional Experience

The first dimension for students to practice and understand is the individual differences and characteristics that influence various judgements from the potential users. It is essential to understand that individuals will differ with respect to their emotional responses. While one person may be attracted to a product, another person may dislike it. Similarly, the same person may experience different emotions to a given product at different points in time. For designers to create deep connections between the users and their designed products, they need to understand the emotions of their users and their journeys. Advancements in new technologies are changing the ways people work, play and interact. Technologies designed with a lack of empathy for their users can lead to a failure in delivering pleasurable experiences and result in a sense of isolation for the user (Shin, Im, Oh & Kim, 2017). Students can practice interviewing techniques to grasp several users’ experiences and their expectations to capture any individual differences such as capturing diversity in lifestyles, hobbies and values. This dimension can be practiced at early stage of the course and before the first stage of design and ideation, so the students can identify users’ various emotional needs and expectations.

#### 2.2.2 Physiological Process

Smart products are rapidly integrating into most everyday activities (Coughlin, D’Ambrosio, Reimer & Pratt, 2007). Examples including booking appointments, calling taxis, measuring our physiological responses such as monitoring heart rate, calculating ECG, and learning behaviour patterns such as sleeping time and favourite routes to work, are now part of our everyday products. They are considered to require minimal instruction and training (O’Brien & Rogers, 2013). However, this shift towards integrating technologies into everyday activities has caused great difficulties and frustration for older users to interact with contemporary smart products smoothly (Pattison & Stedmon, 2006). After first stage prototyping, we will introduce the physiological measurements to the students for measuring their first initial design. Physiological changes in users can be triggered by positive or negative experiences. These physiological changes can be measured through bio-signals. Studies in HCI and user experience use the data captured from bio-signals to deduce the emotional state of users (Subramanian et al., 2016). The physiological process can monitor hormonal levels, heart rate, circulatory and nervous systems. Famous techniques to measure user experience responses include galvanic skin
response (Nakasone, Prendinger & Ishizuka, 2005), pupillary response (Chen, Epps, Ruiz & Chen, 2011),
electroencephalogram known as EEG measurement (Das, Chatterjee & Sinha, 2013), and electrocardiography (ECG) data
(Haag, Goronzy, Schaich & Williams, 2004).

By visualising the data captured from physiological responses, students can study the similarity and differences of for
example ECG data that are captured from different emotions such as excitement, happiness, fear and boredom. Using
physiological processing will allow them to start learning how to compare and contrast the opportunities and limitations
of the captured quantitative data with the qualitative, explanatory or observation techniques.

2.2.3 Thought-Action Tendencies
While teaching the shadowing technique to the students on how to observe users’ emotions can be very beneficial, it
needs a lot of practice and time for them to be mastered in. Some emotions are more easily detected in people’s
expressions and gestures. They act as a communication channel about individual intentions and actions (Desmet, 2018).
Facial Action Coding System (Ekman & Friesen, 2003), Genetic Programming (Loizides, Slater & Langdon, 2002),
Maximally Discriminative Facial Moving Coding System (Izard, 1979), and the AMUSE tool (Chateau & Mersiol, 2005) are
some of the well-established quantitative approaches of data collection in usability testing studies. These studies
quantify emotions using scale techniques proposed by Ekman (2007) on recognised key expressions such as happiness,
sadness, anger, neutral, fear, surprise and disgust. Introducing the techniques for measuring users’ expressions and
gestures while interacting with the prototypes will provide the opportunity for the students to compare how some basic
expressions can be easily grasped and identified while some other gestures and expressions might look similar. These
processes can assist the students as supportive evaluating systems in the observational and usability tests of smart
products.

2.2.4 Behavioural Tendency
One of the essential elements of user-product interaction is the temporality of the experience. Karapanos, Zimmerman,
Forlizzi and Martens (2010) recommend a conceptual model for extended user experience studies. They suggest four
weeks’ timeframe can present the transition of users’ experience in the adaptation phase of the product. They propose
that users’ familiarity, functional dependency and emotional attachment increase over time. An extended user
experience test can measure the level of excitement and overall evaluative judgement of users across time. These
techniques are significant when measuring users’ emotional responses toward smart products that handle several tasks
and require longer period of time for adaptation. Their aim is to study the users’ activities shared with the subconscious
level of everyday actions such as the continuous learning of functions and interfaces of a newly designed mobile phone.
Standard techniques used for measuring users’ behavioural responses range from self-report and journaling in
naturalistic approaches through studying users in real environments (Wu, Thomas, Drobina, Mitzner & Beer, 2017).
Other techniques include monitoring behavioural responses, task performance and usability in controlled laboratory
settings (Hertzum, Borlund & Kristoffersen, 2015). We recommend that instructing the students with the journaling,
observation and usability tests at the final design and prototyping stage when several improvements toward their design
has been made, can provide deep understanding of the interaction steps and the challenges or benefits of their design
elements. These techniques can support the students only after they have gained some good level of understanding
about their users’ expectations and needs.

2.2.5 Cognitive Process
Emotions help users to evaluate whether a product is generating positive or negative feelings. Emotions can provoke
memories, perception, attention, identification, classification and reasoning (Chowdhury, Reddy, Chakrabarti &
Karmakar, 2015). A product’s character is considered a cognitive structure. Cognition is closely related to emotion.
Certain cognitive structure of a product can generate different basic emotions. For example, a simple user interface of
a product may represent the product as easy to use, even if the user has no actual hands-on experience with the product
(Hassenzahl, 2018). There are many well-established studies in the field of product design that explain the underlying
cognitive processing of emotions (Chen et al., 2016). Students will capture users’ experience of interacting with the
prototype using scale-rating interviews. It will allow them to capture users’ evaluations and responses toward their
design while understanding the reasons for it in a quantifiable method.

3 Expected Outcomes
The suggested pedagogy seeks to equip students with the skills to instantiate comprehensive information that can
augment the reliability of their designed products. We suggest this model can provide the possibility to assist UX
students in differentiating their design practices through understanding older users’ emotions concerning smart
products. It will explain a feasible opportunity for them to learn how to refine new technologies into humanised instruments that can create meaningful and engaging experiences for the users.

The implementation of the UX evaluating techniques in the design workshops can demonstrate more user focused approaches that are being used by the businesses and scholars. Such practices can teach students how to prioritise users’ emotions in all stages of their design and keep up-to-date with measuring techniques available through learning basic knowledge about data collection, analysis and data visualisation processes. These practices can extend the students’ skills in how to differentiate themselves as UX practitioners compared to other design curriculums. By comparing and analysing users’ emotions, students will gain more in-depth understanding of the significance of conducting UX research in design practices. They will learn how to design solutions based on enhancing users’ emotional needs at every stage of design practice, from ideation to final prototyping.

4 Discussion

The UX pedagogy presented in this paper focuses on the evaluation of older people’s emotions when interacting with smart products. The main goal is to prepare future designers to tie their design practices with data collection processes that are necessary to understand advanced digital technologies including smart products. We propose that by positioning older users’ emotions and empathy stage at the core of UX workshops, students will gain deeper knowledge about UX practices and inclusive design.

We recommend that adequate information can be gathered to test the proposed pedagogy throughout the project by collecting users’ evaluation of the students’ designs at each step based on each captured dimension. It can work as a justification tool for the decisions that were made and whether or not the final designs had better desired outcomes for the selected demographic. Another relevant approach could be students working on either two mini projects, one without the proposed dimensions, and one with learning the tools and applying the changes based on the captured emotions. This can help them to compare the results and evaluate their own learning process as well as getting the final feedback from users on what they think of the final designs. Same approach can be tested among two different classes to compare and document the learning process of each group.

This paper aimed to address the importance of user-centred programs designed for students seeking to become UX practitioners by teaching the different dimensions of evaluating emotions. It is important that concepts of individual differences, such as different generation of users, concepts of familiarity being discussed in this pedagogy in more detail to address these influential factors that can deepen students’ knowledge. Research related to the design of technology for older users distinguishes age-related changes as essential factors in the application of information and communication technologies (Braun, 2013). The goal of a majority of the research on older users is to increase adoption and effective use of technology. Brophy, Blackler and Popovic (2015) argue that smart products should not only be useful and usable by the next generation of older users but appropriate, engaging and meaningful. It is essential to understand the relationship that older users have with technology.

Studies suggest that a combination of cognitive, physical, sensory and attitudinal changes that occur as a result of age also impact older users’ interaction with technology (Rogers, O’Brien & Fisk, 2013). They interact with current smart products less intuitively and more slowly. Familiarity and knowledge gained from past experiences is a fundamental component of an intuitive interaction (Lawry, Popovic, Blackler & Thompson, 2019). Older users interact with products less instinctively than younger generations due to less familiarity. One approach of improving the experience of complex contemporary products is to integrate intuitive interaction into design practices with an aim of shifting towards a more inclusive society.

The design community needs to have a broader perspective for the envisioned future of technologies designed for older users. According to Blackler et al. (2010), it is tempting to believe that, as the population matures, users that are experienced with technologies will likewise mature, and the age-related issues will resolve themselves. However, it is likely that the dynamic nature of technology will create a disparity between the experience of older users and the new products of the day (Fisk, Rogers, Charness & Sharit, 2009). We recommend that the design of future products has to extend beyond the narrow focus of age-related decline. Designing for this space is not exclusive to supporting functional independency, but also about living experiences that have been digitalised, such as activities like reading, listening, making and creating, playing, communicating, and sharing. The design community needs to prepare UX practitioners with broader perspectives for the envisioned future of technologies designed for older users.
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Quantifying Design for User Experience Assignments: Using Rubrics as Assessment Tools

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Abstract: There is an increasing interest in teaching user experience design in many of the industrial design bachelor’s programs. The subjectivity of the topic requires new approaches as well as reliable and valid assessment tools. It has always been a challenge for the teachers to assess creative work in higher education. In relation, the assessment of how products create user experience in student works requires extra attention. In this paper, we discuss the difficulty of properly assessing design and explain the development and application of rubrics that we aimed to facilitate the assessment of design for user experience assignments of a 3rd year bachelors’ course of the University of Twente. We present evidence of the reliability and validity of the assessment through the rubrics. Usability of the rubrics for assessment purposes has also been addressed.

Keywords: assessment; evaluation; grading; design assignments; user experience assignment

1 Introduction

It has been more than 25 years that the term user experience (UX) has become a breakthrough in human-computer interaction studies (Hassenzahl, 2018). Since then, it has been regarded as an interdisciplinary field that studies human behaviour systematically to design useful and desirable products. Several frameworks have been developed to unfold the dimensions of people’s experience with interactive products and systems. Understanding the importance of the involvement of people’s experience in the design process, companies recently expect from designers a new type of expertise, so-called designing for user experience. However, according to our knowledge, there is no bachelor program that directly trains the students as user experience designers, and thus the ongoing discussion in filling this gap in design education is very significant. Several bachelors and master’s programs are designed to prepare students to the job market with skills to design for user experience. Even scholars discuss the importance of integrating UX into human-centred design related higher education programs (Faiola, 2007). Within this context, there are several efforts...
Designing for meaningful user experiences (Hassenzahl et al., 2013; Orth, Thurgood & van den Hoven, 2018) without a significant approach to follow could be vague for designers. When integrating this phenomenon into design education, it becomes even more challenging to assess students’ work. This paper opens the question of how to assess students’ works that aim to design for user experience. For this, we exemplify the approach we followed to assess the user experience design works and take one of the courses we coordinated in the Netherlands. The context for this paper is to design a bachelor’s course for industrial design students at the University of Twente. In this course, several frameworks and topics related to user experience such as human needs (Deci & Ryan, 2011), product experience (Desmet & Hekkert, 2007), product personality (Govers, Hekkert & Schoormans, 2003) as well as the one we developed in 2014 (Bogazpınar, Bakırlıoğlu, Kuru & Erbug, 2014) are delivered. The students were asked to explore the possibilities and design products that would fit the usage scenario they developed. Basically, the course aimed to make students identify the role of product design at different levels of people’s experience and formulate design-based documentation of people’s experience. Taking the learning goals of the course as the core, a rubric was designed that identified the expectations from the assignments. In this paper, the approach and the utilization of rubrics in assessing the user experience design assignments in design education are discussed. The contribution of this paper is twofold: (1) it puts forward the challenges of assessment of user experience assignments, and (2) it demonstrates how rubrics, a commonly used way of assessing creative work, could be a way of resolving these challenges. In the end, we suggest that usage of rubrics for assessment of user experience assignments in design education could be one of the ways to assess the vagueness of user experience work.

2 Method

In order to explain our approach, we will first give the structure of the course as well as the assignment we designed. Then, we will explain and discuss the approach we followed to develop rubrics and assess the student works of user experience with the rubrics we developed.

2.1 Structure of the Course

The education system at the University of Twente is unique within the country with its TOM model that is characterized by project-led education. According to this model, each educational year is divided into four thematic modules¹, and project-led education is supported with other courses within each module. That is, the core of each 10 weeks’ quarter is the project courses, and the other theory-based courses in the module supports the students with the knowledge and experience they could use during each module. These courses end mostly with written exams, but there are also courses that end with smaller design assignments next to the bigger projects. This approach is not only applied to design education but also to all engineering and social sciences undergraduate programs. Students are expected to apply the knowledge they gain from other components of the module in the projects.

Within this system, Design and Meaning course is a third- and final-year bachelor’s course of the Industrial Design Program. It is one of the theory-based design courses of the program which is integrated into the Systems Engineering module. This course stimulates students to work on their own to fully develop a consumer product by taking the relevant theories into account during the design process. The course is expected to prepare the students for their bachelor assignments as well as their future careers, and it compliments other human-centred design-focused courses of the curriculum. Mainly, the course delivers recent models and frameworks of user experience by focusing mostly on conveying meaning through product design.

During the course, students get acquainted with several theories and frameworks that connect design, meaning and user experience. The course focuses on the role of design at various levels of people’s experience with products, and it consists of theory lectures with exercises and an individual design assignment. The theories and frameworks are examined using literature, assignments and practical work. Throughout the course, students iteratively develop means to analyse, appropriate and generate design following the provided user experience frameworks. The course was conducted in 2018 with the participation of 76 students.

¹ In University of Twente, study programs consist of modules that comprise of several individual courses with different ECTS. In total, each module has 15 ECTS and to graduate from the study program, each student has to get at least 120 ECTS.
In the course, we formulated a fictional story and asked students to design a physical product for facilitating cryptocurrencies as daily payment mediums. This new type of product would transfer several experiences from the currently used products and would generate new experiences as well. Students were free to decide on the qualities and meanings that the product would convey. However, the given two qualities were being portable and being secure. Students were assigned to submit three assignments: Needs Analysis, Extending Product Meaning, and Design for Holistic User Experience.

The course was offered for seven weeks, and the study load of the course was 2.5 ECTS. Students were expected to spend 72 hours within seven weeks. Thirty-two hours of this period of the total time was spent with lectures, workshops and tutorials, and the assignments were designed in a way that students would not spend more than 40 hours. The tutorials, brainstorming sessions and workshops that were listed as the official lecture hours of the course were designed in a way that the materials students produced during these hours would be used as part of the assignments.

### 2.2 Expected Learning Outcomes

While designing or redesigning a course, an important aspect is a constructive alignment. Constructive alignment means that the learning outcomes are in line with the way they are assessed and the teaching method applied during the course (Biggs, 2014). The clearer the learning outcomes are formulated, the easier it is to guarantee constructive alignment. Because if the final result of the course (the learning outcomes) is clear, it is clear what the students should display at the end of the course. One way of formulating clear learning objectives is to use SMART (Specific, Measurable, Achievable, Realistic and Timebound) objectives; this method is originally developed for management goals, but is also advised to be used in educational settings (Bjerke & Renger, 2017).

In design education, this can be quite a tricky part. Design is very often interpreted as something vague and therefore subjective (Vorvoreanu et al., 2017). One person can describe for example soft or modern in a specific way, and a different person might give a different meaning to these terms. Having clear learning outcomes is the first step, and when zooming into the quality assessment itself, it is essential to look at the reliability and the validity of the assessment (Moskal, Leydens & Pavelich, 2002).

<table>
<thead>
<tr>
<th>Level</th>
<th>Learning goals</th>
<th>Assignment 1</th>
<th>Assignment 2</th>
<th>Assignment 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowing</td>
<td>Define the role of product design at different levels.</td>
<td>Identifying, criticizing and designing with the product personality.</td>
<td>Identifying, criticizing and designing with the product personality &amp; product experience model.</td>
<td>Highlighting the product qualities of your design and reflecting on how your product responds to human-related qualities discussed during the Backwards Design Workshop.</td>
</tr>
<tr>
<td>Understanding</td>
<td>Identify opportunities to influence product experience through design.</td>
<td>Identifying, criticizing and designing with the product personality.</td>
<td>Identifying, criticizing and designing with the product personality &amp; product experience model.</td>
<td>Writing an organized reflection on the product experience.</td>
</tr>
<tr>
<td>Applying</td>
<td>Design a consumer product by evaluating the models and frameworks of design and meaning.</td>
<td>Recalling the previous knowledge and skills for product development.</td>
<td>Demonstrating critical thinking on people’s experience with the crypto-wallet, that was performed throughout the product development process.</td>
<td>Showing the product development process in creative visual essay format. Relate your design with the models and frameworks that we have discussed throughout the course, but mainly with the Path to Long-Term Usage Model.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Recalling the previous knowledge and skills for product development.</td>
<td></td>
<td>Demonstrating critical thinking on people’s experience with the crypto-wallet, that was performed throughout the product development process.</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
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</tbody>
</table>

Assessment with high reliability means that the outcome of the assessment by the assessor himself is not influenced. If there are multiple assessors, they assess equally and are not biased by possible personal preferences. The reliability is about objectively assessing only what is being assessed. For example, when assessing a sketched concept of design and the assessment is purely meant to be about the concept, the quality of the sketch does not affect the grade. The last aspect is how transparent the assessment is, it is about whether the students know what they are being assessed for. Students should know what is expected of them before heading into the assessment or making the assignments. A possible method to increase all three of these aspects (reliability, validity and transparency) is the use of rubrics.
Jonsson and Svingby (2007) came to the following three conclusions after their literature review about the usage of rubrics:

“(1) the reliable scoring of performance assessments can be enhanced by the use of rubrics, [...]; (2) rubrics do not facilitate valid judgment of performance assessments per se. However, validity can be facilitated by using a more comprehensive framework of validity when validating the rubric; (3) rubrics seem to have the potential of promoting learning and/or improve instruction (p. 130).”

As stated above, the usage of a rubric does not automatically contribute to the validity and transparency of assessing. The validity and transparency depend on how the rubric is created and communicated towards the students.

In this specific course, it was highly essential to help the students use their knowledge for creating design work. Therefore, rather than other forms of assessment, students were given visual assignments in order to motivate them to develop their creativity skills. While designing the assignments, the learning goals of each assignment were listed and reflected on how each assignment serves for the main learning goals of the course. Table 1 exhibits the learning goals of each assignment and indicates how the learning goals of the course were achieved through each assignment. These learning outcomes are in line with the learning goals of the industrial design program. Hence, we can conclude that these learning outcomes serve for improving the design and intellectual skills of the graduates. To achieve this, the learning goals were discussed with the program director before the structure of the course was set.

2.3 Rubric Development Process

Just as in every type of educational programme, design education has specific goals that students have to achieve. Students are expected to come to a certain level at identified skills and provide high-quality work. The difficulty in design education is that there is not one right answer to the problems (Cross, 2001) and the last thing educators want is that all students produce the same product. Thus, the goals are the same for each student, but the way students show how they have achieved those goals can differ. This can result in friction when formulating specific assessment criteria. To reduce the tension, and to provide clear assessment criteria for the assessment of user experience assignments, we designed rubrics for each assignment of the course. For that, we followed the rules for developing reliable rubrics. It should be noted that the goal of this paper is not to provide a general and fully-reliable rubric that could be utilized for every user experience assignment, but to provide evidence for quantifying design for user experience assignments by developing rubrics.

2.3.1 Design of Rubrics

In education, rubrics are used as scoring guides in assessment with three features: criteria for evaluation, the definition of each criterion and the strategy for scoring (Popham, 1997). Accordingly, the criteria, the definition of each scoring criterion, and the rules of scoring criteria should be clear. Rubrics are also used and perceived to have a neutral or positive impact on students’ creativity (Haugnes & Russell, 2016). The straightforward process for creating rubrics includes listing the criteria (such as learning outcomes), the scores of quality indicators (such as pass-fail) and the definition of each quality indicators (such as good / no indication of knowledge) (Andrade, 1997).

Consequently, together with the definition of the assignments, one rubric was generated for each. Those were designed with two questions in mind: (1) what do we expect the students to learn through the assignments and (2) how should these learning goals be distributed among the requirements of each assignment. By following guidelines for creating rubrics, we first created a draft version of the rubric. Through discussion on the learning goals of the course, we incorporated those guidelines with the learning goals of each assignment. To make the rubrics clear for both the assessors and the students, another lecturer checked the understandability of the rubrics. Several changes were made before the rubrics were used for grading. A rubric example is given in Table 2. It should be noted that before this assignment, students were introduced a model that we developed for exploring the experience of certain products (Bogazpınar et al., 2014; Karahananoğlu & Bakılogoğlu, 2017). Therefore, the students were familiar with the terminology used (e.g. human-related qualities) in the rubric made.

2.3.2 Reliability of Rubrics

In an assessment of design works, different assessors could come up with different conclusions. Increasing the quality of assessment and ensuring consistency are the most mentioned benefits of using rubrics in the assessment process, especially if there is more than one rater (Jonsson & Svingby, 2007). This consistency with the rubrics is measured by inter-rater reliability analysis, and the alpha values for inter-rater reliability analysis above 0.70 are regarded as sufficient (Brown, Glasswell & Harland, 2004).
In order to understand whether the rubrics we created were reliable for grading, we conducted interrater reliability analysis as well. After the students submitted assignments, the coordinator of the course randomly picked three of the assignments and did grading separately with an external assessor. We then came together to discuss the consistency of the sub-grades as well as the overall grade of the assignment. The interrater agreement of the initial round was 0.83, which is very high for the first round (Brown et al., 2004). We did not continue with a second round of grading for interrater reliability, as the first round showed that the rubrics are very reliable. We discussed the points that we did not agree in the first round. The disagreement was very small, and then we agreed that the rubrics could be used for further grading.

**Table 2. Rubric of Assignment 3**

<table>
<thead>
<tr>
<th>Expectations of the Assignment</th>
<th>Learning outcome</th>
<th>Unsatisfactory</th>
<th>Fail</th>
<th>Satisfactory</th>
<th>More than S.</th>
<th>Good</th>
<th>Very Good</th>
<th>Excellent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Highlighting the product qualities of your design and reflecting on how your product responds to human-related qualities discussed during the Backwoods Design Workshop</strong></td>
<td>Analysis of human-related qualities of the product (N=0)</td>
<td><em>Identifying and utilizing the product’s human-related qualities.</em></td>
<td><em>No visible knowledge and analysis of human-related qualities.</em></td>
<td><em>Shows limited knowledge of human-related qualities of the design.</em></td>
<td><em>Discusses human-related qualities of the design.</em></td>
<td><em>Discussions of the human-related qualities.</em></td>
<td><em>Makes a very good analysis of the human-related qualities.</em></td>
<td><em>Makes an exceptionally outstanding analysis of the human-related and Shows outstanding in-depth analysis of the relevance.</em></td>
</tr>
<tr>
<td><strong>Posing the design with the Path-to-Lang.</strong></td>
<td>Relevance of the product with theory and product realization (N=0)</td>
<td><em>Identifying, criticizing and designing with the path-to-lang. usage model.</em></td>
<td><em>Reflecting the product knowledge and skills for product development.</em></td>
<td><em>Refers to the (PLU) model with limited knowledge.</em></td>
<td><em>Offering incomplete interpretations about the crypto-product.</em></td>
<td><em>Tackles on some/all of the dimensions of the model by showing biased or unclear knowledge.</em></td>
<td><em>Tackles some of the major relevances about the crypto-product.</em></td>
<td><em>Tackles all the dimensions of the model.</em></td>
</tr>
<tr>
<td><strong>Showing the product development process in clear and visual story format</strong></td>
<td>Visualization (N=0)</td>
<td><em>Demonstrating the skills of harmonizing the knowledge in an understandable and clear way.</em></td>
<td><em>Irritable/confusing and poor use of the tools.</em></td>
<td><em>Problems with clarity and concise.</em></td>
<td><em>Major problems with space and word usage.</em></td>
<td><em>Problems with clarity and concise.</em></td>
<td><em>Problems with clarity and concise.</em></td>
<td><em>Makes an outstanding and clear and understandable, with good sketches.</em></td>
</tr>
</tbody>
</table>

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### 2.4 Validity of Rubrics: Evidence from Results of Assignments

Rubrics allow students to identify the critical components of the assignments, which help them to evaluate their performance and progress, and make the marks fair and transparent (Reddy & Andrade, 2010). To achieve this, the language of the rubrics should be clear and understandable for the students as well. This ensures the validity of the designed rubrics (Reddy & Andrade, 2010). The results of the assignments could be used as evidence of validity (Jonsson & Svingby, 2007) in order to understand (1) whether each subpart of the assignment contributed to the learning goals of the course and (2) whether the rubrics were effective in measuring those goals. To check the consistency of each assignment, we analysed the variance of grades of each assignment. To remind, the students worked on the first assignment as a group and proceeded individually in the second and third assignments. Therefore, the range of the distribution of the grades of Assignment 1 was smaller than the other two assignments (Figure 3).

As can be seen, there were three different subgrades in the first assignment: students had to discuss the models and frameworks we covered during the lectures, define a scenario for a potential of a product to be designed and present all these in a good quality poster. In the end, the final grade was calculated by considering the weight of each part, in line with the learning outcomes (See: Table 1). Cronbach alpha for this assignment was calculated was 0.85, which indicated that each part contributed to the measurement of the learning goals of doing this assignment.

The range of the distribution of the grades of Assignment 2 was more extensive than the first assignment. It is also because the number of assignments graded was more than the first one. As can be seen in Figure 4, the range of the grades of “product personality” and “product experience” was greater than “product development” and “visual representation,” while the mean value of each part was around 7.00. Still, the Cronbach alpha calculated for this

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2 Cronbach alpha is a statistical indicator of the reliability of measurements, which could be minimum 0.00 and maximum 1.00; the higher the value, the more a test is reliable.
assignment was 0.90, which is also high, indicating that each subpart of the assignment contributed to the reliability and validity of the assessment.

Figure 3. Distribution of Grading of Assignment 1

Figure 4. Distribution of Grading of Assignment 2

Figure 5. Distribution of Grading of Assignment 3
The situation with the third assignment was almost the same as the second assignment. The range of the distribution of the grades of Assignment 3 was broad, and the mean value of each subpart is around 7.00. Still, the Cronbach alpha calculated for this assignment was much higher (0.92), again indicating that each subpart of the assignment contributed to the reliability and validity of the assessment.

These results showed that each assignment was reliable within itself and contributed to measuring the learning goals of the course; besides, the rubrics that we created for measuring the learning outcomes fitted to understanding whether or not the students achieved the goals of the course (Listed in Table1). These also indicate that the assignment properly fitted to measuring all levels of stated learning outcomes of the course. On the other hand, the reason why the range of grades for Assignments 2 and 3 was high was that some of the students misunderstood the requirements of the assignments. That was one of the issues that require clarification for the assignments rather than the rubrics.

3 Discussions and Conclusion

In this paper, reflecting on the challenges of assessment of design for user experience assignments, we explain the usage of rubrics we developed for a fictional story for experience assignment. In doing this, we focused on the reliability, validity and transparency of the rubrics. Our findings showed that the reliability of the rubrics we created for each user experience assignment was high, indicating that the definition for each grade reduced the subjectivity in the evaluation. That is to say, the grades given to the students is not biased by the lecturer and if another lecturer would give this course in the future, by using the same assessment criteria, together with the same rubrics, the validity and reliability of the grading would be high.

Since the rubrics were highly detailed in rating the assignments, it was easy to find the evidence of student learning. The rubrics also made it clear for the students on how they were graded. Once the grades were announced with given feedback on the assignments, students were given the opportunity to discuss their grades. Only three of the students, whose works were graded less than satisfactory approached the assessors to get extra feedback. Other than those, none of the students wanted to discuss their grades or ask for additional clarification. This incidence on its own is another evidence of the clarity, validity and transparency of the assessment. A challenge the assessors faced was that filling in the rubrics and adding personal feedback was quite time-consuming. Since the rubrics provide a lot of clarity about what is expected of the students, maybe the use of the rubrics could be taken a step further. In the future, we could also experiment with using rubrics as a tool for self-assessment.

To conclude, through developing a clear rubric for this course, we were able to better convey the expectations for each assignment and overall learning outcomes to students and implemented a fair assessment strategy for design outcomes that is clear and objective. The distribution of grading for each assignment presents the reliability of the assessment in this case, and we believe the rubrics can be adapted for other UX-focused assignments and courses with design outcomes elsewhere, according to the different grading systems. However, although the rubrics presented in this paper were useful instruments for students to understand the learning outcomes of each assignment, the clarity of assignment descriptions is also an important factor for fair assessment of UX-related design work.

References


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UX Modelling in Design Education: Methods, Processes and Examples

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Abstract: This paper presents user experience (UX) modelling as an educational goal, outlining and grounding on the growing need for trained UX professionals and opportunities for expanding design expertise in this direction; and emphasises the importance of developing a sustained teaching agenda to address the requirements of the contemporary professional practice. After an overview of use and types of models in UX, we offer UX modelling as a teaching tool to equip design students with the theoretical and applied knowledge and skills relevant in user experience research (UXR) and design process. From this point of view, we demonstrate how we utilised UX modelling in graduate level industrial design education and illustrate examples from student works. We discuss applications of this approach by offering the use of modelling as a tool for analysing and communicating user experiences, as well as an apparatus to shape the process of transferring user insights into design implications.

Keywords: user experience; design education; industrial design; user research; UX modelling

1 Introduction

As the digital products and services have become more pervasive in daily lives, there has been a shift from object-focused towards a holistic, experiential approach in design fields. The experiential approach is typically described by how it differs from traditional usability. For example, Jordan (1999) recommends a rather holistic view towards user-product interaction beyond instrumental aspects by taking into account hedonic features including emotions, expectations and dreams of the users. Similarly, according to Hassenzahl and Tractinsky (2006), usability deals with task-related, instrumental dimensions of interactions with a product or system, while user experience as a paradigm expands this by tackling also with less explicit issues such as meaning and values attached to products by users. This naturally brought about an interest to conceptualise this complex nature of UX by taking a more holistic lens in an
effort to develop design strategies to mediate potentially positive and meaningful experiences (Fulton Suri, 2003). Therefore, it is required to expand the focus of inquiry from the instrumental interactions between the product and the user towards adopting a holistic approach, which takes into account subjective, social and contextual factors, thus placing the object of design into a complex system of users, products/services/systems and environments.

In the meantime, the disciplinary growth of UX has gained impetus with an increasing number of UX conferences, workshops, seminars and publications, as well as communities such as the Interaction Design Association and User Experience Professionals Association. Concordantly, UX has become an emerging profession in a diverse range of industries, so much so that specialist positions for UX designers, researchers, engineers and writers are being opened up in the job market (Gonzalez, Smith & Youmans, 2017). Nevertheless, a common and sustained educational agenda has not been achieved to train the future UX professionals within academia. For example, UX education programmes are mostly unavailable, which leads to individual efforts of self-taught professionals (Getto, Potts & Salvo, 2013). Thus, in line with the increasing demand from industry for job-ready UX specialists, online UX courses, internship programmes, workshops and camps begin to emerge to address the immediate necessity for practice-ready UX professionals.

The challenges of developing a shared agenda for teaching UX lies beneath the transdisciplinary nature of the field. As it holds true that UX as an academic discipline and professional practice has evolved within a myriad of fields, it may raise managerial issues as to who “owns” or teaches the course (Getto, Thompson & Saggi, 2016), as well as the content and structure of it. Nonetheless, various design and technology disciplines have been putting effort to integrate UX awareness and skills into curriculum, including human-computer interaction (Faiola & Matei, 2010), industrial design (Budd & Wang, 2017), human factors (Gonzalez et al., 2017), interaction design (Bødker & Klokmos, 2012), and technical communication (Getto & Beecher, 2016), naturally focusing on expanding the traditional boundaries of knowledge and skills attributed to their own field. Despite this diversity in disciplinal approaches, user research is recognized as a central skill embedded in the UX design process, and inarguably one of the highly-favoured skills shared by many disciplines. Particularly, the importance of teaching qualitative methods of user research is emphasised, including ethnography (Faiola, 2007; Hanington, 2010), requirements gathering (Getto et al., 2013), and participatory methods (Hanington, 2010).

Given the centrality of user research in this transdisciplinary UX practice and to correspond to the aforementioned educational needs, our teaching approach and efforts as industrial design educators have been primarily focused on introducing a more specific approach—user experience research (UXR)1 into graduate curriculum. The ability to individually plan, execute and communicate UXR is an important skill in the UX process, which is highly valued by not only professionals (Gonzalez et al., 2017), but also students and educators (Churchill, Bowser & Preece, 2016). From this point of view, our teaching efforts have focused on strategies to equip design students with the knowledge and skills to independently plan, conduct, analyse and communicate UXR. Through this process, the aim is to build UX models and we called this process “UX modelling”. We propose UX modelling as a resourceful tool to not only introduce students with a theoretical understanding about what UX is, but also guide them towards acquiring skills in making sense of user data, visualising insights and transferring them into design requirements, thereby bridging theory with practice.

Considering these, the aim of this paper is to present UX modelling as an educational approach to train designers in UXR and discuss the potentials of using models in UXR education by illustrating how models are constructed and used by students. Accordingly, in the rest of the paper, we first discuss the functionality of models in UX and introduce types of UX models. Then we present our efforts to integrate UXR into graduate level industrial design education with the UX modelling approach. After that, resulting models are illustrated from student projects. Finally, the paper is concluded with discussions on the functions and use of UX models in design education together with limitations and future directions.

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1 At this point, we feel the need to indicate our stance towards the terms “user research” and “user experience research (UXR)”. Although both terms cover same or similar methodologies and practices, user research is more generic and inclusive in that it also covers the approaches and methodologies that focus on user-product interaction before the emergence of the term UX. In this text, the term “user research” is used to denote a more generic approach for exploring, investigating and evaluating user-product interaction, whereas UXR refers to a more specific approach we adopted in this course and the historical underpinnings of which are briefly reviewed in the introduction of this paper.
2 Modelling in User Experience

In broader terms, modelling is an essential part of understanding complex systems and processes. That is the reason why they play a crucial role in the conception, dissemination and recognition of knowledge (Gilbert, 1991; Gilbert, 2005). Gilbert (2005) summarizes the function of a model as a tie between reality and scientific theory because models may pertain to the simplifications and abstractions of the reality as observed or to the idealisations of a possible reality. According to Deutsch (1952), models are based on patterns of the past (i.e. behaviours of a social group), organised through a judgement of relevance, which otherwise would be virtually impossible to grasp directly, and give the interpreter the predictive power to describe further impact. So, no matter what the specific scientific domain at issue is, models are powerful to make abstract and/or complex concepts visible and supposable. Looking from an extended perspective—i.e. involving different meanings and appearances of models in different branches of science such as physics, chemistry, biology, geography, and so on—models can portray abstract/fictional concepts or material/physical things (e.g. magnetic field vectors or structure of a bridge); can present independent scientific entities, parts of larger systems, or the whole system (e.g. an atom, an atom in a molecule, atoms in a certain material); may have a larger or smaller scale than the scientific entity that it stands for (e.g. a bacteria or a human body); and may depict a snapshot of an event or a longer process (see Caws, 1974; Giere, 1999; Gilbert, 2005; Frigg & Hartmann, 2018). Hereby, models, and inherently visualizations, are central to science education and learning as well in order to analyse, organize, teach and present (Frigg & Hartmann, 2018), as they facilitate the comprehension and navigation between scientific concepts, meanwhile allowing to focus on major blocks of the research topic rather than less significant parts.

The benefit of the use of models in UX is evident in its multidimensional, dynamic and complex nature. The motivation behind the effort to better comprehend the aspects of experience is to come up with design strategies that mediate experiences which are potentially positive and meaningful for users (Fulton Suri, 2003). Therefore, making sense of such a complex phenomenon is challenging, yet crucial for developing and improving products and services relevant to that experience. Investigation of UX through modelling can be a resourceful approach in order to discover, understand and communicate; as well as serving as an actionable medium for transferring insights into ideation.

The approach to modelling can be qualitative, as much as quantitative as in measurement models (such as the ones described in Law & van Schaik, 2010). Our approach to UX modelling in education is manly qualitative, with a strong emphasis on understanding the underlying paradigms of the experience (which are inherently rich, multidimensional and even sometimes latent), such as user concerns, behavioural patterns, impact of contextual factors, interactions afforded by products/services/systems and so forth, which eventually constitute the experience holistically. Such a holistic understanding can be obtained by utilising qualitative research methods including interviews, observations and generative techniques, and requires visualisation skills to communicate insights beyond statistical modelling (Gonzalez et al., 2017).

3 Types of UX Models

Given the multifaceted nature of UX, a UX model can focus on representing particular aspects of the experience at hand. One approach is to represent the activities and works of users, which can capture the work of users, their networks, involved organisations and environments in diagrams or such visualisations. These representations include work models in contextual design, such as the flow model, the cultural model, the sequence model, the physical model and the artefact model, as categorised by Holtzblatt, Wendell and Wood (2004). Models representing the user can be in the form of either data-driven or inspirational personas (Pruitt & Adlin, 2006), as well as task-based user segments based on mental models (Young, 2008). They are important to humanise design focus, consummate scenarios, and aid forming an estimate of dealt user behaviours and practices (Hanington & Martin, 2012). Especially, data gathered as a result of ethnographic research or other generative techniques focusing on daily experiences of the user are of great importance to understand the user, performed interactions, and contextual frame, upon which activities and works or users might be mapped.

Models depicting the concepts and their relations are related more to the mental content and conceptions of users. Specialised interview techniques may allow formation of specific types of models representing the concepts and their relations. For example, analysis of laddering interviews can be visualised as hierarchical value maps (HVM), a specific format illustrating the relationships between the elicited product attributes and attached meanings, hierarchically organised as attributes-consequences-values (Reynolds & Olson, 2001; Miles & Rowe, 2004). Repertory Grid Technique (RGT) can be analysed and visualised as cross-impact analysis (CIA) in order to demonstrate the issues...
which are found more critical based on user statements (Kuru, 2015). Conceptual or cognitive maps can also be used to represent concepts and their relations (Farsides, 2004).

Models can also represent *experience over time* by focusing on the temporality of the experience and how it evolves over a given period of time (Karapanos, Zimmerman, Forlizzi & Martens, 2009). Longitudinal ethnographic studies such as diaries focus on temporal changes of an investigated experience by methods such as UX Curve (Kujala, Roto, Väänänen-Vainio-Mattila, Karapanos & Sinnelä, 2011), and are powerful to achieve models representing experience over time. Finally, as a rather direct approach, models can be used to represent *design recommendations*, either by being integrated into mental models (Young, 2008) or as infographics. Design recommendations can be fed from a broad array of UX methods.

After this brief introduction, the following section presents our approach to integrate UX modelling in an educational context and dwells on the aforementioned UX models and matching UXR methods in detail, with illustrations from the outputs by sample student projects.

**4 UX Modelling as an Educational Approach**

We devised a graduate level industrial design course, which is structured around UX modelling and aims to allow students acquire hands-on skills in planning, conducting, analysing and communicating UXR. As effective modelling requires mastery in selecting and applying appropriate research methods, course objectives involve raising awareness towards contemporary issues in UX and variety of UXR methods, and obtaining skills to independently plan, research, analyse and model UX. In this section, we first introduce how we guide students in developing UX models and then present typical examples for resulting models from student projects.

**4.1 Developing UX Models: The Course Structure**

The course structure consists of a combination of lectures, assignments and class workshops distributed over fourteen weeks. Lectures include UX concepts and models, a comprehensive list of UXR methods, use of research equipment, data analysis and data visualisation. Parallel with the lectures, students are guided through a collection of assignments of literature survey on specific UXR methods, planning studies and specifying research protocols, conducting pilot studies, data collection and analysis, and visualisation of the findings. Aligned with this process structured by the lectures and assignments, class workshops are organised on categorising UXR methods, data coding, data visualisation and peer evaluation. Workshops both help fostering the theoretical knowledge and practical skills obtained from lectures and assignments, and encourage peer learning as each UXR case involves using different UX methods and visualisation techniques. Students work either alone or as pairs on subjects (experiences) of their choice, and the course is concluded with a poster design for each project, which is discussed and assessed in a final jury and exhibition.

During the course, around 60 methods, techniques and tools for UXR are presented to students by grouping them under six major categories, namely survey methods, interview methods, observation methods, diary methods, workshop methods, and expert evaluation methods. Students are expected to choose two of them and compile a UXR project based on their interest areas. Each project is supervised by the course team through the aforementioned assignments and workshops. After the data collection phase, students are lectured on types of UX models introduced in Section 3 and they are asked to select an appropriate model and apply it for their projects.

The course has been offered and completed for two semesters and is currently on its third semester. A total of twenty-one graduate students have completed the course so far, and twelve different UXR cases have been worked on as separate projects. These twelve projects, resulting UX models and matching UXR methods employed in these cases are presented in Figure 1.

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2 A more detailed procedure of the course is presented in Töre Yargin, Süner and Günay (2018).
4.2 UXR Methods Applied in Students Projects

As seen in Figure 1, there was an array of methods applied by the students including interview methods, such as traditional interviews and focus groups, laddering (Reynolds & Olson, 2001), repertory grid (Fransella, Bell & Bannister, 2004) and UX Curve interviews (Kujala et al., 2011); observational methods, such as naturalistic observation, shadowing and collecting device logs to observe behaviour; diary methods, such as traditional diaries,
experience sampling (Hektner, Schmidt & Csikszentmihalyi, 2007) and cultural probes (Gaver, Dunne & Pancetti, 1999); and workshop methods conducted with users and designers. In order to understand and model the experience, for each project, different methods were selected to plan a multi-stage study. Figure 2 demonstrates graphics that explain methodological stages for some of the projects. Although, for each project, usually two or three methods were selected, additional stages such as screening surveys, pilot study sessions and complementary interviews were necessary and involved in the figure. Having such diversity in the methods applied during the projects enabled the students to triangulate data, thereby enrich their views while modelling the experience more holistically.

When the overall projects are considered (Figure 1), most of them involved eliciting user attitudes and behaviours through interviews, observations and diaries, although two studies went further on collecting additional imaginative knowledge through workshops with designers and users. In the first case (P04), insights through observations and interviews were generated regarding Syrian refugees’ concerns and experiences related to the registration process to official services, and then a generative workshop with designers was conducted with the purpose of developing innovative solutions based on those insights. For the second case (P11), within the scope of a study on enhancing children’s healthy eating habits, a generative workshop with children was carried out to understand children’s dreams and expectations on the subject following interviews with parents and a diary study with children.

For some of the cases, there were concrete products or services to be evaluated (e.g. headsets in P01, mobile apps for budget management in P02, car sharing in P03, online learning platforms in P08, and online shopping in P12), whereas for others, there were only experiences to focus on without any mediating product or system related to the experience (e.g. lunch break in P07, registration process of the refugees in P04, children’s healthy eating habits in P11, and using idea generation techniques in design education in P10). Additionally, the variety in UXR methods used in a single research case also allowed the generation of multiple UX models where applicable.
4.3 Modelling Approaches Adopted in Student Projects

For each project, UX models were generated representing concepts and their relations, experience over time, activities or works, the user, and design recommendations. In this section, how these models were generated is briefly discussed together with example models from student projects.

4.3.1 Representing Concepts and Their Relations

The most common modelling approach preferred by the students is representing concepts and their relations. During the course, students were expected to conduct qualitative research and apply content analysis (Miles, Huberman & Saldana, 2014) to interpret data, which resulted in identifying important concepts related to the needs, expectations, concerns, perceptions and habits of the users, and relations between these concepts. Such analysis can constitute valuable input for the design process, since becoming aware of these concepts enables a designer to understand the user and their context, and hence, design products which are meaningful for the target group. To generate models focusing on concepts and their relations, mostly interview methods, which rely on collecting attitudinal data, were selected (Figure 1). Moreover, diary studies including experience sampling and cultural probes accompanied by post-interviews facilitated identification of these concepts and relations by providing in-depth data about user experience. Figure 3 illustrates two examples for such models. The first one (P02) focuses on motivations, strategies and challenges of budget management and how they are related to personal values as a result of the laddering interviews with undergraduate students. The second (P06) represents expected qualities of online tools that support the design process and facilitate teamwork in studio education, exemplified with participant comments.

![Figure 3. Models representing concepts and their relations (top: Hierarchical Value Map in P02; bottom: Conceptual Map in P06)](image-url)
4.3.2 Representing Experience over Time

Representing UX over time is the second common modelling aim found in the course outputs. Beyond the momentary experience, how products are experienced by users throughout their lifecycle has been an important topic for UXR. To represent experience over time, students collected data through longitudinal studies involving diaries and device logs, and retrospective interviews including a UX Curve activity, which aims to understand key events and components of the previous experience with a certain product or a service. Figure 4 includes two different models in the form of experience maps; one of which (P05) illustrates stages of makers’ 3D modelling and printing experience and their concerns and strategies related to these stages based on a diary study. The second one (P08) is aligned with a conceptual map demonstrating important constructs of self-learning experience with Arduino through online learning platforms. The map demonstrates stages of self-learning and concepts related to each stage derived from the data elicited through a UX Curve activity.

![Figure 4. Models representing UX over time (top: Experience Map in P05; bottom: Conceptual Map and related Experience Map in P08)](image)

4.3.3 Representing the User

As an outcome of UXR, typical users can be characterized and personified with the purpose of building empathy in the design process. Both attitudinal and behavioural data can be used to generate such user representations. Figure 5 illustrates two different types of personas resulting from the student projects. In the first one (P07), personas with different motivational orientations were developed based on lunch break experiences of science park employees. In the second one (P04), experiences and backgrounds of Syrian refugees related to the registration process for the official services were represented to be used in the following generative workshop with designers.
4.3.4 Representing the Activities or Works of the User

Representing the sequential process and activities of users can be helpful when there is a need for developing use case scenarios for a product or system. To understand such activities and processes, it may be necessary to collect behavioural data through observations or interviews on the user’s current habits and behaviours. In Figure 6, the first model (P07) represents science park employees’ decision-making processes while planning their lunch break. Based on this model, the students proposed a mobile application design focusing on supporting this decision-making process and the model was contemplated while developing the use scenario for the application. The second model (P04) focuses on refugee registration process based on observations in the migration office, which enabled the students to generate insights related to the current process and identify the possibilities for idealised scenarios.
4.3.5 Representing Recommendations

To specify future directions based on user insights generated through UXR, visual representation can be functional in terms of communicating the recommendations effectively. In order to generate recommendations, designer workshops, where the research outputs are used to guide designers, can be considered as in P04. There were three projects where recommendations were proposed and modelled based on research outcomes. Figure 7 delivers two of them, first of which (P04) focuses on designer workshop outcomes aiming to improve refugees’ registration process, whereas the second one (P12) highlights the areas open for improvement for mobile shopping applications and supermarkets based on laddering interview and shadowing data.

Figure 6. Models representing activities of users (left: Decision Making Process Model in P07; right: Registration Process Model in P04)

Figure 7. Models representing recommendations (top: Recommendations for refugee registration process in P04; bottom: Recommendations for mobile shopping app in P08)
5 Discussion

Based on the course outputs and our observations during the course, we see that UX modelling in student projects functioned in three ways; (i) making sense of the experience, (ii) enabling effective communication of research insights, and (iii) effortless transference of these insights into actionable design requirements (Figure 8).

First, modelling is a process involving prioritisation and organisation of complex data in a way that is more graspable. It guides the interpreter to discover the relationships between different concepts, patterns of elements (i.e. user behaviours or concerns) and impacts of various factors holistically in a systemic manner. This process naturally involves elimination and prioritisation among pieces of information available in the data, based on judgements about their relevance to the issue at hand (Deutsch, 1952). All these decisions are highly important for forming an estimate of the relevant experience and empathizing with the user.

It goes without saying that all types of models aim for purifying the complexity in examined phenomenon to make sense out of it; yet, especially during the investigation of processes and behaviours that are also highly unfamiliar to the researcher, models can be useful firstly to help the researcher in learning about the existing situation. For instance, Registration Process Model in P04 (Figure 6) was developed initially to capture the essence of the registration processes of Syrian Refugees in Turkey by the students themselves, before proceeding to the next phases in their research.

Apart from being a medium to step into a stranger topic to the researcher, some models are helpful in exploration. The Conceptual Map, and related temporal Experience Map in P08 (Figure 4), have such a function by exploring the contents of and links between experience concepts and process. Even though this hybrid model is not conclusive and might be difficult for direct inferences, it is highly informative to be an exploration medium for a researcher, the next step of which can be identifying patterns.

Secondly, once the experience is modelled, it is no longer confined to the individual mind; it is now internalized, synthesized, yet consolidated; thus, ready to be shared with others. Effective communication of the research findings is a critical issue within organisations (Töre Yargin & Erbuğ, 2017). Since a model is a visual deliverable, it helps build a shared understanding and collective knowledge; hence, provides transparency within organisations and stakeholders, and supports team collaboration. It not only allows the transference of knowledge derived from UXR, but also mediates formation of new knowledge through collective discussions and reflections.

Again, all models harbour this aim, i.e. delivering the information. Considering the audience of the models and the format in which the models deliver the information, models representing the concepts and their relations as in Hierarchical Value Map in P02 (Figure 3) can communicate manifold concepts related to the perceptions of the users in a well-founded frame. Also, these conceptual maps can be enriched and concretised by verbal anecdotes from users, as in Conceptual Map of P06 (Figure 3), making them more meaningful for the audience. Besides, personas are utilised in P04 to communicate user types and concerns to the design team, and in P07 to guide and justify the design of suggested interface design (Figure 5).

Finally, modelling can serve as a bridge between the phases where user insights are generated and where those insights are used to design products/services/systems. The predictive feature of a model aids interpreting and pinpointing potential issues for design intervention. This is not merely the result of the model, as both making sense (analysis) of the data and communication (collective interpretation) involve a somewhat prioritisation process by
eliminating certain issues whereas focusing on others. In this sense, modelling as a process, together with the model as its product, is a continuous progression from structuring the problem space towards building the solution space. In the course, all models involving recommendations, even if they appear in different levels and fidelity, are important to act on.

As can be seen from the exemplified cases, the students accomplished applying the models, aligning with the three modelling functions identified in this paper: make sense, communicate, and act on. Although the course we outline here is offered as a graduate course opened to students from multiple disciplines, our students mostly have bachelor’s degrees in industrial design. This warrants that most of them have prior experience in applying user research for their design studio projects to different extents. Accordingly, design students typically practice integrating user insights to the design process in undergraduate education; however, externalizing such processes and communicating the outcomes of their user research are not usually something they elaborate on during their education, though it can contribute well to their skillsets in practice. The major premise of this course, which is teaching UX modelling, and enabling students to experience these three modelling functions, can empower the students in externalizing—in addition to internalising—user insight generation and integration processes, which would hopefully make them be more equipped as future practitioners.

6 Conclusion

This paper presents a teaching approach for equipping design students with the theoretical and applied knowledge and skills relevant in UX projects. Our approach for design education has been driven by the need for fully fledged UX designers in industry, which is hardly achieved with traditional design curriculums that are not specifically developed for training UX designers and researchers.

Models, which own a central importance in science involving a wide range of connotations from physical and fictional objects to equations, have been utilised for analysing, teaching and presenting scientific data, meanwhile allowing to focus on major blocks of the reach topic. In view of these benefits, models can be adopted in UX, as experiences are intrinsically multidimensional, dynamic and complex in nature. Different types of models and matching UXR methods from outputs of our students’ projects underpin our inference of major roles of modelling in UX. Apart from their main functions discussed in this paper, models may also influence the selection and construction of opportune research methodology to investigate a certain experience.

The limitations of this paper are based on its seemingly descriptive representation of modelling UX. As these are preliminary steps for drawing up such an educational approach on UX, the effectiveness of diverse models and the modelling approach in UX are continued to be explored and evaluated. It is also important to note that the course is being iteratively updated since both theory and practice of UX are in constant change.

Future work will focus on students’ evaluations of the course in order to improve the content and execution, as well as an investigation of the needs and experiences of designers employed in UX professions to develop comprehensive educational strategies for integrating UX-relevant knowledge and skills into design education.

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References


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Teaching (with) Empathy and Creativity in Design

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Abstract: Empathy and creativity are desirable core design competencies. The relationship between these concepts, however, has remained largely unexplored – including how this relationship shapes, and is shaped by, design education. This work unfolds the creases between empathy and creativity, identifies their synergies and contradictions in design education, and defines a research programme to improve the teaching of and with creative and empathic dispositions. A comprehensive research programme for the advancement of empathy and creativity in design requires diverse and highly inventive approaches to design knowledge. Design researchers are encouraged to draw from their professional and personal areas of expertise to formulate new research questions that connect empathy and creativity, and to adopt and adapt methods of inquiry to study these connections.

Keywords: design education; ethics; collaborative design

1 Introduction

An increasing tide of policies and public opinions shows a lack of empathy, as seen in the ongoing case of the detention centres in the United States where children are being separated from their parents. Examples from June 2018 include the First Lady Melania Trump wearing a jacket reading “I really don’t care, do u?” while visiting the incarcerated children. We argue that a sustainable society requires advanced understandings, actionable ideas, and effective interventions beyond the dominant agendas to creatively imagine preferred futures that improve well-being (Srinivasan, 2017). The capacity to imagine different futures requires a creative agency that is as radical as it is humane. We believe that advancing knowledge and transforming practice in the teaching of empathy and creativity are key to equip people to ask powerful questions, generate innovative ideas, and make more responsible and sophisticated decisions in everyday life. This is particularly relevant in design education, yet the connections between empathy and creativity are often treated superficially and remain largely unexplored. It is critical to show how they can be systematically developed through learning (McWilliam & Dawson, 2008). This work unfolds the creases between empathy and creativity, identifies their synergies and contradictions in design education, and defines a research programme to improve the teaching of creative and empathic dispositions and skills to prepare learners not only for future jobs, but to collaboratively tackle the pressing global challenges and formulate new opportunities to create a more inclusive, sustainable, and happy planet.

1.1 Empathy

Empathy is a multi-dimensional and complex construct historically intertwined with sympathy (Davis, 1996). One way to distinguish empathy is to denote an active attempt to “get inside” or reach out to understand and interpret the affective or emotional state of others, whilst sympathy refers to compassionate feelings that precede an intellectual effort to connect (Davis, 1996). The study of empathy is still fragmented, often focuses in different parts of a larger phenomenon, and has evolved along siloed disciplines and research communities. As a response, an “organisational model” emphasises the connectedness between constructs related to empathy including the person and the situation, cognitive and non-cognitive processes, and affective and non-affective outcomes (Davis, 1996). Perceptual, cognitive, and affective varieties of role-taking allow people to imagine, model, and infer the affective states of others (Davis, 1996). An examination of forty-three definitions portrays empathy as “an emotional response dependent upon the interaction between trait capacities and state influences, a process automatically elicited but also shaped by top-down control. The resulting emotion is similar to one’s perception (directly experienced or imagined) and understanding (cognitive empathy) of the stimulus emotion, with recognition that the source of the emotion is not one’s own” (Cuff, Taylor, Brown & Howat, 2014).

Empathy is often addressed in design education, although usually with unsupported claims such as that students “learn how to ask and how to observe the user in order to gain empathic knowledge about the user that he himself does not know or cannot verbalize” (Jobst & Meinel, 2012). Personal “empathetic habits” have been mapped onto design activities including “immersing oneself in another’s life” (Barnes & du Preez, 2015). Such views of empathy across methods including Design Thinking (Jobst & Meinel, 2012) and Creative Problem Solving (Treffinger, Isaksen, & Stead-Dorval, 2005) are extractive, utilitarian and politically naïve. It does not help that a fundamental concept of empathy is missing in the design literature (Kouprie & Visser, 2009). The intellectual innocuousness explains a lack of attention to the power imbalances between designer and others, especially who they view as “users”. The biases, the privilege, and the authority that designers enact when targeting, immersing on, interpreting, and then withdrawing from people’s lives all go often unaddressed (Kouprie & Visser, 2009). The goal here in the elicitation of empathic design is to challenge views of empathy as a useful means to frame new problems, to ask new questions, and to generate creative ideas that are validated as “human-centred”. Here the focus is shifted to questions of “useful to whom, useful for what?”, raising ethical doubts about the right of designers to target, interpret, immerse themselves, and tackle the affective state of others, even under the guise of good intentions however sincere (Gerrard & Sosa, 2014). Recently, a more sophisticated perspective of empathy challenges the utilitarian sense and transfers empathy from the designer’s ability to design for others or to dictate the relationship or experience of others, and adopts relational aesthetics to denote the capacity to be with others while preserving otherness as a value for “a more collaborative, sustainable, and creative society” (Devecchi & Guerrini, 2017). This angle of empathy shifts from designing with empathy, to designing within an empathic sociability (Devecchi & Guerrini, 2017) - a sense of empathy that connects to creativity as the capacity to change with others.

1.2 Creativity

Creative capacities challenge the status quo by imagining preferred situations or conceiving future worlds, and they transcend an artistic sense as well as the realm of cognition (Csikszentmihalyi, 2014). Paraphrasing the Universal Declaration of Human Rights, we are convinced that all human beings are born free and endowed with reason, conscience, and creative capacities, i.e., free to imagine. This capacity to instigate dissent and transform our social, physical, natural, and cultural environments is a defining human capability that played a central role in the evolution of our species (Asma, 2017). With an increasing brain capacity, increasing societal groups, and an increasingly complex aptitude for language, early hominins began to imagine a world that was different from the one surrounding them. This innate appetite for imagination manifests in all domains and aspects of our lives, from revolutionary scientific discoveries and influential artistic expressions, to subversive political ideas, persuasive philosophical argumentations, and the continuous evolution of languages and cultures.

We view creative capacities as diverse, universal, and organic. Whether in galleries or the street, from luxurious delights to audacious modes of subsistence, humans create new ideas and new artefacts (services, products, and systems) daily around the globe. Especially in Western academic and professional circles, creativity has been appropriated from around the 1950s by elite groups in positions of power, whether motivated by profit or as gatekeepers of the cultural establishment (Csikszentmihalyi, 2014; Reckwitz, 2017). People have an extraordinary power to creatively frame new and unprecedented problems (Sosa, Connor & Corson, 2017). Unfortunately, schooling, societal, and consumption structures often weaken and kill the creative power of most people (Illich, 1973) in ways that are convenient to those in power and the sanctioned “creative class” (Peck, 2005).
The dominant research paradigm for the study of creativity is built upon unexamined assumptions such as its use to separate “creative” from “non-creative” individuals (Power et al., 2015). Not surprisingly, too many people are disempowered and exhibit low creative self-efficacy (Karwowski & Kaufman, 2017). Teachers’ beliefs about creativity and their behaviour in the classroom carry important weight. Studies about how teachers conceive of creativity, whether innate or acquired, and their attribution of creativity to their students often show that whilst most teachers may consider creativity as suitable for development, they simultaneously recognise it in only a very small proportion of their students (Aish, 2014).

1.3 The Empathy-Creativity Nexus

It is revealing that an initial literature search in the cross-over of empathy and creativity shows a scant overlap between these seemingly central concepts for design education and practice. A search applied that includes both words in the title (search parameter "allintitle" in Google Scholar, June 2018) yields a mere 78 results. Moreover, out of 2795 articles citing a classic textbook on empathy (Davis, 1996), only one has creativity in the title (Boltz, Henriksen, & Mishra, 2015). A search for empathy in the top books on creativity returns null or marginal results, and in the thirty volumes of the Creativity Research Journal since 1988, not a single article includes empathy or empathic in the title. A systematic literature review is recommended to inform a research programme linking empathy and creativity in design.

Whilst creativity can be defined as the trigger of change, empathy gives purpose to change. Both empathy and creativity are viewed here as innate human capacities that lead to well-being, and both are developed through learning. They are also deeply personal and intimate constructs that are experiential in nature, yet they have a fundamental societal nature, as humans are empathetic toward others, and are attributed creativity by others. A key link between empathy and creativity is imagination considered as the source of “fellow-feelings” (Davis, 1996). In this sense, empathy may be viewed as using imagination for consensus, whilst creativity uses imagination for dissent. Ethical tensions in creativity include breaking rules, challenging authority and tradition, feeding on conflict and competition, and risk-taking (Baucus, Norton, Baucus, & Human, 2008), all of which involve behaviours informed by the consideration for others. By “others” it is wise to include empathy towards nonhumans (Forlano, 2017). Next, we examine the challenges and opportunities in design education.

2 Teaching (with) Empathy and Creativity

This section presents insights from teaching empathy and creativity as content matter including competencies, dispositions, skills, and learning objectives (McWilliam & Dawson, 2008), as well as insights about teaching design empathically and creatively. To teach empathically denotes a radical departure from “banking” education where the experts transfer knowledge onto students (Freire, 2000). To teach empathically opens a dialogue where the responsibility and ownership of learning is appropriated by the learners in a mutually enriching social encounter (Biesta, 2015).

Design education inherits pedagogical practices that include student autonomy and peer learning to an extent. However, studio learning carries a strong master-apprentice power relationship that enacts authority and hierarchy issues typically associated to banking education (Freire, 2000). The lack of empathic approaches to design education are identified in methods such as Design Thinking (Jobst & Meinel, 2012) and Creative Problem Solving (Treffinger et al., 2005), often applied prescriptively and mechanically imposing a mandated step-by-step process from the certified facilitator (Jobst & Meinel, 2012). A fixed starting state and a defined solution sequence go against all we know about ill-structured or wicked problems (Goel & Pirolli, 1992). Recipes to design remove the agency of teachers as well as learners, as they impose a predefined journey that is sanctioned by the promoters of those techniques. Alternatives to such formulaic methods are required that are more dialogical, generative, and empowering (Berger, 2014).

Likewise, there is a marked difference between teaching creativity and to teach creatively (Jeffrey & Craft, 2004). When the “expert creative” is summoned to teach creativity, there is a logical preservation of the myth that only certain type of people are creative, i.e., the type instantiated by the person teaching. This tacit power tension permeates teaching across subjects and disciplines: the expert structural engineer teaches her students how to become, like her, good at solving equations to calculate the optimal beams for a structure. The problem becomes clear when creativity is recognised as uniquely personal and deeply experiential; i.e., imagine the consequences of imitating what happy people do as a way to reach one’s own happiness. Along this line of reasoning, people may logically subscribe to the dictum that “creativity cannot be taught”, a view that stems from a deep misunderstanding about what both creativity and teaching actually mean. In such power-mediated relationships, teachers are enacting a lack of empathy for the learners portraying themselves as role-models, which runs against ideals of creative capacities.
being diverse and deeply personal and situational. Teaching creativity requires deep empathy and humility to realise that teachers learn with and through learners new ways of becoming and being creative.

Paradoxically, most books and training programmes of creativity show a worrying lack of originality (Jeffrey & Craft, 2004; Rehn, 2011) as evidenced by the re-use of old exercises such as the “nine-dot problem”. In that exercise, nine dots are arranged in a set of three rows in a piece of paper and the “challenge” is to draw four straight lines that go through all the dots without taking the pencil off the paper. Such exercise seems to have led to the asinine expression “to think outside the box” (Pally, 1955). Like many of the cases and exercises recurring in creativity books, the “nine-dot problem” is ill-fitted to define, apply or illustrate creative problem solving as it has one single correct answer, going against the principle that design problems have a range of solutions (Rittel & Webber, 1973). Another rather unoriginal and uncritical approach to creativity training is based upon the adoption of artistic interventions such as painting, acting, or music (Antal & Strauß, 2013). These “creative” activities can often be unproductive or even counterproductive to teaching creativity outside artistic fields, as they can emphasise aesthetic criteria and technical skill rather than focus on the core dispositions of creativity (McWilliam & Dawson, 2008). Creative activities that explicitly target empathy include ideation in Empathic Design (Mattelmäki, Vaaajakallio, & Koskinen, 2014) and nudging strategies (Selinger & Whyte, 2011). Teaching creativity through empathic activities demands an ethical sensibility of how activities are received by learners (Light & Akama, 2012).

2.1 Challenges and Opportunities

Design education has yet to demonstrate how empathy and creativity as key design competencies interact, build on and outweigh each other. Tensions, paradoxes and opportunities are reviewed in this section. On the one hand, prominent creators consistently show a lack of empathy and ethics. Whilst Thomas A. Edison is often celebrated as the most prolific inventor, his infamous stunts electrocuting animals in the “War of Currents” are well documented (McNichol, 2011). Records also exist showing the racism and bigotry of other original thinkers including James D. Watson, Albert Einstein, and Henry Ford. More recently, a growing number of cases is revealing appalling unethical behaviour by TV and film male personalities, many of whom have publicly admitted their deplorable behaviour, or have been found guilty by juries. A thorough biographical study of exemplary creators across domains revealed three types, only differentiated by their level of unempathetic abilities: “disregard for others, difficult toward others, and frankly sadistic” (Gardner, 2011). Those creators (mostly male, mostly Western) are depicted as “committed obsessively to their work” and their self-confidence and self-absorbed nature merging with “egotism, egocentrism, and narcissism” (Gardner, 2011, p. 364). Those creators also showed “childlike features” include curiosity and defiance of convention as well as selfishness. Beyond personality quirks, the concept of “fruitful asynchrony” consistently exhibited by these creators suggests a deliberate and sustained behaviour to exploit, or profit from, a misfit or lack of smooth connections with others. By seeking conflict and dissent, the exemplary creator “stands out in the extent to which he or she sought conditions of asynchrony, receiving a kind of thrill from being ‘at the edge’ and eventually finding it difficult to understand why anyone would not wish to experience the fruits of asynchrony” (Gardner, 2011). These stories suggest a tension between empathy and creativity.

One way to interpret the link between creativity and (the lack of) empathy, is that creative agency may involve empathy with people in future imagined situations rather than with those at present. This is captured by “empathic problem solving” (Weeks & James, 1996) which interprets empathy in creativity not so much toward another person but towards an original idea or a dream. A second potential explanation for the empathy-creativity link is indirectly implied in the study of personal identities of designers (Elsbach & Flynn, 2013). Designers identified as “artistic” are more concerned with their own standards of creativity and with having control over an entire project from initial concept to final production, an emphatic distinction from “problem solving” designers who expressly consider the needs and concerns of others, are more open to work on refining the ideas of others, and are more interested in getting others involved in a project (Elsbach & Flynn, 2013). A third approach to the tensions in the creativity-empathy nexus is the notion that “cold-blooded” rational decisions are necessary to trigger and promote disruptive change, which aligns with the finding that more rationalistic approaches increases unethical behaviours (Zhong, 2011). The ability to regulate intuition and rational decision making would explain empathic capacities to deal with trade-offs and reach compromises in creativity. Such capacity to manage empathic design decisions would also explain the capacity to respond to change resistance. The Schumpeterian concept of “creative destruction” points to the harmful side of creativity, including the effects on how people who are emotionally dependent on the status quo may feel when faced with disruptive change.
2.2 A Systems Model of Empathy and Creativity in Design

The examination of the intricate relation between empathy and creativity in design leads us to formulate a preliminary framework for their study. Figure 1 shows an initial mapping to distinguish means from ends. The intersection of “ill intentions” and “negative means” in Figure 1 acknowledges that creativity can be approached empathically as well as for dark or evil purposes (Cropley, Cropley, Kaufman & Runco, 2010) such as in unprecedented acts of crime and terrorism that change the rules of the game. The quadrant formed by the intersection of “good intentions” and “negative means” in Figure 1 denotes the “Faustian bargain” defined as the choices made by exemplary creators to pay back by sacrificing themselves and treating others cruelly and sadistically using them to advance their ideas (Gardner, 2011, p. 369). This quadrant also includes all unintended consequences, hidden costs, and secondary effects of innovation, particularly technological breakthroughs which tend to exacerbate socio-economic gaps (Srinivasan, 2017). The quadrant between “ill intentions” and “positive means” in Figure 1 can be illustrated by the industry of diamonds engagement rings (Treffinger et al., 2005), as well as marketing scams and pyramid schemes where a minority devises creative means to deceive large groups of people who voluntarily participate. The quadrant between “Good Intentions” and “positive means” in Figure 1 represents the goal for twenty-first century education that we advocate here. Considering the spectrum between the Faustian creativity and Well-being quadrants, design educators can critically examine and reflect upon their choices and framings of learning activities, deliverables, assessment criteria and deadlines to assess the impact of their teaching in the learning experiences of young designers. We thus propose a systematic programme of research to better understand and support the teaching and learning of radical creativity via considerate and humane means.

Figure 1. Framework to examine empathy and creativity synergies and tensions by juxtaposing means and ends.

3 Research Questions

Research questions critically inform the choice of research methods, define what constitutes evidence, and outline the type of outcomes and expected contributions to knowledge (Kara, 2015). We suggest that comprehensive, multi-method, and creative research approaches be used to amplify our understanding and inform future pedagogical practices. A thorough and systematic literature review can help identify the synergies and tensions between empathy and creativity in design — of which only an initial sketch is presented here. This section presents illustrative research questions to orientate a cross-disciplinary inquiry on empathy and creativity in design.

The lack of theorization on the empathy-creativity nexus presents an opportunity for in-depth studies of how designers experience and perceive these behaviours (Baucus et al., 2008). Inductive methods would reveal definitions and connections based on relevant theories of empathy and creativity from psychology, organizational culture, social psychology, education science, and other areas where these constructs are studied separately. Sample questions to base grounded-theory studies are shown under the heading “What is it?”. The examination of learning experiences in design could reveal how empathic and creative capacities interact and complement each other in design education. Sample questions about the art and science of teaching are shown under the heading “How to measure and learn it?”.

The apparent complexity of relations in the empathy-creativity nexus invite research into the mutual effects of these competencies in the design process. Questions under “How do they relate?” examine interaction effects between empathic and creative behaviors. From the initial examination presented in this paper, examining issues of power is likely to reveal important insights about empathy and creativity in design as illustrated in the questions under “Risks and opportunities”. Since both empathy and creativity are life-nurturing and contribute to well-being, sample research questions to examine their roles for sociability and conviviality are depicted under “What for?”.

1. “What is it?” research questions
   Grounded theory research questions: How do professional designers experience empathy in their creative practice? What are the connections that designers and design students recognize in their practice or education between empathic and creative traits? What distinguishes designers and design students from other people in their integration of empathic and creative characteristics? How do personal, demographic, or cultural factors shape empathic and creative characteristics of designers? What are the constructs and indicators that are appropriate to measure empathy and creativity capacities in design?

2. “How to measure and learn it?” research questions
   Questions about learning: What are effective teaching strategies and practices for empathy and creativity across contexts? How to better teach both capacities in tandem, and how may order effects shape the learning of these capacities? How may we distill or extract the learning value from more conventional art and design interventions to teach empathy and creativity? What learning technologies are more appropriate to teach these competencies in design? How may strategies based on narrative, gaming, or Kohlbergian dilemmas be used in the design studio to teach these competencies (Runco & Nemiro, 2003)? What makes community and place-based education effective to teach and apply empathic and creative design? How may the ordering of learning empathic and creative competencies affect their learning in design? What are the control mechanisms to regulate empathetic skills throughout the creative process?

3. “How do they relate?” research questions
   How do creative designers vary in their empathic capabilities (Elsbach & Flynn, 2013)? How may an emphasis on empathy lessen or augment creative ideas? How do individual or cultural empathic traits determine creative behavior in ways similar to personality and domain factors? How to foster creativity in design without encouraging unempathetic attitudes (Baucus et al., 2008)? What are the effects of conflict and “fruitful asynchrony” in the design process and what are the roles of empathy and creativity to manage the type of conflict conducive to creativity (Gardner, 2011)? How do cognitive and meta-cognitive approaches to empathy and creativity interact?

4. “Risks and opportunities” research questions
   What are the power imbalances in empathic discourses in design? How is otherness defined in empathic design? How may creativity be applied to identify and redefine the other in design? (Forlano, 2017). How may systemic analyses help identify and tackle the risks and trade-offs of empathic and creative design? How may simplistic and biased approaches in empathic design backfire resulting in paternalistic or ableist design decisions? What methods are more appropriate to empower users to elicit their own affective states, rather than for designers to try to get inside the mind of others? What design processes may lead designers towards condescendance when they target users with the intention to change their affective states? How may empathy and creativity be effectively applied to design for inclusiveness (Langdon, Clarkson, Robinson, Lazar, & Heylighen, 2012)? How may empathy help the advancement of non-dominant (Western) paradigms of design (Akama, 2017)?

5. “What for?” research questions
   What empathic dimensions affect the transition from mono-disciplinary to multi and cross-disciplinary collaborations (Fruchter, 2001)? How may empathy be used by designers to support reflective practice? What “Faustian bargains” are made by professional designers?

The research questions sampled here lead to a universe of research methods to meet the required heterogeneity and variation desired when studying complex realities (Law, 2004). Some of these methods prioritize inductive approaches that yield rich qualitative insights to augment definitions, reveal critical themes, and formulate new theoretical groundings. Others support deductive approaches where variables are defined from existing theory and their effects measured objectively. A comprehensive research programme for the advancement of empathy and creativity in design requires diverse and highly inventive approaches to knowledge (Law, 2004). Design researchers are encouraged to draw from their professional and personal areas of expertise to imaginatively define, plan, and execute their journeys of inquiry by mixing, adapting, and prototyping methods.


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Representation and Context Based Studio Design Process: Articulating a City (Istanbul)

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Abstract: In architectural education, imparting of stationary knowledge, which establishes space only as physically, is insufficient to achieve the skill that will enable the architect to find solutions to problems encountered in the future. In this case, to perceive space both tangibly and intangibly, a trans-disciplinary milieu is required to acquire derivable knowledge and create a setting of debate and criticism over that acquired knowledge. What might be methods and approaches that can stimulate and re-shape thought, encourage curiosity to acquire creative and critical knowledge in the architectural design studio? How can new experiences and perceptions of the city be reflected in architectural milieu? How are the experiences and outputs produced by different types of representations in the studio? To what extent can a contextual reading trigger the architectural scenario and program? In the light of the above-mentioned questions, this study focuses on the relations of the design studio with the city, the people, the place and everyday life, and, it unveils everyday life by the setting up of contextual readings and representations. It discusses the role of the design studio in understanding the place, the people as a social phenomenon and the reciprocal relationship of space with everyday life through the milieu of the Architectural Design Studios 3-4-5-6 at Istanbul Technical University, Department of Architecture. It is expected that the student’s own journey and experience, rather than the de facto assumptions, are highlighted by grasping the information of place/city at different scales and disassembling (de-composition and re-composition) of existing knowledge. In this respect, different scales and approaches set the design strategy of the studio and direct the design. The study gives a brief theoretical background focusing on the relations of architecture with the city. Secondly, it discusses architectural studio as a platform of representations and narratives for the city and the people. Thirdly, and finally, it gives concluding remarks. Although the results are provisional, this study may give a broader understanding of the relations of the city, the people and the design studio.

Keywords: architectural design studio; context; experience; everyday life; architectural education
1 City/Place/Milieu: Istanbul as the Context for an Architectural Design Studio

In Istanbul in the last decades, a population increase has been associated with unprecedented increases in per capita income; unprecedented investments in urban infrastructures (speed train to Ankara, speedway to Izmir, connection to southern Marmara via bridge over Izmit bay, Marmarail third bridge, airport two) emergence of a new city region and of a spatial frame for the stable electoral and social geographies, new consumption patterns, new life styles, new localities, new activity bundles, non-place realm. In this context, the new infrastructural system is going to form new spatial interaction patterns for the mega-metropolis – causing the generation of a new geography for the 21st Century Istanbul – as depicted by Murat Güvenç (Güvenç, 2017). As a result, the city has been re-shaped and is going to be shaped by the emergence of social and economic segregation, tensions stemming from the contact with contrast interpenetration of lifestyles consumption patterns, a new city region with a new urban society, a new built environment social and electoral geography, and new local Identities. In this framework, sustainability and social cohesion are put at stake. What we are witnessing in Istanbul is a rapid and chaotic capitalist urbanization - very reminiscent of Manfredo Tafuri’s depiction on the one in American cities in terms of the restless, wild, harmful, pitiless commodification and consumption process accompanied with the loss of ethical values – as depicted by David Harvey (1990).

In this ambiguous situation, it is difficult for experts to predetermine the future. Researchers in the humanities deal with the formation and the process of identity and new approaches in humanities question common notions and approaches to the city/architecture - design - human being - nature in a holistic system. These studies approached the city, on the one hand, as the space of power, and on the other hand, as the space of multitudes, negotiation and appropriation. These works put emphasis on the gap between official representations of spaces, and their multiple, conflicting conceptions, remembrances, and imageries. Those works focused on issues related to cultural identity and memory; and discussed how subordinate people negotiated their cultural values and identities through spaces. They saw architecture as a medium where ‘ordinary’ people represented their self-images or reconciled their cultural values with interacting cultural systems. And there is an urgent call for new approaches in the systematization of design/architecture/urban studies. Henri Lefebvre’s theories encouraged researchers and designers from various disciplines to conceive spatial formations as part of the socio-cultural fabric. After several other social thinkers who theorized space as either the background or product of social relations, Lefebvre was the first to see space as both; as at once the ‘medium and outcome’ of social life (Lefebvre, 1991). In other words, for Lefebvre, “space was produced socially as social reality was heavily influenced by spatial relations” as depicted by Hilde Heynen (2013). In Lefebvre’s formulation (1991), “the production of space” did not simply point at a physical production; but included a multiplicity of physical and non-physical layers including everyday practices and lived experiences. The built environment was far from being an end product. It was continuously re-produced in everyday life; through each particular use, experience or remembrance. Thus, according to Lefebvre, spatial production included images, dreams, memories, mentalities and ideologies. Space, therefore, needs a broader understanding, and a new positioning in theory, research and design approaches. Studies in humanities do not provide a unitary method or have not agreed on terms and issues. However, we can detect a common interest: the making of space as a social product. Space is understood as a social entity with particular, localised meanings. Inter-/trans-disciplinary and theoretical intersections continue to use spatial metaphors; studies still require some form of critical remapping – spatial representation. As referred in The Unknown City (Borden et al., 2002), Benjamin treated architecture “not as a series of isolated things to be viewed objectively; but rather as an integral part of the urban fabric experienced subjectively”. Instead of describing buildings in terms of aesthetics or function or categorizing them in terms of their style or means of production, Benjamin approached buildings as aspects of culture. Accordingly, he produced a profound social critique of early 20th century Europe by analysing how the built environment was produced, used and perceived (Benjamin, 1999). Parallel approaches to architecture and the built environment are echoed in numerous recent studies. “Places in the city are not merely architectural metaphors” says Svetlana Boym (2002): “they are also screen memories for urban dwellers, projections of contested remembrances. Of interest here is not only architectural projects but lived environments, everyday ways of inhabiting the city by following and deviating from the rules, tales of urban identity and stories of urban life.” In The Future of Nostalgia (2002) Boym also emphasized the gap between master images and multiple experiences of spaces. She claimed that “the ideal city existed only in architectural models and in the new total restorations”, whereas the city always consisted of infinite fragments (Boym, 2002). Spaces might be produced according to (physical and symbolic) master images of regulative bodies; but they are made up of infinite fragments and are infinitely reproduced through use and imagination: through “multitudes” (Hardt & Negri, 2005) that infinitely re-imagine and transform them.

In the light of this framework, our studio architecture is understood as cultural landscape - a physical and discursive product, continually reproduced through culture, politics and everyday life. The term architecture does not refer solely
to the practice of architects. The *built environment* does not refer to an accumulation of physical objects. The studio as a design research milieu leans on the idea that architecture and the built environment are embedded in cultural and social tissues, and are continuously produced and reproduced by multitudes of actors - discursively, as well as physically. Our studio in the last five years has been designed as a trans-disciplinary research milieu combining a variety of thought systems, most of which derive from critical theory. Our approach to architecture and urbanization as a design research platform is in parallel with Jean-François Lyotard’s towards grand-narratives. It aims to track power and institutional mentalities that still dominate architectural and urban memorialization. It looks critically at the cultural relations, and dominant and recessive patterns, attempting to show how they exclude a multiplicity of embedded meanings. Criticizing institutional and ideological forms of knowledge, Lyotard cherished the multiplicity of human perspectives.

The basic question of what are the contexts and themes in the global context bringing new questions on the format and content, as well as the meaning, and providing students the recognition of the infinite multiplicity of points of view. In the crucial new context, what can be the role of an architect vis-à-vis the built environment? To what extent can we make a difference as architects and as citizens of this city? How to develop a new language to deal with ambiguity? How to set up a dialogue with the foreigner and the other? To what extent can an architectural design studio be a milieu to unveil these chaotic issues and make young candidates of architecture aware of the context? To what extent can an architect be the architect of the 99 percent instead of 1 percent? Whose side can the architect take? How to touch the everyday life of the other?

With the above-mentioned questions, our study unveils the main approaches of our studio in the last five years aiming for the formation of an intellectual. For the setting of a new language in the systematization of architectural studies, our studio questions the common notions and approaches to history/architecture/theory/design. It problematizes yesterday via cultural layers for designing today. The basic question is how to design an integrated/trans-disciplinary design approach based on ecology, cultural economy for the making of a human city/settlement/architecture? How can research in design studio can be combined with urban studies? How can cities be best conceptualized as sites of social and political identity, as ambiguous territories of conflict, and as incubators of innovation and creativity? To what extent does grasping the everyday life and experiencing the place pave the way for critical design thinking?

A critical experiencing of the city, research process and alternatives representations of the contextual narrative from the process provides a multi-layered picture about the place, the people, the theme of the semester.

### 2 Representing the City/Place/People in the Design Studio

The core theoretical framework which determined the general approach of this studio as design research is based upon a wide range of insights from humanities. Besides a core knowledge on the theory and history of architecture and urbanism, it also leans on cultural and social theories, critical theory, poststructuralist theory and others. This framework centres upon keywords such as identity, memory, history, culture, power, architecture, globalization, cosmopolitanism; dwelling on a number of sub-intersecting issues and leading architectural students to face the presence of multi-issues surrounding the reproduction of space in Istanbul.

The studio aims to develop a critical thinking of the built environment for the experimental re-discovery and creative analysis of place/city in different scales. Spatial experience emerges within experience/perception and critical thinking. Perceptions during experiences can be the constituent facts of understanding, grasping the built environment. This unveils how the reflexivity such as awareness, suspicion, care, intentionality, curiosity, remembering and forgetting can be transformed into understanding for the design process.

In Architectural Design Studio 3, 4, and 5, conducted between 2014-2018 at Istanbul Technical University, Department of Architecture, an urban milieu affects the student’s relationship with the city/place, the local and his / her own body and production of a space in the studio with the information gathered from that discovery. The setting up of a critical trans-disciplinary milieu in the design studio provides gathering social and spatial, tangible and intangible information about the place, experience it individually, and transfer this experience into representation(s), and then, to transfer it for the re-production of space.

In the trans-disciplinary design milieu, a critical discovery process is triggered by shared experiences and workshops - initiated instead of training students who just understand what teacher teaches (Rancière, 2014). In the design studio, all works are approached as cultural products (parks-buildings- networks-infrastructures) - the patchwork of the human existence, and thus, all cultural products are also a topic of design research and design. The
The duty/task/responsibility of a young researcher/designer is to work as a detective to question the urban layers and to unveil the mega-narratives. The design research process begins with theoretical readings, mappings and musings, leading to questions interrelating identity, memory, culture, socio-economic structure, power and architecture. The architectural design studio in 2014, titled Pier's Navigation, the aim was to explore the possibilities of structure, space, scale, conflict and relations between city and physical experience. For this reason, the importance of both the analytical and intuitive was emphasized in the process and both were used to comprehend the project area. Urban layers were collected through maps, photographs, written sources and observations for grasping and experiencing of place. Grasp is based on solving and reassembling/recompose. For this purpose, experts from different disciplines supported our studio milieu.

A cartoon workshop on the use of public spaces was realized with the artist Nalan Yırtmaç. Through this workshop, the students shared their observations and experiences in Karaköy via fictional characters. The representation is composed of these cartoons and collages also trigger the production of knowledge and awareness through experience and observations. In Figure 1, it is observed that Özlem Yazgan’s observation, encounter and experience in Karaköy are transformed into visual information with cartoons.

The actress Ayşe Draz organized a drama workshop which stimulate re-thinking of everyday life in Karaköy and on the waterfront with creative theatre techniques. Through this drama work, it was aimed to discover the potential of the body in the formation of space. Body with the dance and drama studies were asked to consider the potentials of the body that is standing and moving. Thus, the positioning of the body in the space and the possibilities of the designed space became questionable. In the studio conducted between 2014-2018, it was observed that space-body and space-user relations were established more strongly during production of space where body workshops were organized (Figure 2).

**Figure 1. Cartoon Workshop by Nalan Yırtmaç, ADS 2017 Spring, Özlem Yazgan.**

**Figure 2. Body, Movement and Space Workshop, TAL Dance, Taşköşla.**
One of the targets in the studio is developing awareness to interpret what you see and the ability to re-discover, grasp and re-experience the built environment, unveiling both ordinary and hidden dimensions. Representations and mappings of the knowledge of place/space is gathered from experiential and creative processes, in different forms have been triggered to continue the re-production of spatial information. Focusing on the everyday life (banal, temporary, simple, standard, conventional, even boring) removes the sacred veil over urban and architectural issues - as proposed by Michel de Certeau (2009) in the 1960s as a tactic to deal with mega-narratives and mega-rules. In this regard, it has been possible to face contradictions, conflicts, dilemmas as well as dynamics and potentials - which have been put under investigations by young architectural students as detectives. In this investigation, setting up a Barthian symbiotic relation with the built environment is a must: a dialogue with place, citizen, and to listen to the voice of the city/citizen, smell it and be a flaneur/flaneuse grasping the built environment. With these holistic approaches, it is possible for students to think of the city with its surroundings, as well as with the local and the human scale (Figure 3).

In the architectural design studio 2017 titled “Re-Experiencing the Golden Horn”, the aim was to reinterpret the place through grasping, experiencing and re-representing the built environment with Roland Barthes’ work (Barthes, 1994). For the all-round consideration, comprehension and interpretation of the place/city, various seminars, workshops and excursions were organized with architects and experts from different disciplines. Re-reading and mapping the urban traces as an archaeologist was the process of the studio. Architects have to integrate local values with global issues, using technology and knowledge on behalf of innovation. They have to bring social awareness, environmental sensibility and ethic responsibility to their work. Referring to the urban experience, we seek ways for re-reading the city through its incomplete experience, cultural codes and historic values – with a flexible approach and critical thinking to grasp its multiple layers of meaning. We experience the paradox of the old city and global place which requires both continuity and change.

Semra Aydinli emphasized the concepts of tangible and intangible and triggered rethinking the possibilities of these concepts. Intangible and invisible channels of space hold within itself perceptual energies. They all refer to place-memory – as depicted by Semra Aydinli (2017). As she argues, enmeshed experience motivates us to grasp the multisensory qualities of the existing environment. It makes possible to be in constant dialogue and interaction with its narrative space. The tangible and intangible experience represented via mappings and transformed into knowledge about the built environment is not only considered as documentary evidence; rather, it speaks to the emerging cultural awareness of the traditional settlements studied and experienced in Istanbul. Grasping the intangibles of space via experiences as well as tangible data, and then transfer this body of experience into mappings / representations of place-space is the essential part of the design process.

Ali Vatansever talked about storytelling methods and made a story-writing workshop on the characters’ photographs taken by students during their trips to Eminönü. By way of the characters which have taken photographs by students in Eminönü, they conducted an analysis of the local with the method, is to be relatively part of the place through creating a fictional story with the local characters, based on their own observations and the knowledge of the place (Figure 4).
Students internalized their scenarios and transformed them into spatial information. Thus, it is possible to investigate the relationship between the user and the space. In Figure 5, the wishes of the children that Selin Sevim encountered in the project area are expressed and these wishes are tried to provide with designing transforming space (Figure 5).

Landscape architect Defne Akyol gave an overview of the approaches to the design of public space on the waterfront and gave examples. With that method, we supported the emergence of the unexpected and heterotopic with Benjamin’s word.
A holistic way of seeing, re-thinking and re-understanding the city/place with the local as a spatial and social structure can be associated with its narrative space during the design process. While investigating the social and demographic structure of the daily life of the local, not the majority, the plurality has been highlighted and an attempt to understand the voice of plurality. Focusing on plural voices of the everyday life in multi-faced and multi-linguistic imperial city is an essential part of the design process. Not only human beings, but natural elements, animals are also accepted as social actors of the built environment, and therefore part of the design research.

It has been observed that students often have difficulty in transforming the knowledge of the place/city into spatial knowledge, which is derived from the exploration of place/city supported by various architecture and trans-disciplinary seminars and workshops. Focusing on urban scale, place, people, body provide to face shifting balances; the multi-dimensional experience and reading create a dynamic effect in perception as well creativity of the student. Representations and mappings of the urban context, everyday life, peoples, body in the design process pave way critical and creative development of a story – scenario - program based on conceptual idea (an argument, an architectural word) for the design proposal – providing a broader meaning, critical contextual inter-relations of the design proposal.
In brief, the main argument and message of the studio to the young candidate of architecture is to provide insights into plurality instead of majority. In this context, it is necessary to prioritize humans and pluralism. Representations focused on experience, space, place and humans / living beings trigger the emergence of the unexpected and heterotrophic. With a broader investigation of the local, participatory design is allowed: in the last two semesters, students designed for chosen locals. Designing for an open and democratic city, the awareness of the city right, citizen right, nature right, water right, etc. were raised. The participatory design milieu has even become more trans-disciplinary and inter-active.

Change, dynamics, conflicts, oppositions, contradictions as well as dynamics and potentials, ambiguity, plurality, transparency, right to the city, water right, nature right can be guiding words for a new design language and an alternative architectural beginning starting from the studio. A tentative milieu exemplifies this.
References


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Abstract: User interaction and experiential aspects of electrical and electronic product design are complex areas for design students to grasp, requiring integration of industrial design (ID) and interaction design (IxD) knowledge and skills. This paper reports on a specific educational challenge that arose during the planning of a new Master of Science programme: how should a highly-compact (14-week, 8 ECTS) introductory graduate course in design for interaction (D4I) be effectively framed and delivered? The paper reviews the boundaries of ID and IxD for clues about the implications of each profession on D4I education, revealing the centrality of user experience (UX) for envisaging successful interactive products and systems. The reported new D4I course is conceived with a structure divided equally between Part 1 (theory/foundations) and Part 2 (practice/design projects). A novel orientation framework comprising five interconnected elements is introduced to assist delivery of Part 1, comprising: (i) user experiences, (ii) domains of interaction, (iii) usage cues, (iv) technologies, and (v) contexts of use. The content of each element is articulated and its contribution to D4I education explained. Student learning culminates in the carrying out of an interaction-focused conceptual design project. The paper is argued as a valuable source for instructors who are considering establishing an introductory D4I course or revising an existing course.

Keywords: product design; design for interaction; user experience; course development; framework

1 Introduction

From the time that we wake up, through our time spent at home and work, we continually interact with everyday things. Through interactions, we understand how to use a product and how that product feels when being used. The mix of sensations, perceptions, cognition and actions during product use defines the instrumental user experience (UX) from a product (Frens, 2006; Pedgley & Sener, 2009; Schifferstein & Hekkert, 2008). Given the centrality of interactions to product use, there has become a growing acknowledgement amongst design educators that students must be able to conceive product designs outside of the prevailing tradition, where a product is thought of “...in terms of appearances and functionalities rather than experiences and interactions” (Pasman, Boess & Desmet, 2011, p.1). This paper reports on a specific educational challenge that was first put to the authors approximately ten years ago: how should a highly-compact (14-week, 8 ECTS) introductory graduate course in design for interaction (D4I) be...
effectively framed and delivered? The challenge originated in the planning phase for a specialist joint MSc programme in Design Research for Interaction, a collaborative effort between TUDelft Faculty of Industrial Design Engineering and METU Department of Industrial Design, initiated under the auspices of the TULIP higher education agreement between the Netherlands and Turkey.

The overall aim of the joint programme was for students to benefit from a fusion of practical design expertise and projects at TUDelft with design research and thesis preparation expertise at METU. Students commenced their first semester of the programme at METU, with most of those enrolled having freshly graduated from industrial design bachelor’s degrees. The principal aim of the introductory course was therefore to accelerate students’ understanding of what D4I involves, from a baseline of relatively little experience of the subject at undergraduate level. Since the introductory course at METU would dovetail into more specialised interaction-related courses delivered at TUDelft, the planning of the course and the joint MSc programme more generally necessitated an exchange of ideas, positions and educational practices amongst staff from both institutions. The result was the ID535 Design for Interaction course. The course was piloted in the 2007-08 academic year and served to the joint programme (2008-2017). In that time, the course also served students enrolled on METU’s own MSc and PhD Industrial Design degrees. The course continues today as an elective course for graduate industrial design students.

In this paper, we outline the rationale behind the course and pick out what we consider to be important steps forward in distilling and communicating the essence of D4I to newly recruited graduate design students. The paper firstly discusses the blurring of professional boundaries operating across design, interaction and UX, so as to define the right pitch for the content of the course. The two-part structure of the course is then explained: first, the orientation framework used to develop students’ initial awareness and understanding; then, the conceptual product design projects in which students develop and demonstrate capability in designing for interaction.

### 1.1 Blurring of Professional Responsibilities: Finding the Correct Pitch

In the broadest terms, the conceptualization of preferred ways of interacting with electronic products requires a synthesis of design for physical interaction and design for informational interaction (Frederking, Cruz, Baskinger & Overbeeke, 2008). To understand what this means in practice, it is useful to make reference to some distinctions between the professions of industrial design (ID) and interaction design (IxD). Historically design for physical interaction has been the realm of ID, where interaction with physical product elements was a logical progression from the design of those elements solely from a visual-form perspective. The man-machine interface is an arcane term that was synonymous with interaction elements of physical products well into the 1980s. IxD emerged alongside ID during the advent of computers, with a special remit to bridge the conceptual gap between interacting with the physical world and interacting with the informational world inside a computer (Moggridge, 2007; Saffer, 2009). In this respect, the roots of IxD served to synergize design for physical interaction and design for informational interaction. Some time since, partly fuelled by the ubiquity of the graphical user interface (GUI), the visual informational aspects of IxD became dominant, such that in the late 1990s and throughout the 2000s IxD became synonymous with website design and digital display design (Löwgren & Stolterman, 2004; Preece, Rogers & Sharp, 2002). In a rare contrast, Kolko (2007, p. 12) described IxD in the mid-2000s in a more inclusive manner, presumably because of the inclusivity of his own creative practices and projects: “…the creation of a dialogue between a person and a product, system or service (…) this dialogue is both physical and emotional in nature, and is manifested in form, function and technology”.

What implication does these professional boundaries and remits of work have for an introductory course on design for interaction? The implication is that there is a correct pitch to find for course content, which must reflect the current and upcoming state of interaction-related design professions. In the current era, boundaries between the work of industrial designers and interaction designers have become blurred, with the advent of hybrid degree courses and hybrid skillsets of graduates and professional designers. Indeed, the most recent definitions of ID and IxD offered by their highest-profile professional associations are notably inclusive in nature, and are provided here as evidence of the merging skillsets (and professions) that are now relevant to product design.

Industrial Design is the professional practice of designing products used by millions of people around the world every day. Industrial designers not only focus on the appearance of a product, but also on how it functions, is manufactured and ultimately the value and experience it provides for users. Every product you have in your home and interact with is the result of a design process and thousands of decisions aimed at improving your life through design. (IDSA, 2019)
Interaction Design defines the structure and behaviour of interactive systems. Interaction Designers strive to create meaningful relationships between people and the products and services that they use, from computers to mobile devices to appliances and beyond. (IxDA, 2019)

We took the stance that our introductory course must achieve an integration of knowledge and skills relevant to physical / materialized product design, as well as knowledge and skills relevant to informational / digital design. Designing products in which the overall interactive experience is embodied and attributable to a combination of physical product handling and electronic content and navigation requires such an integration (Malouf, 2008; Vertegaal, 2011). As an example, the gallery of Grohe faucets in Figure 1 transitions from variations on manual interaction through to the increased integration of electronic and computational components. Under our rationale, the two faucets on the right are mechanically and electronically interactive, and thus represent the kinds of products that we foresaw as relevant to the course aims and objectives.

![Figure 1. (left to right) Transition in Grohe faucet interaction from manual to integrated electronics / computation: Atrio separated manual controls, Eurodisc mixer manual control, Essence infrared control, Ondus display-based control. (© Grohe, 2011)](image)

The focus on value, experiences and meaningful relationships in the latest IDSA and IxDA definitions emphasizes that experiential user-focused aspects of interactions must be at the core of an introductory course. Indeed, the user-centredness of interactions and communicating the complexity and breadth of factors relevant to product use and UX (Lallemand, Gronier & Koenig, 2015) was considered of highest importance. To avoid being side-tracked in this task, we have avoided making qualifications or comparisons with emerging occupations dealing with UX (e.g. user experience design, user interface design) on the basis that these are rather ambiguous in meaning, extremely varied in occupational definition and currently suffering from use as buzz words (Kou & Gray, 2018). Instead, we took the position that enough could be gathered about UX for the purposes of course construction within the bounds of ID and IxD practices and related literature.

### 1.2 Course Structure

One of the most challenging aspects of planning a new course is to define the hierarchy and distribution of content. That is, to make decisions concerning which subject matter should receive highest priority, which should be omitted, and how connections will be made between the various subjects to be covered. With ID535, we sought to give students sufficient theoretical input to be knowledgeable and conversant about D4I, as well as sufficient time to complete a conceptual product design project focused on interactions and interactivity whilst learning and demonstrating practical D4I skills. The course was intended to be supportive of designers’ conceptual design activities, within the third phase (develop) of the four-phase double-diamond model of design activity (Design Council, 2019). Our choice was to create a split course with theory/foundation and practice/application parts, rather than adopt a highly practical-oriented approach delivered predominantly through sequential design projects (Klemmer, Verplank & Ju, 2005). Part 1 (seven weeks in duration) provides foundations and makes use of a new orientation framework to introduce students to relevant theory and principles; Part 2 (also seven weeks in duration) is dedicated to a conceptual product design project. Relating the framework elements to the competencies for UX education recently outlined by Vorvoreanu, Gray, Parsons and Rasche (2017), we can say that Part 1 includes development of visual and interactive representation and design philosophy, whilst Part 2 includes development of social/research methods.
leadership/teamwork and technical skill (although restricted to mock-ups rather than working prototypes and programming). It will be appreciated that over ten years of delivery, the course as given now is different in detail to how it was in 2008. We will not in this paper enter into a historical review of the changes and the drivers for those changes, but instead concentrate on the most recently delivered (and therefore refined) version of the course.

2 Course Part 1: Foundations and Orientation Framework

We use the first seven weeks of the course (Part 1) to build students’ awareness and knowledge of what is meant by taking an interaction-centred approach to design projects, and what the implications are for design decision-making. Teaching and learning are by way of lectures, in-class exercises and student assignments. To help decide on the contents of Part 1, we consulted two sources of information.

First was academic literature in design, interaction, communication, and human-computer interaction (HCI), many of which form the references of this paper. Second were websites of universities offering interaction-related Masters programmes in design. In our investigations, we mostly encountered programmes in interaction design, UX-based design or product-service-system design with emphases on interaction. Programmes did not obviously include broad-based introductory courses to D4I. Instead, most had a curriculum comprising specialist D4I-related courses, which when combined provided a comprehensive education for students. Additionally, very few of the programmes had crossover with the overall content of our joint MSc Design Research for Interaction programme, with its emphasis on teaching and learning D4I with physical-digital products rather than just digital. We identified the following exceptions: MA in Interaction Design (Umeå University, Sweden), MSc in Design for Interaction (TU Delft, Netherlands), MSc in Industrial Design (TU Eindhoven, Netherlands) and, albeit with a greater artistic and critical design approach, MA in Design Interactions (Royal College of Art, UK).

Amongst the Master’s programmes and academic literature, we identified recurring closely-related subjects that could be clustered into five distinct themes, which we named below and organised into a D4I orientation framework for students (Figure 2). The framework promotes a division of subject matter that can be followed by students without being intellectually overbearing. In constructing the framework, we were driven by the keywords reduce (extracting fundamental principles), simplify (emphasizing comprehension rather than detail), and apply (highlighting relevance to design practice). To the authors’ knowledge, the framework represents the first attempt to combine into a single location the subjects that majorly influence the task of designing for interaction with physical products.

![Figure 2. Design for interaction orientation framework showing relative arrangement of elements](image-url)
• User experiences. How are affect, cognition and behaviour implicated in interactions? (e.g. evokes pleasure, easy to navigate, etc.).
• Domains of interaction. What interacts with what or who? (e.g. user-product, product-product, etc.).
• Usage cues. How do products direct us to act and behave in certain ways? (e.g. affordances, conventions, etc.).
• Technologies. How are products made interactive? (e.g. via touchscreens, voice assistance, etc.).
• Contexts of use. What outside factors condition interactions? (e.g. user’s skillset, presence of other people, etc.).

Prior to being introduced to the framework, students learn complementary fundamental principles. They are guided through the anatomy of interaction (sensation-perception-cognition-action-feedback/feedforward cycles), become accustomed to the variety of multisensorial information that may be relevant during interaction (Schifferstein, 2011; Coskun, 2014), and are given foundational knowledge on interaction timelines regarding goals, steps and actions. The principle that interactions and the experiences that they evoke cannot be directly designed is also explained to students. Freedom of interaction in ways that the designer did not intended or foresee is always a possibility, leading to gaps between envisioned product use and what really happens (Hassenzahl, 2003; Overbeeke, 2007; Boess & Kanis, 2008). Students are advised that users can be highly creative (sometimes disobedient) in their interaction with things, or simply unaware of what to do and in what order to operate a product. Therefore, from a pragmatic standpoint, the result of D4I is only to influence preferred or intended interactions and experiences, through shaping, guiding, orchestrating or otherwise persuading certain actions and behaviours whilst discouraging others. This is explained to students with reference to the situatedness of product use: contexts of use are frequently shaped by factors either unknown to, or unaccountable by, the designer. The content of each of the five elements of the orientation framework is now summarized, to give a feel of what each covers. The framework is open-ended regarding didactic materials and educational approaches.

2.1 User Experiences
User experiences refer to how people experience products with regard to affect (sensations, aesthetics, emotions), cognition (comprehension, meaning-making) and behaviour (actions, reactions). It is regarded as the primary and baseline element for planning and evaluating interactions (Hassenzahl, 2013): ultimately, the success of an interaction is determined by the user experience that it evokes. We impart the principle that UX is inextricably linked to user needs, using the hierarchical divisions presented by Anderson (2011): from functional (useful), through reliable, useable, convenient, pleasurable, to meaningful. We extend the arguments by implicating UX with people’s pragmatic and hedonic needs from products (Hassenzahl, 2003; Forlizzi & Battarbee, 2004) and with the point that UX is a time-based phenomenon (Karapanos, Zimmerman, Forlizzi & Martens, 2009). We encourage students to envision UX by focusing on the activities of people (e.g. recording still images, navigating around an airport) rather than end products (e.g. camera, information kiosks). This of course is one of the known approaches for user-centred design. We also present to students different UX frameworks to emphasise the variety and similarity of terminology used in the field, focusing especially on aesthetics, meanings and emotions offered by Desmet and Hekkert (2007) in their framework of product experience.

Direct linkages between interactions and UX are explored with students, commencing with the sensorially-focused term aesthetics of interaction (Overbeeke & Wensveen, 2003; Hummels & Overbeeke, 2010; Locher, Wensveen & Overbeeke, 2010). For semiosis (meaning-making), we adopt the position of Suchman (1987), who argues that meaning is made in an interaction, not prior to it (in our case: in the sensing of material or digital qualities, in moving or activating controls and components, in making sequences of actions, developing behaviours, etc.). In recent years we have explored the idea of transferring product semantics terminology (Krippendorff & Butter, 1984; Demirbilek & Sener, 2003) from a static visual form context to a dynamic interaction context, arriving at what we have tentatively termed interaction semantics (Sener & Pedgley, 2014; Sener & Pedgley, 2015), involving denotations and connotations attributable to visual+other or non-visual (multi)sensorial interaction.

2.2 Domains of Interaction
Domains of interaction as an element is not defined in the literature. We refer to it as the various ways in which products can be connected to people. Domains can be regarded as the skeletons onto which the details of D4I can be built. We show students four basic domains that cover the majority of interactions between users and products (Figure 3).

• User-product. Interactions in this domain occur on a personal one-on-one basis. For example, taking a shower, putting the kettle on, loading a dishwasher, driving a car, operating a phone.
• User-product-product. Products can share resources and achieve improvements in functionality and experience for end users through wireless and physical connections with other products (e.g. cloud computing, Bluetooth®,
memory card transferability). Interactions in this domain occur on a personal basis but through multiple connected products.

- **User-product-user.** In this configuration, the presence of more than one user brings a shared dimension to interactions, which may extend to social experiences. Users can interact simultaneously in the physical presence of each other (e.g. a two-player Xbox game), or the interaction can be sequential without the other user being present (e.g. recalling personalized settings on a shared home hi-fi system).

- **User-product-product-user.** Interactions in this arrangement are defined by telecommunication exchange of information between geographically distant people, via the medium of products. This domain of interaction is dominated by apps installed on mobile devices, which can include chats (e.g. Whatsapp, Skype, Messenger) as well as access to collaborative computing services.

![Figure 3. Four domains of interaction linking users to products.](image)

### 2.3 Usage Cues

People understand how to interact with a product by processing cues or clues based on what they see, feel, hear, etc., from that product (Satterfield, 2003). Usage cues are defined as the ways in which product features, manifesting as sensorial information, can direct us to use a product (to act and behave) in a certain way. We use Locher et al.'s (2010) organization of sensorial information according to functionality characteristics independent of modality: inherent information (pertaining to physical actions performable on the product); functional information (giving clues about relationships between the form and arrangement of components and their product function); and augmented information (arising from layers of feedback communicating the status of product operation). In essence, we provide students with guidance through the world of affordances, constraints, conventions, mapping and other use-related concepts. We take a product-oriented approach, which may be regarded as rather simpler than the use cues described by Kanis, Roeden and Green (2000) and Boess and Kanis (2008), which in their terms arise from the enacted, lived relation between people and things. In other words, use cues is a more encompassing term that is located in the ongoing interaction whilst using a product; our usage cues instead refer directly to product features that may be describable outside the context of interaction. This simplified approach was deemed appropriate for an introductory course.

### 2.4 Technologies

Technologies are defined as the technical means that enable products to be interactive with users and to connect to other products. Such technologies are generally electronic and electrical (e.g. touchscreens, gesture controls, ubiquitous computing, biometrics) but in principle can extend to electro-mechanical, bio-mechanical or other more diverse technologies. Technological product design has a long history of aiming to humanize technology to make it fit to the needs and desires of people. Students are introduced to the reciprocal points that technology embedded in products not only shapes those products, but critically “technology shapes us” (Löwgren & Stolterman, 2004, p. 144).
by way of behavioural changes or changes in our expectations from new products. Echoing the thoughts of Saffer (2004), we propose to students that design can sometimes be a means of introducing new technologies to consumers through new products, and that accordingly designers should be fully involved in the consultation process to decide what kinds of technology might be relevant to achieving preferred kinds of interactions. We enter into the details of technologies in Part 2 of the course (conceptual product design project), covering only those technologies that are especially relevant to, or explicitly mentioned in, the project brief.

2.5 Contexts of Use
Interactions do not occur in a vacuum: they are situated, occurring in the real world, where various factors affect what goes on (Dey, 2001; Obrist, Tscheligi, de Ruyter & Schmidt, 2010; Saracevic, 2010; Hekkert & van Dijk, 2011). Contexts of use are defined as the factors outside the control of the designer, which influence and condition the actors and situation in which an interaction takes place. Contexts are presented to students according to the predominant classifications in the literature, related to either the user, the product, or the user-product interaction as it occurs (Dourish, 2004; Hekkert & Schifferstein, 2008; Locher et al., 2010).

- **User context.** This characterizes the demographics, knowledge, values and physical and cognitive status of individual users (e.g., age, gender, financial circumstances, religion, sensory awareness, intellect, educational level, familiarity with products, practical skills, mood, psychology, cultural conditioning, prior experience).
- **Product context.** This characterizes additional information or circumstances surrounding a product that are not directly part of that product, but on which the product’s operation may rely or be enhanced. For example, ubiquitous computing is a product context whereby distributed low-cost but high-speed Internet access is available as the means to connect devices to the Internet. Or, the availability of 4G, 3G or GPRS data services within remote geographic areas can open-up or limit the operation of mobile telephones.
- **Interaction context.** This characterizes the situation in which an interaction episode occurs (e.g., location, environment, culture). For example, the use of a mobile telephone whilst driving is punishable by a heavy fine in some countries, so people carry out such interactions within a context of risk. In another example, some products are operated in private (e.g., an epilator), whereas others must be used in the presence of other people (e.g., a ticket vending machine at a busy train station).

3 Course Part 2: Conceptual Product Design Project
In Part 2 of our ID535 Design for Interaction course, we deliver an interaction-focused conceptual product design project to students. The project lasts seven weeks, with the aim of developing students’ practical competence in D4I. The topics are set by tutors, with projects occasionally run with industrial partners (Table 1). Students are expected to draw upon their recently acquired knowledge from Part 1 to assist in the planning of their projects and the conceptualization of their design ideas. Because Part 1 provides a holistic introduction to designing for interaction, product use and user experiences, students are given autonomy to reference and transfer what they have learnt from Part 1 on an individual basis, as they see fit and relevant. However, for the presentation of final design concepts, students are made aware of the expectation to use concepts and terminology in a proper manner and, therefore, to have integrated these at some point during their design development. Since most students taking the course are graduate industrial designers, they are competent in the underlying skills needed to traverse from a design brief to a finalized design concept.

<table>
<thead>
<tr>
<th>Session</th>
<th>Semester</th>
<th>Student No.</th>
<th>Project</th>
<th>Main Technologies</th>
<th>Industrial Partner</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018-2019</td>
<td>Spring</td>
<td>16</td>
<td>Tactual Communication</td>
<td>Haptic interfaces, shape-changing surfaces</td>
<td></td>
</tr>
<tr>
<td>2017-2018</td>
<td>Spring</td>
<td>11</td>
<td>Smart Built-In Oven</td>
<td>IoT, social networking, displays</td>
<td>Bosch-Siemens Hausgerate</td>
</tr>
<tr>
<td>2013-2014</td>
<td>Fall</td>
<td>9</td>
<td>Bedside Alarm Clocks</td>
<td>Varied (open brief)</td>
<td></td>
</tr>
<tr>
<td>2012-2013</td>
<td>Fall</td>
<td>14</td>
<td>Home Barista Experience</td>
<td>Varied (open brief)</td>
<td></td>
</tr>
<tr>
<td>2010-2011</td>
<td>Fall</td>
<td>11</td>
<td>TUI Home Audio Players</td>
<td>Tangible user interfaces</td>
<td>Vestel</td>
</tr>
<tr>
<td>2009-2010</td>
<td>Fall</td>
<td>15</td>
<td>TUI Media Player for Seniors</td>
<td>Tangible user interfaces</td>
<td></td>
</tr>
<tr>
<td>2008-2009</td>
<td>Fall</td>
<td>11</td>
<td>Emotion Communicators</td>
<td>Varied (open brief)</td>
<td>Nokia</td>
</tr>
<tr>
<td>2007-2008</td>
<td>Spring</td>
<td>10</td>
<td>Timekeeping</td>
<td>Varied (open brief)</td>
<td></td>
</tr>
</tbody>
</table>

The exact steps taken to guide students through their projects varies from year-to-year, but some general points can be made. Our main method of teaching and learning is the studio critique: either one-to-one or small group discussions around progress and plausible next steps. We hold an interim and final presentation, both of which are
assessed and accompanied with verbal and written feedback. Students maintain sketchbooks to document their work-in-progress. They create presentation boards and/or slideshow presentations to communicate their designs, especially through the use of storyboards that describe steps along the interaction timeline (Figure 4). In many cases students use lo-fidelity full-size physical mock-ups for role play. They source existing products where possible to exemplify the qualitative experience that they seek from interactions. We arrange in-class exercises focused on generating research insights and design ideas. We have experimented with using a meaningful interaction approach – similar in intention to the interaction vision of TUDelft’s Exploring Interactions course (Pasman et al., 2011) – to help students define a qualitative interaction direction early-on in a project and make links to possible physical features and materialization (Sener & Pedgley, 2014). On one occasion, we asked students to use augmented reality to project dynamic audio-visual content onto otherwise static final presentation boards and physical mock-ups, thereby bringing interaction steps to life (Topal & Sener, 2015).

Figure 4. Example storyboard to communicate steps along the interaction timeline (Zen by Koray Benli, 2013-2014 session: bedside alarm clock with calm interaction)

4 Discussion and Conclusion

ID535 course has been taken by eight cohorts of students from 2008-2019. Whilst the course has evolved over that time, the broad structure of theory-foundations followed by design project has remained constant. Our orientation framework gives students a grip on what they need to cover, directs them to subjects that they many otherwise overlook, and provides an understanding of how efforts on one element of the orientation framework are likely to affect other elements.

We have received positive course feedback through questionnaires and informal discussions with students. With regard to the orientation framework and its elements, students find it (i) actionable, in the sense of directly influencing the rationale they employ in their design projects, and (ii) effectively pitched, in the sense that the framework provides a foundation but also acts as a springboard for acquiring more detailed knowledge through further reading and subsequent specialist courses (this being especially the case for students on the joint programme, moving to TUDelft for their second semester). Anecdotaly, we have received praise from our students who are now employed in design and UX professions, commenting on the relevance of the subjects covered and how well it has equipped them for interaction-related design work. Taking such informal student feedback as a whole, we can say that the course has successfully guided students towards D4I competence. Regarding areas for improvement, one observation we have mirrors a point made by Pasman et al. (2011), that students’ translation of qualities of interactions into qualities of things in their projects is a difficult process. There is a need for new educational tools and exercises targeted at helping students in this translation process.

In conclusion, this paper has presented the rationale and outlined the content of a graduate-level course aiming to accelerate students’ D4I capability within the constraints of a single-semester 8ECTS course. The work is the culmination of iterations made over ten years of instruction and student learning. Through the structuring of the ID535 Design for Interaction course, we have picked-out what we consider to be important elements for
Accelerating Students’ Capability in Design for Interaction

Communicating the essence of D4I to recently graduated Bachelor’s design students. Unique to the course is the adoption of an orientation framework, intended to provide students with a broad panorama of the complex issues involved in conceptualizing user-product interactions. The framework is built around five distinct elements that bring together recurring subjects that overlap interaction design and industrial design (user experiences, domains of interaction, contexts of use, usage cues, technologies). Each element is taught in a ‘bite-sized’ manner appropriate to an introductory course. The framework is used as a foundation for project-based learning and development of practical competence in the final seven weeks of the course. Our anticipation is that by exposing the rationale and content of our course, we can assist and inspire instructors who may be considering establishing an introductory D4I course or revising an existing course.

Acknowledgements: We are grateful to all students who have taken IDS35 Design for Interaction: thank you for your participation, enthusiasm and feedback. Your successes motivate us to continually revise and improve what we do and how we do it.

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Teaching the Critical Role of Designers in the Data Society: The DensityDesign Approach

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Abstract: In the modern data society, designers play a key role in the creation of artefacts that mediate our access to data and information. These artefacts include data visualisations and interfaces. Within this context, there is a growing risk of design educators training professionals who are indifferent to, or unaware of, the political power of the devices they contribute to creating. In this paper, we draw on our experiences in the DensityDesign course to identify and formalise a didactical approach providing students with opportunities to critically reflect on their work while gaining the technical skills they need as information designers. The paper describes the course’s historical evolution, its didactical goals and its current structure. It then provides an overview of the didactical approach identifying practices that other design instructors can reproduce, entirely or partially, at three different levels: through the methodological framework, the situational tactics, and the research artefacts students produce throughout the course. Finally, a critical discussion evaluating the limits and risks of the proposed approach is provided based on our didactical experiences.

Keywords: information visualisation; information design; issue mapping; data publics; teaching tactics

1 Introduction

Designing visual artefacts in the so-called data society requires a set of skills that traditional design education often fails to provide. Designers assume the role of data intermediaries (Baack, 2015) able to transform data into
information and bring it closer to individuals’ daily experiences. The rapid shift to digital communication and the rise of data infrastructures as main access points for information requires not only technical skills, but more importantly, a critical stance that avoids a-critical data enthusiasm or data-isms in general. As stated by Hankey and Tuszynski (2017, pp. 53-54) the growing belief in techno-solutionism and in the infallibility of data has become a pervasive threat in today’s data society:

Efforts need to be made to educate designers, technologists and engineers to more fully understand the contexts in which their designs are used and the impact they may have in the real world once they are implemented. This effort could begin at the educational level, ensuring that designers, technologists and engineers are taught not only to produce and create innovative and commercially viable technologies, but also responsible ones.

In the current time there is indeed a growing risk for design to become weaponised (Tactical Tech, 2018) also thanks to the work of designers who are unaware of, or indifferent to, the political power of the devices, interfaces and data structures that mediate access to information.

The DensityDesign course is a teaching lab that has aimed to make the complexity of social phenomena visible, accessible, understandable and manageable since 2004. Over the years, the course structure, contents and methods have been adapted to mirror the evolving nature of the technical and critical skills needed by design students entering the professional world. The overall goal of the course is to teach students how to design in a complex world, provoking them to reflect on the social and political implications of creating data and information intensive artefacts. By integrating statistics and semiotics into information design, the course also introduces students to the interdisciplinary collaboration required to manage complex issues through data and information.

With this paper, we formalise the current approach, showing the course’s didactical goals, organisation and outcomes. In so doing, we seek to provide a modular educational model that can be replicated, entirely or partially, by other design educators.

2 History of the Course

The DensityDesign studio-course has roots in the visual communication of complex phenomena: since 2004, it has allowed generations of students to engage with and reflect on the role of information design and data visualisation in addressing complex issues. Through the years, it has evolved according to transformations in the communication landscape and the media sphere.

Deeply rooted in complexity theory (Ricci, 2010), the course originally focussed on creating visual artefacts seen as generative devices (Scagnetti, Ricci, Baule & Ciuccarelli, 2007). After a few years, it reached maturity (Valsecchi, Ciuccarelli, Ricci & Caviglia, 2010) moving towards the idea of social complexity, with reference to Actor-Network Theory and Controversy Mapping (Venturini, 2010). In 2014, we reflected deeply on the increasing availability of data through the Web and reframed the course’s sources, methods and tools while taking cues from issue mapping practices (Marres, 2015). The current structure incorporates approaches from the aforementioned areas in order to present our students with design challenges that force them to engage with the issues inherent to the visual communication of information.

3 Course Structure

The course is a five-month studio attended by students in their last year of M.Sc. studies in Communication Design; as such, these students already have a solid background in visual communication. The course typically enrolls about fifty students who work in groups of four to six; group work is essential to developing the skills required in the course.

To address the concepts of social complexity through data by designerly means, the course interweaves other disciplines that provide students with knowledge in statistics and semiotics. To do so, the course utilises individual exercises, such as info-poetry, and hackathons in statistics. The course primarily relies on workshop sessions, in which teachers review and discuss students’ work with them. Theoretical lessons are used to introduce the conceptual bases for designing communication devices with data. The faculty provides each group of students a theme that will be

1 Info-poetry (in Italian infopoesia) explores the artistic side of data visualisation in order to stimulate an empathic reaction with the represented topic.
explored in different ways during a three-phase process. The provided themes are broad enough to allow students to choose their specific frame for addressing them.

The course is divided into three phases that gradually introduce students to the criticalities arising when communicating with data and information in complex scenarios. Each phase approaches data from a different perspective (Figure 1).

3.1 First Phase: Data as Material

In the first phase, students approach data as a material to design with: as they would do with any other material, they obtain it, evaluate its quality and provenance, test its limits and eventually design with it. In this phase, students are introduced to the tools and technical skills needed to deal with data (e.g., visual variables, spreadsheets and visualisation software). At the beginning of the course, students pick one theme among those proposed by the faculty. Proposed themes tackle societal challenges and span across different domains (e.g., the environment, migration, radicalisation and unemployment). The first task for each group is to select a sub-topic from the broader theme. Then, students are asked to explore the chosen sub-topic through the data provided by official sources. The first phase ends with the delivery of two communicational artefacts: an infographic and a webpage for a newspaper meant to provide an overview of the sub-topic.

Alongside learning new methods and tools for data visualisation, students are confronted with many questions, such as, “Which visual models should we use?” “Which visual variables should we consider?” and “How can we decline a visualization on different devices?” During the process, students also are forced to think critically about data sources, questioning the nature of “official sources”. The didactical focus is indeed on the evaluation and use of data sources: How are datasets produced? By whom? With what goals? What assumptions were made in the production of the data? What is a reliable and official source? Can data from different sources be combined into a single visualisation?

3.2 Second Phase: Data as Artefact

In the second phase, the focal point changes, moving from the use of pre-built data to its collection. Here, students deepen their knowledge on their sub-topic by collecting, analysing, cleaning and formatting data from online platforms. The task is to locate a controversial issue on the web, identify its actors, and map their positions and alignments (Section 4.1). The process is question-driven (Figure 2): each group starts with a set of research questions, defines a protocol for data collection and analysis, and produces research findings using data visualisations. At the end of the phase, students deliver an interactive research report (Section 4.3.3) and present it to the class.

In this phase, data visualisation supports the iterative research process: each exploration must have a research question that is answered through a visualisation. Students also are asked to trace the research process by designing protocol diagrams (Section 4.3.2), thus allowing reproduction of the process. In addition to learning how to use data visualisation to answer a research question and to keep track of the research process, students also reflect on technical and ethical issues related to dataset design. Which data should be collected? Which biases do the chosen

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2 During the last three years, we have collaborated with a major Italian newspaper - “Corriere della Sera” - and its Sunday cultural supplement, “La Lettura”, which publishes some of the students’ work.
3 In the course we use controversy as defined in Controversy Mapping literature: “controversies begin when actors discover that they cannot ignore each other and controversies end when actors manage to work out a solid compromise to live together” (Venturini 2010, p. 261).
4 We adopt the broad definition of “actor” from Actor-Network Theory: anything (people, groups or non-human beings) that acts or is activated by a social issue (Venturini et al., 2015).
tools/methods bring? What should be considered an error and discarded? How can we make transparent the process of data collection? How should we deal with sensible information collected from the web?

Figure 2. The figure shows a group’s output for each of the three phases on the theme of radicalisation. Delivery outputs of phase 1 are a single page web report (a) along with an infographic for a newspaper (b), both based on data provided by official sources (here an example: https://densitydesign.github.io/teaching-dd12/es01/). Following phase 1, students deepened the subtopic using digital methods. In phase 2, students have to illustrate their research using a web template (c) delivered by the instructors (https://densitydesign.github.io/teaching-dd12/es02/). The output of phase 3 was the materialisation of their research in phases 1 and 2 by means of a third website (d) and a physical installation (e) (https://densitydesign.github.io/teaching-dd12/es03/).
3.3 Third Phase: Data Publics

In the third phase, the focus shifts from data to publics. Here, students learn how to foster public engagement when designing data experiences. Building upon the results of the second phase, students are asked to choose a position among the ones represented by the different actors identified in the previous phases. From (and with) that point of view, students develop a public engagement strategy designing data experiences and communicating them through the Web. In this process, data are used both to understand and communicate the complexity of social phenomena (similar to previous phases) and to trigger a response from their public. The technical choices communicating artefacts are left open and may include interactive websites, performances and physical installations. All of the outcomes are presented to the public during the Open Day, the final exhibition of the course, which usually takes place at the university.

The challenge of the third phase is to use data in order to share the complexity of an issue and to create public engagement. How do we engage a public that might be resistant to dealing with data? How can we take a position providing a specific point of view while respecting the complexity of the entire issue? How do we create interest and find a suitable balance between simplicity and completeness? In this phase, students also are motivated to reflect on what the public means, how different groups are mobilized around various issues (DiSalvo, 2009) and how data might play a central role in the process of public formation.

4 Didactical Approach

By asking students to describe, analyse and visually communicate one chosen issue, as mediated by available data, we seek to instruct students not only in visually communicating data and information, but more importantly, in reflecting on data’s effects on such issues. At the same time, students engage with the larger role of communication design in a data-intensive society. To achieve this twofold didactical goal, we have adopted a strategy based on critical making (Ratto, 2011). Through various design tasks, students mature a reflective stance towards the political role of their practice. The devised approach entails a didactical infrastructure that guides students in their work, pushing them to react to the limits, risks and challenges of designing in our data society. This infrastructure involves three levels:

1. A theoretical and methodological framework that informs the research and design activity;
2. An array of situational tactics: work settings that encourage particular activities among work groups; and
3. A set of research artefacts that students produce throughout the course in order to guide the research process.

4.1 Methodological Framework

The didactical goal of the course involves teaching students to design and build communication artefacts both from the technical and the conceptual points of view. Students learn by doing while simultaneously becoming aware of their role as designers and the implications of their design decisions.

The methodological framework identified to achieve this goal is based on two main pillars: the proposed themes and the adoption of non-design concepts to guide the research design.

The first pillar is related to the themes that students are invited to explore. Working with “wicked problems” (Buchanan, 1992) or broad societal challenges that are in the process of definition or redefinition (such as poverty, immigration and freedom of speech), students face cases in which no prior visual representations have been attempted, therefore requiring a new visual language (Latour, 2008). Since as teachers we are not expert in such themes, we identified two possible strategies to choose them: the first one is involving ‘issue experts’, persons that work in a given field and are able to point the students in the right direction (Section 4.2.1). The second strategy is to rely on intergovernmental organizations that identify societal challenges: in our case we relied on studies from the European Commission. From those broad topics, we are confident enough that students will be able to identify and study one controversial issue that is close to their context or that they care about. As an example, starting from the theme of climate change, a group composed of Chinese and Italian students studied how the debate related to nuclear energy unfolded in Western and Chinese society (Figure 5).

The second pillar involves adopting concepts and methods that appear distant from the design field, namely Controversy Mapping, Digital Methods and Issue Mapping, all of which are applied primarily during the second phase (Section 3.2). We borrowed these concepts not out of a desire to teach sociology or turn our students into media specialists, but to help them think critically about the complexity of the issues they investigate.

5 To identify topics for the course, we draw on the “societal challenges” identified by the European Commission (see https://ec.europa.eu/programmes/horizon2020/en/h2020-section/societal-challenges)
studies experts; rather, we introduced them into the course in order to force students to recognise the criticalities related to data mediation in our daily lives. Through these two pillars, the framework provides a setting (or better, a design challenge) in which the students are pushed to use all of the knowledge acquired in their design studies.

More specifically, we use Controversy Mapping to adopt the metaphor of maps (Venturini, Ricci, Mauri, Kimbell, & Meunier, 2015). Maps ultimately are visual devices that help explorers communicate what they have seen. They are also tools for other people who want to visit those places. The notion of the map also resonates with the idea of an evolving artefact, one that can be modified, annotated and improved (Mauri & Ciuccarelli, 2016). From Controversy Mapping, we inherited the concept of actors to include everything that acts within the analysed sub-topic (Venturini, 2010). From Digital Methods, we learn that all of our online actions produce digital traces that can be used to form a mirrored image of what is happening in society (Rogers, 2013). From the same methods, we also take on the concept of platform specificity; that is, every web platform provides different digital objects, each one with its own unique, medium-specific characteristics. From Digital Methods, we incorporate as well the important concept of the repurposing approach,6 which resonates in the design field. Finally, following the Issue Mapping approach, rather than trying to mitigate the effects of digital bias, we embrace the idea that media technologies actively participate in the formation of the issues under study, and therefore need to be included as well in the study of controversies (Marres, 2015).

Weaving these concepts together, we ask students to understand what can be found about their sub-topics on the web. From there, we ask them to design approaches to collect relevant traces while keeping in mind the specificity of the medium and the platform analysed. The results are then collected in visual reports (Section 4.3.3).

The mentioned pillars are used across all the three phases, even though they are explicitly visible only in part of them. While in the third phase they are not mentioned, the described concepts are widely used to address the students work.

4.2 Tactics

In addition to the methodological framework described above, we make use of a number of didactical tactics. We create a series of semi-structured moments, or situations, that promote particular ways of working while training specific skills. The same tactic may be deployed at different stages of the course, with slightly different goals. For example, hackathons (Section 4.2.2) are used in the data visualisation module as well as in the statistics one. Another example is peer-to-peer learning (Section 4.2.3), which is consistently promoted throughout each phase of the course.

4.2.1 Issue Expert Symposium

During the initial phases of the work, students are asked to explore their chosen theme and to identify the sub-topic they will analyse through the course. To support this task, the student groups, supported by the statements and dataset map (Section 4.3.1), present and discuss their themes with experts on the topic. This discussion is not a project pitch by the expert to the students or a presentation made by the students to the experts. Rather, it is a collective moment of knowledge transfer.

The map becomes a space for discussion: students use it to show what they found and which issues they identified. For their part, the experts can highlight the most interesting ideas and fill the map with their knowledge on the topic, helping students in their process of sub-topic framing. At the same time, like many of the other tactics, this step also forces students to reflect on useful concepts. First, because the issue expert review happens with the help of the statements and dataset map, the moment is also a way to appreciate the role of visual languages in fostering interdisciplinary conversation. Secondly, talking with a domain expert in person shortens the distance between the group and their theme, which otherwise only would be approached with, and mediated by, various datasets.

4.2.2 Hackathon

During the course, students participate in a series of hackathons, time-boxed efforts during which students are asked to perform a task. For example, students approach the task of visualising a dataset during one half-day hackathon. The hackathon begins with each group picking a random dataset; then, each of them has to find one question to ask the dataset before designing a visualisation that is able to answer that question. The hackathon ends with a collective

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6 In the Digital Methods context, the term means to analyse the original use of a device, identify the digital objects it provides and understand how this information can be used for a different purpose. It is a common operation done to understand how different web platforms can be used for social research, understanding their role, their limits and biases (Bounegrou, 2012).
presentation (Section 4.2.3), during which students share their results and groups discuss the criticalities encountered during the hackathon.

Hackathons often aim to design a prototype that then is developed in a second stage. In this course, we use hackathons as sandboxes, spaces for error: students are provided with the very rare opportunity of throwing away a project. Having to produce a visualisation in half a day and publicly present it, they encounter several problems related to data visualisation: how to deal with data, how to set up strategies to avoid errors in the encoding, how to make something legible and how to add decoding instructions (legends). Through this practice, we have seen that hackathons are more efficient than teaching the same concepts in theoretical lessons. We also adopted this format in the statistics module in order to engage design students in the subject while showing its practical uses.

4.2.3 Peer-to-Peer Learning

During the course, students present on the progress of their work to the rest of the class and receive feedback. These presentations have a twofold objective: to help students reach a clear understanding about the state of their work and to underscore problems shared among groups. In terms of format, one group presents its work in front of the whole class, while another group asks questions and provides feedback.

Since students are not experts in their subjects, verbalising to an audience requires them to do critical editing and preparation. This exercise also encourages them to anticipate possible weaknesses in their project ideas. Meanwhile, the group of students who must ask questions of the presenters is compelled to listen critically to their colleagues’ work. Therefore, the dual role of students — to present and to listen — allows them to reflect critically on how to present in order to be criticised and how to listen in order to build critiques. Opening up the work process among students allows them to share successes and failures. At the same time, it helps to position students as micro-experts on their topics, serving as points of reference for the other groups.

4.3 Research Artefacts

During the three-phase research process, students are asked to produce various communicative artefacts. Alongside the three main outputs delivered at the end of each phase, we ask them to design a series of (minor) artefacts during the entire research process, with the goal of guiding their process. These research artefacts, like methodologies and tactics, force students to reflect on various issues while assisting them in developing data-related skills. In this paper, we propose the three most interesting and reproducible of these artefacts.

4.3.1 Statements and Datasets Map

In the first phase of the course (Section 3.1), we ask each group to research and design a “statements and datasets map”. The map (Figure 3) visually connects actors’ statements with available datasets describing the issue under study. Students look for statements and datasets online (on blogs, news sites or social media) and connect them based on their affinity. Later, they search for datasets available from official sources and connect them to the statements. The map offers a visual overview of the various positions and sources composing a social issue.

The main didactical goal of the map is to help each group move from the broader theme to a specific sub-topic: each group uses the visual overview provided by the map to locate an interesting focus. At the same time, the design of the map should stimulate critical reflections about the diversity of points of view around a particular topic, and the related sources and datasets. Collecting and analysing very different and sometimes antithetical statements is a way to experience the impossibility of total objectivity. As such, we should explore multiple stances to gain so-called second-degree objectivity. The availability of multiple sources providing data about a given issue encourages students to evaluate the quality of each source and to make an informed decision on which to use. Finally, comparing the features of various datasets describing the same phenomenon represents one way of reflecting on the notion of measurements: a single phenomenon might be measured in very different ways.

7 “Second-degree objectivity” is an objectivity obtained by the multiplication of different viewpoints; an objectivity that comes from diversity rather than from uniformity; an impartiality that comes from exploring a multitude of partial bias, rather than abstracting from them” (Venturini, 2012).
Figure 3. Examples of statements and dataset maps made by students on issues of worldwide significance: water conflicts, online hate speech and the opium crisis in the U.S. Using different techniques, they produce maps in which they visualise the relationships of the actors and their statements, connecting databases available from official sources. (see other examples at this link: https://archive.org/search.php?query=subject%3A%22DD14_statements-map%22)

4.3.2 Research Protocols

In the second part of the course (Section 3.2), students document their process by designing and updating a protocol diagram (Figure 4 and Figure 5) for each analysis performed. A protocol diagram is a visual explanation of the steps undertaken during the research process. It includes research questions, analytical steps, tools used and designed outputs. The diagram is continually updated as the research process goes on, and it is meant both for internal use and for communicating the research process to others.
The task of keeping track of the research process in graphical form stimulates students to expose their analytical choices to public scrutiny. The protocol diagram works as visual evidence of the personal, subjective and arbitrary choices undertaken during the research process, thus teaching students about the non-objective, situated and interpretative nature of any data-driven study.

### 4.3.3 Research Template

During the second phase (Section 3.2), students learn to **design a dataset.** The focus of this phase is not so much on visualising a dataset, but on making choices during the process of dataset creation. In this phase, students are provided with a template: an interactive report structure that they need to fill in with content (i.e., text and diagrams). The template has a modular structure, and each main section is composed of four parts: a research question, a visualisation, a text describing the findings and a diagram of the research protocol.

The layout shifts the focus from the output to the process. With a pre-designed structure, students can put their effort into the design of the research process, focussing on how to build a dataset and how to operationalise a research question. Furthermore, the fixed structure of the layout forces students to proceed in a question-driven fashion: every visualisation included in the website should serve the purpose of answering a research question.

### 5 Discussion

Having tested the described approach with our students, we identified a few criticalities that design educators should keep in mind when adopting parts of the didactical scheme presented in this paper. The first critical aspect relates to the cross-disciplinary nature of the course and the involvement of disciplines relying more on lectures than studio-based activities. This fundamental difference can cause difficulties for professors from other disciplines when engaging with students in weekly reviews and providing feedback through a project-oriented mindset. As one solution, we paired professors from theoretical disciplines with tutors coming from a design background. A second difficulty emerges in integrating these disciplines into the course in such a way that students do not view them as independent (and less relevant) modules. Finally, because students mainly come from design backgrounds, they usually are more interested in project work and less willing to engage in more theoretical disciplines. To manage these issues, we identified assignments that put the concepts discussed by the professors into practice.

A second problem is that proposing broad and complex themes (Section 3.1) could cause students to get lost. When they fail to frame a specific sub-topic, it becomes difficult for teachers to help because the topic is outside their areas of expertise. Also, when students manage to identify possible sub-topics, it remains difficult to choose the one that will be most fruitful. As such, they risk spending too much time on exploring and looking for data, possibly discovering too late that the sub-topic is not sufficiently interesting. More generally, the students who are accustomed to receiving clear instructions on what they are supposed to do can become frustrated about being responsible for defining their own sub-topics. A possible solution would be to involve issue experts (Section 4.2.1) more in the process. However, more sustainable strategies should be identified because it is difficult to ask these experts to take the time to follow a course. They also may have their own points of view on the topic, which could heavily influence the students.

Another problem inherent to design education activities concerns the teacher-student ratio. Exceeding a certain number of students may make the professor-student relationship discontinuous and cause distress. In our case, the team includes five professors and five assistants, and more than 50 students has proved to be problematic.

Many parts of the described approach borrow concepts and practices from disciplines distant from design, making them sometimes hard to grasp for students. The course is heavily focussed on data, which, at the time of this writing, is not a topic introduced in our university’s design curriculum. These factors may intimidate students. They might be scared to show that they haven’t completely understood the topic; afraid of doing something wrong, they might limit themselves by mechanically reproducing examples provided by the teachers.

Finally, because the course introduces a series of tools to the student (e.g. Gephi, RAWGraphs, Excel, Tableau), they might design on the basis of functions provided by these tools, rather than think how to use them for their own research goals. Relying on tools brings about other criticalities, such as obsolescence and outdated status. As such, we continually update the course content and its tools.
Figure 4. Based on a research question, the students experiment with digital methods in order to investigate different topics with the data. Visualisation is the visual device that answers the question. The image shows the protocol followed by a group of students and the resulting visualization in the topic of the migration crisis in Europe. The project is available online at https://densitydesign.github.io/teaching-dd11/es2/g4_migration_images/introduction.html
Teaching the Critical Role of Designers in the Data Society: The DensityDesign Approach

Figure 5. The image shows the protocol and the resulting visualization made by a group of Italian and Chinese students in the “nuclear power” debate. The protocol followed shows the use of tools that confront Western approaches with China (e.g., Google News and Baidu News). The project is available online at https://densitydesign.github.io/teaching-dd13/es02/group06/
6 Conclusion

This paper formalises the approach used in the DensityDesign course in order to make it replicable, partially or entirely, by other design teachers. The didactical approach has been formalised on three levels, from the theoretical framework, to situational tactics, to the artefacts used during the course (Section 4). On one hand, the goal of this approach is to train strong information design professionals. On the other, it aims to stimulate reflection on a designer’s role in the information society by highlighting three possible perspectives: data as material, data as artefact and data publics (Section 3). The overarching goal is to encourage students’ critical approach to data, opening up reflection, through practice, about the criticalities related to the visual communication of data and information.

Though we have yet to conduct a structured evaluation of this didactical approach, we can extract qualitative insights from the questions posed by students. For example, in the first phase, many students started to ask questions like, “Is this a proper source? What makes it more reliable than others?” Such questions demonstrate actual reflection on sources. More fundamentally, some asked, “I’m a designer, why should I define the structure of a dataset? Why should I define the most relevant aspects of a topic?” Such questions are actually the starting point for understanding designers’ authorial role in communicating data and information.

To conclude this paper, we would like to identify future steps to address the limits and criticalities found in applying this approach. First, it could be beneficial to find a more structured way to involve issue experts during the entire course, in order to reassure students about their topical choices. Second, we would recommend stronger involvement from the other disciplines in the course, defining research artefacts that highlight the relevance of such disciplines to the information design profession. Finally, it could be beneficial to extend the training of design students to data-related software with ad-hoc courses or workshops in order to overcome the risk of a tool-driven approach to data and information communication.

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Figure 2: project “Is so Isis” by Francesco Cosmai, Giacomo Flaim, Francesco Giudice, Barbara Nardella, Giulia Zerbini.

Figure 3: project “Water conflicts” by Alessandra Facchin, Alessandro Ferrari, Jingjing Gui, Paula Lozano, Nicolò Marchetti, Valeria Quiroga; “Hate speech”: Nicola Brignoli, Francesca Broto, Lea Mara Fabiano, Elena Filippi, Edoardo Guido, Jacopo Poletto; “Opioid crisis”: Luisa Cadelli, Yixiao Cai, Eleonora Cappuccio, Francesca Grignani, Paolo Vernocchi, Carlotta Xiao.

Figure 4: project “When a picture is worth more than 950.317 words” by Agata Brilli, Giacomo Ciurlo, Michele Invernizzi, Giulia Piccoli Trapletti, Laura Toffetti, Hou Xuanxuan.

Figure 5: project “Do we need Pandora’s gift?” by Manli Zhu, Simone Casartelli, Xiaoxi Huang, Xuechun Zhao, Yue Qiu.

References


Teaching the Critical Role of Designers in the Data Society: The DensityDesign Approach


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Abstract: The discipline of industrial design is in continuous change due to the developments in information and production technologies. As a result of this change, designers are expected to be equipped with diverse skills and sets of knowledge. Hence the scope of formal design education needs to be enlarged and the theoretical and methodological basis of it needs to be reconstructed according to this new scope. This enlarged scope is embedded in the curriculum on theoretical and practical aspects. On the account of basic design, which is regarded to be the foundation course of industrial design education, these newly emerging aspects are generally introduced by relating practical bases of the course with new sets of design knowledge. This study proposes a three-step framework for a basic design course in industrial design, which intends to construct the practical bases in accordance with the current needs, skills and mindsets for design practice.

Keywords: basic design; practical basis; transition of design practice; design knowledge

1 Introduction

In general terms, industrial design is a professional service that creates the concepts and optimizes the functions and forms of products and systems for both user and producers. Industrial designers not only focus on the appearance of a product, but also on how it functions, is manufactured and ultimately the value and experience it provides for users. The term industrial design refers to idea generation, concept development, testing and production of a physical object or a service (Ulrich & Eppinger, 2008), and is related with style and ergonomics as well (Unver, 2006). In professional practice, industrial designers are often part of multidisciplinary teams made up of strategists, engineers, user interface
UI) designers, user experience (UX) designers, project managers, branding experts, graphic designers, customers and manufacturers all working together towards a common goal. The collaboration of so many different perspectives allows the design team to understand a problem to the fullest extent, then craft a solution that skilfully responds to the unique needs of a user (IDSA, 2018).

The concept of industrial design is an outcome of industrial revolution. Until 20th century, the act of producing was mainly carried out by craftsmen (Çetin, 2006) and the place of design in production was not clearly defined. The profession of industrial design first appeared as the form-giver to the standardized products produced in quantities with mechanization. At the beginning, the sole duty of the designer was to breed forms for mass produced objects. With time, the role of the industrial designer evolved to solving ergonomic problems in these mass-produced items. This continuous change still persists as a result of the changing economic, social and technological conditions. Valtonen (2005), defines the changing roles of the designers between 1950’s and 2000’s as follows:

- The designer as the creator: as the form-giver,
- The designer in a team with mechanics and marketing: who cooperates with the product development team,
- The designer as an end-user expert: who defines product’s usability and ergonomics,
- The designer as coordinator: who deals with design management,
- The designer creating experiences: who is a part of the strategic planning of the new product,
- The designer pushing innovation: who operates products, innovation and trends on corporate and global levels.

Inns (2007) defines the roles of the 21st century designer as value producer, idea facilitator, visualizer, orienter, moderator between stakeholders and survey coordinator. Today, the designers are expected to be equipped with knowledge on many other domains besides the skills for pursuing conventional design processes. In short, the scope of industrial design, whose main concern is product development, is enlarging. Within this context, WDO (World Design Organisation) redefined industrial design in its general assembly held in South Korea in 2015 as:

Industrial Design is a strategic problem-solving process that drives innovation, builds business success, and leads to a better quality of life through innovative products, systems, services, and experiences. Industrial Design bridges the gap between what is and what’s possible. It is a trans-disciplinary profession that harnesses creativity to resolve problems and co-create solutions with the intent of making a product, system, service, experience or a business, better. At its heart, Industrial Design provides a more optimistic way of looking at the future by reframing problems as opportunities. It links innovation, technology, research, business, and customers to provide new value and competitive advantage across economic, social, and environmental spheres (WDO, 2015).

This expansion of the scope of the profession widens the scope of knowledge provided in formal design education and necessitates re-elaboration of theoretical and methodological basis of the curriculum. In general, the curriculum of the design programs consists of studio courses, as the backbone, and other courses focusing on technical and cultural aspects of design. The studio courses provide the practical skills for the design act. Among these studios, basic design stands as the general foundation course which appears in almost all of the design curriculums.

Among the design courses, basic design stands in a crucial place since the freshman design students encounter the phenomenon of design first in this course (Denel, 1998). In the first year of the curriculum of every art and design department in any university, regardless of the fields of specialization, there is always a course called basic design which deals with the grammar of visual language. This visual language is the basis of design creation and a designer must be equipped with the knowledge of principles, rules and concepts of visual organization in order to enhance his capability in visual organization (Wong, 1993). The scope of basic design, in general, is common in almost all departments and focusses on basic principles. The design knowledge particular for any design profession is gradually provided in studios beginning from second year. However, the expansion of the scope of profession and the blurring boundaries necessitates a more detailed education. In this respect, the knowledge particular for any design practice is needed to be provided in earlier phases of education. Hence, the practical basis of basic design education, can be regarded as a ground for transition to the profession, rather than solely providing basic principles and elements.

1.1 Aim

This study undertakes restructuring of the outcomes and approaches of basic design course considering the widening of the scope of industrial design. The aim of the study is to propose a new perspective directed to the practical basis of basic design with design knowledge and practice.
1.2 Method
In the study, a framework is proposed to relate practice base of basic design with industrial design studios in undergraduate curriculum. The approach to design practice and design knowledge is handled with a three-step transition model as convention, interaction and function, which is demonstrated with studio works acquired during course.

2 Industrial Design Education and Basic Design
Design is a process that aims to explore often an ill-defined problem in order to create solutions. Design knowledge, on the other hand, is the knowledge a designer acquires during design education and professional practice. Industrial designers are expected to be equipped with certain knowledge and skills during formal design education. The designer is responsible for many factors such as aesthetics, materials, production techniques, marketing, cost, usability, sustainability in product design (Norman, 2002). Hence, the knowledge sets for industrial designer is diverse and should be combined with problem solving skills. Van Aken (2005) assembles design knowledge under three titles as:

1. Object knowledge: knowledge on objects and the material properties that form the objects,
2. Realization knowledge: knowledge used in the production of the designed object,
3. Process knowledge: knowledge about the design processes.

On the other hand, Cooper and Press (1995) categorizes the content of the courses in industrial design undergraduate education curriculums in three groups as design knowledge, design skills, contextual apprehension. The courses belonging to the contextual apprehension are Design History, Design Theories, and Marketing; whereas design knowledge refers to materials, production techniques, model making and human factors. The scope of design skills covers developing design solutions, generating creative problem-solving techniques, research, CAD, drawing, sketching techniques, as well as oral and written presentation skills.

The contextual apprehension courses appear in the curriculum of industrial design undergraduate programs beginning from the first year. However, the courses related with design knowledge and skills come forth in the curriculum after the first year. Such structure is consistent with the Bauhaus pedagogy. Founded in Weimar by the architect Walter Gropius, the impressive design school Bauhaus claimed that creativity is disciplinable. In order to do so, Vorkurs program in the first year of the school was developed. Today, the preliminary course, Vorkurs is regarded as the beginning of basic design education. The pedagogy of Bauhaus consists of the material to be transformed, formings process, and thirdly the decision-making agency, the design, which directs the forming process in which the material is converted into a meaningful entity of specific character. These three aspects constitute the Transformation Process (Figure 1). (Bredendieck, 1962, p. 16). In this trinity, the design component was emphasized following Vorkurs, beginning from second year in the workshops that the students are specialized. The elementary course was designed as a basic workshop practice where the fundamentals and elements of design and the nature of the materials were experienced with structural exercises. After Vorkurs, the students were attending workshops specialized in certain materials. With the innovative approach in education, Bauhaus aimed to combine art, design and industry.

Figure 1. The aspects of Bauhaus model a) Bredendieck, 1962, b) Itten, 1964
Similar to other branches of design, in industrial design education, basic design appears as a compulsory preliminary course. In every art and design department, there is a basic design or an equivalent first studio course which forms the backbone of the curriculum. The main aim of the course is to discover visual complexity (Zelanski & Fischer, 1996, p. 2), to awaken awareness by enhancing visual sensitivity (Akbulut, 2010, p. 5332), to develop basic skills and to present basic design knowledge. In general, the course curriculum includes topics such as:

1. Elements of design: point, line, direction, size, shape, value, texture, colour,
2. Visual perception: organization principles, proximity relationship, similarity, shape properties, figure-ground Relationship,
3. Principles of Design: repetition, harmony, contrast, concept, balance, unity, hegemony,

These topics covered by the curriculum, together with the use of Gestalt theory, help enhance visual perception and form manipulation skills (Senemoğlu, 2009). The elements and principles of design, on the other hand, act as the components and grammar of the language of design (Toktaş, 2011) and help the student in creating his/her own dialect.

Basic design course stands on theoretical, practical and pedagogical basis. The curriculum framework, which is constituted of basic principles and elements, forms the theoretical base. The practical base is about how the theoretical knowledge is handled. The pedagogical base aims to develop creativity and abstract thinking skills (Akbulut, 2014). Lang (1998) puts three fundamental aims for a modern basic design course: Creativity and development of problem-solving skills, development of perception and development of design language. In a basic design studio, the students mainly learn how to understand and analyse a problem by interacting with the instructors and other students. This experience leads the students to idea generation, development, execution and presentation for new problems. Dikmen (2011), summarizes the outcomes of basic design education as:

- self-expression by using verbal, written, visual (drawings, models, graphics etc.) techniques,
- identifying a problem, collecting data, interpretation, proposing solutions, evaluating knowledge, acquiring design skill,
- focusing on a subject,
- acquiring consciousness and different points of view,
- acquiring individual and group study skills,
- acquiring abstract thinking and perception skills,
- acquiring 2- and 3-dimensional thinking skills.

In the curriculum of almost all of the design schools today, basic design act as the foundation studio (Blachnitzky, 2009). However, the course is criticized for its problematic relation with the following design studios; it is treated as a separate part of design education, which deals with the subjects that are somehow useful in design but not directly related to it (Farivarsadri, 2001, p. 10). In order to overcome these criticisms, and to fit the course to the enlarged scope of design profession in 21st century, product design practice and knowledge can be related with the practical aspect of basic design education in industrial design programs.

3 A New Practical Base for Basic Design

Fundamentally, the aim of educational practice is to provide knowledge, skills and sensitivity on certain subjects (Saranlı, 1998). The common ground knowledge provided in basic design, helps to develop visual sensitivity. The practical base of the course is about how the theoretical knowledge is undertaken. In general, the practice carried out during the course is on reading and creating visual material. However, the expansion of the scope and knowledge in design profession forces basic design to provide a more profession-specific ground to students rather than just focusing on common basic principles and elements. Each branch of design has its particular knowledge set consisting of diverse interactions. For this reason, the course exposes slight variations on the materials, techniques and concepts specific for various design departments. In this section, a framework for a new practice base depending on the theoretical grounds of basic design for industrial design is proposed. This new base for practice consists of a three-step structure (Figure 2). The first component consists of exercises reflecting traditional and common aspects of the course. The exercises in the second component have reference to the forthcoming courses in the following years, while the third component exercises can be regarded as transition to industrial design projects and executed towards the end of first year.
The exercises conducted in the first step, current theory-based practice, consists of two- and three-dimensional works applicable for all design departments. In these exercises design elements are used to reflect design principles and create compositions (Figure 3). The aim is to develop visual perception and teach visual language. The exercises are usually conducted on a daily basis; however, the three-dimensional works can last longer. Generally, paper-based materials are used for this foundation step and the exercises gradually precede from two dimensional compositions to relief and three-dimensional structures. Creating a unit and obtaining unity by meaningful repetition of the unit is a common example for this step. Manuel skills are developed together with knowledge on materials and tools. Time management is another aspect of this first step in which the student recognizes the structure of the course and the design act.

The second step, augmented theory-based practice, aims to slightly introduce to students the concepts particular to product design. These concepts are generally emphasized in the curriculum beginning from the second year. The knowledge set integrated to the basic design framework in this step overlaps with Cooper and Press’s (1995) design knowledge concept covering production techniques, human factors, model making and materials. This step tries to combine the product design specific knowledge to basic design elements and principles. The transitory nature of these projects provides the ground to relate basic design with the forthcoming design studios. The main aim is to exercise and awaken awareness on product-design specific design knowledge. The techniques used to form the structures in this step are varied and experimental, while the materials are generally in sheet form. Besides, support elements out of various materials such as rope, wire, sticks are used. Interaction with the body and the space is one of the keywords for the executions in this step. The students are expected to evaluate the structure’s scale and its interaction with human body or the space it stands. Examples specific for this step are presented in Figure 4. Maracas made with papier-maché technique also proposed alternative handles for the aspect of interaction. The shelter identifying personal space and the tree structure were projects made with corrugated cardboard. The scale of the structures was found crucial for experiencing statics and relation with the space. In the mask project, on the other hand, the students first made abstractions of the selected animals then transformed these abstractions into paper masks with basic geometries. The two aims of this project were, abstraction of a natural form and the mask’s interaction with the face. The exercises in the second step are long term assignments and unlike the first step abstract definitions, points to concrete three-dimensional works.
The third step projects appear towards the end of first year and have high reference to product design courses and act. In these projects, basic design is intended to be related and blended with studios and courses in the following years. The materials used for this step is varied and is not limited to paper or other sheet elements. As a result, the student may experience subtractive techniques of production or alternative molding techniques. The interaction keyword of second step transform into function in this product design-based practice. Simple functions defined with products refer to an interaction not only with human body, but also with the other components of the product. In Figure 5 examples of student projects addressing this third step are demonstrated. In concrete table-top objects, paper lampshade, or Ytong tealight-holder projects, the students not only experienced diverse materials, but also the product’s interaction with its content. In bodily accessory made out of wire, the starting point was another animal-abstraction exercise. The two-dimensional abstraction first was transformed into three-dimensional wire structure, and lastly a bodily accessory. The functions of the products in this step are tightly interwoven with multiple interactions. The functions address interactions such as product-user, product-content, and product-environment/space.

4 Conclusion

In 20th century’s modernist construction of design education, the Bauhaus model treats basic design and product design studios as a separate aspects and components of design education. However, the social and technological conditions confront compulsory changes in current design education paradigms, and this change does not let the borders of basic design to be neatly drawn. In fact, the qualities and expectations from a designer today is observed to be changed and expanded with respect to 20th century. While the knowledge and skill sets to be acquired for students have expanded, the duration of education remains the same. As a result, the scope of the curriculum is re-handled
and compressed many times. This study aims to propose a framework for basic design which provides a transition between the foundation year and product design studios. The program structure attempts to re-elaborate the conventional Bauhaus model with design knowledge specific for industrial design. Basic design elements, principles, knowledge and skills serve for the formation of visual language. On the other hand, design knowledge, as Cooper and Press (1995) suggest, materials, production techniques, model making and human factors. This knowledge base provides aspects directed to occupational practice for basic design.

The proposed framework deals with the transition from basic design to product design through three steps. The first step, *convention* takes the conventional Bauhaus model and provides the students with notions of visual language and composition. The two- and three-dimensional exercises are short in duration, abstract by its nature and paper-based in material. The second step, *interaction*, associates basic principles with objects and humans. In this step, the students are expected to question design knowledge via the structures created and the structure’s interaction with the environment. The exercises are generally longer in duration; the materials are sheet but not limited to paper. The interaction aspect may be considered with materials, ergonomics or space. The problem definitions provided do not directly point to a product in this step. The third step is named *function* since the problem definitions point out to products serving for certain functions. In this step, the knowledge used has reference to forthcoming years’ curriculum and studio practice. The materials used and the techniques experienced are not limited to sheet. The student is expected to broaden the viewpoint and evaluate design with respect to many other components of industrial design. Since basic design principles are generally overlooked in product design studios, these exercises give the students the clues on obtaining unity in a product by using basic principles.

The strict distinction between basic design and product design courses is currently disappearing. As the scope of the profession widens, the skills and roles of the designer transforms. Under such conditions, transition of basic design curriculum with transitory projects combining basic design knowledge with design knowledge can be offered as a solution. This approach can also overcome the foundation program’s separation from other years and studios, and provide students with hints on how to use basic principles in product design practice.

**References**


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Abstract: The aim of this article is to discuss the potential of studying contemporary art to foster critical skills in designing. This aim is part of a larger argument of the requirement of equipping design students with arts and humanities as well as design skills for a more meaningful and ethical future professional practice. It is hypothesized that contemporary art content guides students towards this meta aim. Here, contemporary art comes into play as a resource of not only liberal art theory but also its manifestation in art form. This method of art practice founded intensely on criticality is proposed as a tool for critical industrial design studio practice. Prior research by the author has indicated that students exposed to contemporary art content in elective courses acquire consciousness on the meaning of their future profession, but ways of integrating this content to compulsory industrial design studio courses remains unknown. Based on the findings of prior research, this study presents as initial argument of developing ways of such integration. To explain the role of contemporary art as a resource of criticality, first the criticality implicit in the nature of contemporary art is explained with art historical theory. After that, the change in art after the end of modernism\(^1\) is explained with the ready-made with reference to Fountain (1917) by Marcel Duchamp. Following this, the presented features of contemporary art are matched with the parts of the design process it can enrich with particular reference to “utility”, “viability” and “agency”. This is discussed in more detail with the reported experiences of students who have studied contemporary art content during their schooling. Experience from the elective course “Contemporary Issues in Design and Interaction Between 20\(^{th}\) Century Art and Design” is presented in relation to related theory. The reports collected from students indicate the ways in which the content is reflected to product design practice in the studio.

Keywords: design education; industrial design; contemporary art; liberal arts; criticality

1 Introduction

Schön’s definition of designing as a reflective practice has been a major influence in design education. According to the interpretation of Schön by Nicola Wood (2006), designing is an “argumentative process” that proceeds in cycles of reflecting and doing iterating each other with intersections and overlaps at times (Wood, 2006). Schön has pointed at

\(^1\) It can be argued that Modernism has never started, therefore cannot end according to Bruno Latour (Latour, 1993). Here, the term modernism is confined to the movement of Modern Art with reference to Clement Greenberg’s essay titled “Modernist Painting”.

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the architectural studio education to present it as an example of dealing with uncertainty to other university educators who presented theory first, applied experience and practicum later. The reason for intervening in the latter type of education was the “lack of confidence” of professions as explained by Schön reporting from a meeting with professional educators at MIT in 1972: “Albert Keil, then Dean of Engineering at Massachusetts Institute of Technology (MIT), said that engineers knew how to build ships but not how to decide what ship to build.” (Schön, 1984, p. 1) If we take a second look at this sentence, it states a problem of social relevancy and ethics. It says that the aim of professional practice is beyond having the ability to solve problems but it is also solving problems that are helpful and meaningful, in other words relevant.

How can we as design educators teach designing relevant products to students? For this, it is required to move beyond asking students didactically to design with relevancy as a matter of teaching style in the studio critiques. In other words, a structured pedagogy of relevancy is necessary. Hence, methods of critical thinking must be provided to students during design education.

The main driver of investigating the ways in which contemporary art can nurture critical thinking is avoiding a sole market-driven approach, a sole function-driven approach or a sole conceptual approach.

To teach students how to design relevant products, art can be a useful resource more than thought. The intersection of art and industrial design is beyond the common assumption that industrial design objects are sculpturesque and that the new art is utilitarian. The most important link between art and design is not the rise of design as the inheritor of high art, because it has been a major reference in and after pop art. The role of design in pop art is only its signification of the rapidly industrializing society and not its ontology. A less investigated link in design education and practice is the introduction of the ready-made and its role in the birth of contemporary art. The ready-made’s role is significant. Contemporary art is not an ethnographic style but as a question of viability.

2 Contemporary Art as a Resource

Here, I propose contemporary art theory and practice as a resource of critical thinking methods for industrial design students. The scope of this article is confined to industrial design since my personal studio teaching experience has mainly been in industrial design studios. However, the experience reported here can be used in the curricula of other creative applied fields.

It is extremely easy to provide theory indicating that artists are critical thinkers in history. Anyone who has taken any course of art history would have heard that art movements typically have been reactions to the previous art movement. In one of the few empirical studies comparing the critical thinking dispositions of art students and non-art students, Nancy Lampert (2015), collecting data from 141 students with California Critical Thinking Disposition Inventory (CCTDI) has found that art students have significantly high score in truth seeking, maturity and openness (Lampert, 2015). In past research significant success in critical thinking was found in arts students by other researchers who study the link between the two (Burton, Horowitz & Abeles, 2000). Although, the reasons of these findings need further research, we understand that art students have potential to better grasp and respond to critical content about meaning of their profession.

Looking back at the features of contemporary art, ideas have as much value as technique. A major shift in contemporary art has been moving from the “ostensive paradigm” to the “discursive paradigm” (De Duve, 1999) also argued by Danto (1998; 2005) as taking ideas into concern as well as modernist elements such as material, technique and form (Danto, 1998; 2005; Greenberg, 1960). This shift has opened room for addressing social, environmental and ethical concerns with the instrument of verbal discussion beyond sole physical manifestation. Hence, the method of art criticism employed building links between a repertoire of liberal arts theory and technique. The major example of this turn is the Fountain (1917) by Marcel Duchamp which opens up the question of viability of art. Arthur Danto explains the question of viability in contemporary art with an example from pop art:

...nothing need mark the difference, outwardly, between Andy Warhol’s Brillo Box and the Brillo boxes in the supermarket. And conceptual art demonstrated that there need not even be a palpable visual object for something to be a work of visual art. That meant that you could no longer teach the meaning of art by example. It meant that as far as appearances were concerned, anything could be a work of art, and it meant that if you were going to find out what art was, you had to turn from sense experience to thought. In brief, you had to turn to philosophy (Danto, 1998).
The philosophical feature of contemporary art was used before to teach conceptual skills in art education. In past research, Julia Marshall taught conceptual art in San Francisco University to foster metacognition of students (Marshall, 2008). Marshall taught students analyzing contemporary with two specific techniques: conceptual collage and metaphors; and asked them to make art with these two techniques. Here, students gathered critical material such as words, images and packaging and made conceptual collages and metaphors with this content to make art. Marshall (2008) advocated that conceptual skills should develop while technical skills are acquired, not one after the latter as widely practiced (Marshall, 2008).

3 From “Ostensive” to “Discursive”: Viability

To explain better how viability in contemporary art was used as a method in design activity during industrial design education, Fountain (1917) can be examined. Fountain, is the most well-known read-made of Marcel Duchamp. It is known as the milestone of conceptual art. Here, Marcel Duchamp sent a urinal to an exhibition as a work of art. This was not an object made as art in the modernist sense with content depicted with mastery or experimentation of technique. It was a mundane industrial object. Duchamp purchased a urinal, signed it with the pseudonym R.MUTT and sent it to the Society of Independent Artists in New York.

According to De Duve (1999), Duchamp has replaced the labour-intensive process of making art to a gesture. This gesture is only pointing at a found object and naming it as art. In this regard, Duchamp has set the minimum conditions that defines the art which is the declaration of the artist. Asking if a urinal is art or not is a question of viability.

In another example, the emergence of the discursive paradigm by just pointing to the object reveals in the works of Haim Steinbach, who exhibited the objects of mass production without interfering, while showing the inter-object discursive dimension. Steinbach puts together a variety of ready-made objects from the 1970s, revealing a dialogue between them only in the same space as a gesture of approach (Stillman, 2012). Steinbach often exhibits objects such as a toilet brush, vacuum cleaner, detergent box on a wall-mounted shelf. In Steinbach’s work, he reveals that his ontological boundaries are stretching by creating a context in which the only function of a single object is to be interpreted by the combination of two objects. While Duchamp's transformation from the physical paradigm to the discursive paradigm continued, Steinbach added inter-object dialogue to this paradigm.

The ready-made opened a new era in art by bringing making art with ideas into the art scene as opposed to the dominance of style. This is the foundation of conceptualism and later contemporary art. This turn is what design students benefit most from contemporary art related content. They learn a method for creative inquiry and motivation for advancing critical thinking during designing.

4 Contemporary Art Content

In this section, findings of a past study on the impact of contemporary art on design students is summarized. This summary from past experience published with the title “Contemporary Art and Critical Perspectives in Industrial Design Education” indicates concrete evidence that the content can be useful in product design studio education in the future. In past research, feedback from students exposed to contemporary art content were collected to understand its impact from the perspective of the students (Kaya Pazarbasi, 2017).

The research followed the tradition of field inquiry of “wicked problems” in Rittel and Weber’s Dilemmas General Theory in Planning from 1973. Knowledge emerged during extensive action. For this reason, it is an in-depth inquiry that does not aim at pinning down a generalizable subjective result. Instead, it is a report of facts collected to make results apparent. The aim of the interviews was to understand if the content offered was relevant for the students, it it had impact on their designing and how the courses could be improved from their point of view.

Contemporary art content was introduced to design students within two electives titled Contemporary Issues in Design and Interaction Between 20th Century Art and Design2 offered since 2012 at Istanbul Technical University Industrial Product Design Undergraduate Program. The maximum number of students in this course could be 20. The course contents are not identical since 19th century movements were also covered in Interaction Between 20th

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2 The course catalog of ‘Interaction Between 20th Century Modern Art and Design’ was initially designed and offered by Maryse Posenaer Erkip when she was teaching ITU (also taken by the author in her undergraduate education). Contemporary Issues in Design was a new elective offered by the author. This article is based only on the courses’ syllabi prepared by the author.
Century Art and Design at the beginning of the semester. The 20th century content was the same. 20th century critical theory presented with examples from histories of art and design. The course also had a practical component. Students were required to make a work at the end of the 14 week-long semester and exhibit in a collaborative exhibition as seen in Figure 1. In addition to the works, each student prepared a written artist’s statement. At the beginning of the semester the students were provided with syllabus explaining the content and the scope of the course with a weekly time plan. Each week or once in two weeks, a case example was presented in the form of teacher presentations. Before the presentation students were asked to read related theory provided. The readings and practice introduced in teacher presentations include Italian Radical Design, Critical Design, Frankfurt School of Thought, DesignArt, excerpts from writings of theorists such as Jean Baudrillard, projects of Krzysztof Wodiczko, Stephanie Syjuco and Dunne&Raby. Readings were first done at home. They were read for the second time together in class. In the classroom first, I explained the new concepts to students if there were any and answered their questions on concepts or language they had difficulty in understanding. This was followed by a session where students read aloud the parts they underlined and each underlined part was discussed together.

![Figure 1. View from the group exhibition.](image)

When making a work at the end of the class students were not assigned a subject, nor dimensions, neither a method. Students did self-directed study in their own timeframe and the only requirement was to bring the works to the exhibition before the opening. Students were provided with critiques during the semester about their final work if they wanted to. Most students chose to spoke once about their work where they only reported some basic information about their work to assign how much room they needed in the exhibition and where their work would be best to install.

There is no brief in this course. Hence, the problems are not confined. Therefore, projects are about subjects that student are interested in, which means avoiding doing because it is demanded but because students want it. In other words, the goal of instructing is not influencing the work of the students but opening up the students’ vision. There is a high motivation. As a result, for this course design does not have to have a function. They discover their own interests because there is no design brief. Their contact with their projects is stronger. When a brief is given to students, they refrain from criticizing their own work whereas when they do a project without a brief on a subject they are interested in they are prone to criticize themselves more. Philosophical rationality is not negated by technical rationality.

Feedback on the content, instruction style and contribution of this course was collected with semi-structured in-depth interviews with students at the end of each semester both to study the impact of this class and improve it. Interviews with students were made after 10 courses (Interaction Between Art and Design was offered 5 times and Contemporary Issues in Design was offered 5 times) between Spring 2011-2012 and Spring 2016-2017. All students who took the class were invited to take part in the feedback collection. Forty-eight students participated in the interviews. The interviews were made without time limit either at the last class or by making appointments with the students based on their availability. One of the issues discussed with the students was whether the course content was beneficial for their design activity in industrial product design studio, the major course of a design student in a semester with the highest credit value. Students indicated that they have integrated the course content into their designing as a new method of inquiry of subject matter. Therefore, the material was reflected as part of an informed methodology of consciousness as opposed to new subject matter. Hence, a change of philosophy can be seen in the students’ processes.
According to some students, change in their approaches to designing in the studio was reported as a change in their attitude. For example, one of the students indicated that s/he no longer tried his/her design to be liked by all of the instructors and that she learned that there will be a number of supporters of her design. Students reported that they could take decisions in the studio better. The difficulty of trying to respond to very different critiques of different instructors was overcome by asking for the viability of the project when necessary. A detailed article on this research was produced based on this past research (Kaya Pazarbasi, 2017).

For the second phase of the research, which is the topic of this article, three alumni who had taken the courses were asked directly whether the courses had impact on their thinking and practice during the production of this article. These three students were selected randomly. In the future, all students who would like to contribute in the development of the course can be asked this particular question.

Two works by Tugay Topçu and İrem Çakıroğlu can be seen in Figure 2 and Figure 3. For example, in Figure 2 “Untitled” by Tugay Topçu was made after the problematic of the machines and humans where he questions the interactions of machines and humans. In written his artist’s statement Topçu explains his work as:

“Throughout the history, humankind has found several answers to “why do we exist?” question; the increased complexity and increased concepts increase the number of questions and answers. Most answers have emerged from the concepts which derive their existence to maintain the human race (mortality-based religions etc.). And also, the arts emerged from being aware of mortality along with desire of meaning the life and after death, too. Throughout the process, we can obviously see the fact that wisdom overcomes everything indeed, even if it happens slowly. It can be said that we are the ruler of the earth that we were born in a vulnerable condition. So that we can manage many of our business with machines and computers, without even moving, like we are god. Have we even taken one small step to answer the question “why do we exist”, throughout this period? Or all we can do is generating new answers and then refute them all?

We can cross the boundaries the universe puts us?
Is there really something called free will? Or do humans take their all decisions with algorithms under the rules of the universe put like robots?

In the future, will robots do questioning the existence on our behalf? Will they live the processes we already had, too? Will they notice the fact that they are not able to find and answer about existence? Will they be poisoned by “consciousness” like us? Is this a loop?

Someday, is it possible that survival instinct replaced with the death drive?”

According to Topçu, this work provided an opportunity to apply theoretical art history and design history knowledge to practice. Topçu explains this as: “This course provided a platform for me to express my own ideas and feelings without the constraints of a design brief. Scientific designing as we do in the design studio develops with imagination and philosophy. In this class we could use our designing abilities for depicting philosophy and imagination. Our practice was existential and philosophical in my point of view. If I did not take this course my own thoughts and feelings would be left as emotions and feelings. The course provided freedom to reflect our inner world.”

According to Eli Bensusan “The course fosters alternative ways of thinking by its exposure of subjects like semiotics, design philosophy in a different context. The course was a bridge to translate some concepts in art to design. This helps a unique design perspective to be created. Hence, added value could be part of novel products in the market which is full of similar products. I could acquire different approaches while creating strategies of added value.”

İrem Çakıroğlu who made the work seen in Figure 3 explains how the course content changed her thinking and practice as such: “In the product design studios, we proceed with a realistic perspective. Although we develop concepts at the beginning of the project, at the end of the day we are required to design feasible and marketable products. In this course, the priority of design criteria was different than the project studio. The constraints were different. When the confines of the realistic constraints are removed the blindness about feasibility is shrugged off. Then, the role of products in the society can be investigated from a different perspective. When we concentrate on feasibility that perspective would not be revealed. For example, in Silent Headset I could identify a different need from
a sociological point of view and show that need. The headset is designed to listen to music but beyond that it is an object to set boundaries of privacy in public. It indicates that the person does not want public communication.” Here, Irem states that she had access to the idea that designed objects have agency as well as utility.

Figure 2. “Untitled” by Tugay Topçu, 2016, plastic display model, plastic water disposal hose used in washing machines, spray paint, polyurethane foam

Figure 3. “Silent Headset” by Irem Çakıroğlu, 2016, ready-made plastic.

5 Reflection of Content in Industrial Design Studio

As stated in detail in the previous section, it was found in past research that some students acquired an attitude of designing during the courses as depicted in some of their quotes. A question that arose during this past study, which is the subject matter of this article, was how to amplify the impact of the content. As indicated at the beginning of the article, this could be possible with integrating the content in compulsory product design studio. This requires developing a method of integration without negotiating the fundamental outcomes of the studio. Two concepts that can be used to adopt criticality in the studio can be “viability”, “utility” and “agency”.

The significance of questioning viability is its unstated central role in critical industrial design studio practice which has started being unravelled with the feedback of the students who have been exposed to contemporary art content. Here, viability can come into play to guide students while going through the extremely complex argumentative process of designing. To explain viability better, one can simply ask whether the design is viable to be named as “design”. This means deliberately moving away from the brief provided as a starting point and formulating a new set of criteria which is highly personal but which does not oppose to the design brief. For example, Topçu could include personal content into designing.

A tool contemporary art content provides is lack of utility. In an education condensed on functionality and a market pull, it can be hard for students to move away from the limitations and restrictions of industry to be open, creative and critical lying at the foundation of radical innovation. A method of scaffolding can be adopting uselessness from art: the most distinct feature of art practice separating it clearly from applied creative fields. As explained by Topçu, without the constraints of the design brief, he could find freedom to bring personal interpretation of theory into

210
practice. And he finds this valuable since he thinks designing can develop with imagination and philosophy. According to Eli Bensusan utility is a narrow understanding of design and contemporary art can serve for design to have agency.

6 Towards an Informed Conceptualism in the Studio

It would not be wrong to say that pragmatism through functionalism shaped the history of design education pedagogy, based on Fern Lerner’s article “Foundations for Design Education: Continuing the Bauhaus Vorkurs Vision” (Lerner, 2005). In this study, instead of sole pragmatist functionalism other strategies for conceptualizing novel and meaningful products are proposed. Although the words “concept” and “conceptual design” exist, we need to understand that conceptual design should not be limited to “concept products”, those products designed without or with limited focus on feasibility. Having observed in past research that contemporary art provides a door for critical performances of industrial design as a profession, it can as well lend the method of viability and lack of utility to the design studio. In addition to this, contemporary art content serves design to have agency beyond utility. It can be a strategy to vocalize the agency of the designed object suggesting layers of meaning beyond utility.

A danger about using the freedom of art is its ignorant and irresponsible interpretations in conceptual design. Anything being able to be art after Duchamp for some has opened room for bad art that for some does not qualify as art in brackets. The same problem is present in design. I name avoiding labour-intensive work of industrial design for supposedly the sake of conceptualism easy politics and ask this crucial question: “Have you done the reading?” meaning that conceptualism should not be confused with identity construction as a student but has to be discussed with related theory. To get back to Duchamp, he was not anyone who one day became a celebrity with a gesture as simple as saying that a urinal is art. He was a cubist master painter before that. Liberal arts readings are crucial for conceptualism not to negate skill mastery.

How to integrate new content needs further study to teach students structured methods of how to integrate new content to their industrial design practice. Otherwise, conceptualism is misunderstood and the fundamental requirements of the profession for designing meaningful industrial products can be omitted beyond the intention of conceptualism.

A question to be investigated in further studies based on this research is the experience level in which the mentioned content can be offered to students. Although, these courses are offered as an elective for sophomore and senior students; arguing that skill acquisition and conceptual growth should develop simultaneously, freshman and junior students can be exposed to this content in their studio education.

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References


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Motivational Factors for Participation in Industrial Design Competition

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Abstract: Design competitions play an important role in education. The purpose of this paper is to explore the motivational factors of the participants in industrial design competitions and what attributes of the competitions affect these factors. In this study, a two-stage method combining qualitative and quantitative methods was used, including evaluation grid method (EGM) and quantification theory type 1 method. These methods are based on Miryoku engineering theory. The results of the study reflect the motivational factors of students to participate in design competitions, and establish the weighted relationship between these motivations and the competition attributes. The study indicates that the participants want to compete in design competitions with a sense of authority, a sense of fairness, a sense of self-realization and a sense of honour. These abstract reasons contain the corresponding rationale and specific reasons. The results of the study can provide a theoretical reference for participating students, educational institutions and competition organizers.

Keywords: industrial design competitions; motivational factors; EGM; quantification theory type 1

1 Introduction

Motivation for learning is a central problem in a modern university, since motivation is a source of activity, it performs an urging function and brings sense into education process (Bazylev et al., 2014). Many design pedagogics aim at improving students' motivation for learning.

A large number of literatures show that solving real-world problems and social needs can improve students' enthusiasm for applying knowledge. “Students have to get out in the real world” (Ahlgren & Verner 2013, p. 134). Cannon and Newble (2000) stated that if students are faced with a true-to-life example in which they practice methods that they are destined to use in their future employment, they are more likely to learn. The immersion of the learner in a complex realistic real-world problem is, therefore, seen as instrumental for creating the context for learning. If a problem-based learning design project is carefully chosen so that it strengthens the attributes that
students will require for their career, the knowledge of their experiences is more likely to be retained. This is a problem-based learning theory, has been widely used in several higher educational institutions across the world. (Masek & Yamin, 2010) Solving real-world problem play a very important role in social responsibility education. It helps to improve the social responsibility of design students as future designers. Collaborations between industry and academia have been recognized as a valid alternative to expose students to more realistic problems and situations than the ones that are typically offered to them. Currently, design schools can cooperate with industries, academic institutions, and non-profit organizations to create opportunities for industrial design students to resolve authentic problems and design for social change, thereby enhancing their social responsibilities (Yang, 2016).

One particular way to implement the industry-academia collaboration is by means of design competitions. (Rodriguez & Choudhury, 2014) “Student competitions can play an important role in education: they promote interest and engagement of the students, as well as of the teachers” (Gadola & Chindamo, 2018, p. 3). “The idea of having well-defined and controlled competitions as pedagogical technique to motivate and get students involved, particularly in pre-college years, is not a new concept.” (Rodriguez & Choudhury, 2014, p. 1). Other than this, the relevant literature proposes that design competition is considered to be the best educational method to improve students’ awareness of social responsibility. (Abdul-Wahab, 2005). According to related literature (Nguyen & Pudlowski, 1999), the main benefits of design competitions are to help students:

- gain a variety of experience and knowledge in the associated problems;
- acquire skills to identify and solve Social problems;
- acquire an awareness and sensitivity to the total society;
- acquire a set of values and attitudes for the society and the motivation to actively participate in environmental improvement and protection;
- participate with an opportunity to be actively involved in working towards the resolution of social problems.

For the purpose of this study, the definition of design competition is limited to design awards given as public recognition by means of competition. Design award in this article refers to a prize that is given to a person who wins a design competition. Although the meaning of competition and award is different, design competition, design award and design prize refer to the same research object in this article: design-related competition events. For example, in the 35 industrial design competition research samples listed in Table 1, they are all the same type of event, but with different names.

Many design educators have a positive assessment of the design competition. Design competitions can assist in the development of equipment for the elderly and the disabled (de-Juan et al., 2016), are “useful in teaching the creative and practical aspects of engineering design” (Davis & Masten, 1996, p. 276), provide “improved communication and idea exchange” (Deserti, 2011, p. 8), improve soft skills (Chua & Koh, 2017), promote school-enterprise cooperation (Abdul-Wahab 2005), enhance motivation of the students (de-Juan et al., 2016), “promote interest and engagement of the students” (Gadola & Chindamo, 2012, p. 1), and helps students gain a competitive-based mindset (Bibbings et al., 2018).

Although the benefits of design competition and the advantages of improving students’ social responsibility are self-evident, the motivation of teachers and students to participate in the competition is vague and still less explored. for many instructors, finding suitable design projects is one of the most difficult tasks associated with a problem-based learning design course. (Davies, 2013). The number of industrial design competitions is huge. There are many types of design competitions in existence today. Students have completely different experiences in the process of participating in the competition. They often participate in the process of exploration, which is easy to produce negative effects. Teachers should also have a reasonable basis when choosing the right design competition. Bielefeldt (2012) points to the importance of offering a range of project options to students.

In addition, it is difficult for the organizers and organizers of the competition to understand the needs of the contestants, which makes it difficult to meet the needs of the contestants and thus fail to achieve the intended purpose. The enthusiasm of students to participate in design competition is supported by motivational factors: Motivation is a key factor in students’ learning (Bielefeldt, 2012).

From the competition participants ’s point of view, they had a lot of doubts when they took part in the design competition. A literature on architectural design competitions puts forward that participants believe that the success of the design competitions depends on luck and is random, or because the jury is in your favour. here are also opinions which say that well known architectural studios, the so-called architecture stars are most likely to win the
competitions. These ambiguities and doubts may be a stumbling block for students to participate in design competitions (Bonenberg, 2019). Therefore, it is important to clarify the relationship between the specific attributes of the design competition and the motives of the contestants, so that students can successfully participate in the design competition and help to improve the social responsibility of design students. Also from the perspective of organizers and sponsors, Lampel and others (2012) believe that effective design competitions must adapt to the idiosyncratic requirements of their particular contexts by developing practices that modify and complement formal competition processes. However, in most contemporary design competitions, it is difficult for sponsors and organizers to capture the key elements of the design competition. We are in need for a scientific approach to evaluate or determine the potential motivational factors of design competitions as a tool of design education.

In this study, the evaluation grid method (EGM) and the quantification theory type 1 (QTT1) method were conducted. The EGM and QTT1 are main research method of Miryoku engineering to analyse the psychological needs of users. they often used to explore user preferences, motivations structures through interview process and statistical analysis (Ho & Hou, 2015). In this study, we applied Miryoku Engineering as a methodology to determine the ways in which the motivational factors of design competitions is based on human emotions.

According to Vroom’s motivation theory, each person’s expectations of the results have their own preferences (Vroom, 1964). Miryoku Engineering is a design concept based on consumer preferences and builds a bridge between designers and consumers (Miryoku Engineering Forum, 1992). Miryoku Engineering is put forward by the Japanese scholar Ujigawa Masato and other scholars in 1991 It is a theoretical method for preference-based design and is used to develop attractive products or systems (Ma et al., 2011). Although very little published work has studied design competition directly, using the methodology of Miryoku Engineering, the critical motivational factors of design competition can be evaluated effectively, and can also be used to assess design competition through their specific attributes.

The purpose of this article is to study the following two points:

- 1 Find motivational factors of industrial design competitions.
- 2 Establish a quantitative relationship between design competition attributes and students’ motivational factors.

2 Methods

The focus of this study is to find out the motivational factors of industrial design competitions. The research methods and procedures are divided into two parts. The research method is a two-stage comprehensive method which integrates qualitative research and quantitative analysis. In the first step, the motivation factors of the design competition participants are extracted by using EGM, and the second step is to establish the mathematical relationship between the motivation factors and the design competition attributes by means of questionnaire method and quantification theory type 1. The method is summarized as follows:

2.1 Sample Selection

This study conducts research in the context of industrial design competitions. First, we collected more than 200 international and domestic industrial design competitions through literature review and website data as initial study sample. These industrial design competitions have different settings in terms of organization, sponsors, jury, entry topics, submission requirements, awards setup, competition process, awards, rights and obligations. Subsequently, 120 samples were initially screened for these design competition samples. Industrial design competitions with too few game information, closed, and too small a range of competitions were deleted through the screening process. In the end, this study invited professors who have experience in hosting and reviewing industrial design competitions, high-involved participants who won many industrial design awards, and industrial design teachers with rich experience in organizing the competition, these 8 experts made a final screening of the samples. and the design competition samples with similar properties and no features were excluded. A total of 35 representative samples were obtained, including 12 international industrial design competitions and 8 national industrial design competitions and 15 provincial and municipal industrial design competitions. The sample covers industrial design competitions in the United States, the United Kingdom, Germany, Italy, Japan, South Korea, China. For example, IDEA Industrial Design Competition, Red Dot Award, iF Award, Good Design, Red Star Award, National Undergraduate Industrial Design Competition. The final 35 research samples were made into A3 size posters with important entry information. Each sample panel has a QR code for the design competition website for participants to access. All samples are shown in Table 1:
2.2 Participants

A group of sixteen students took part in the research. Participants were selected based on their major, experience of participating in design competition, age, and gender. All 16 participants were majoring in industrial design, including 11 undergraduate students, 4 postgraduate students, and 1 PhD student. They have at least three years of experience in participating industrial design competition, each participant had participated in more than 10 domestic and foreign industrial design competitions, and had won at least 5 industrial design competition awards. The 16 participants, including 8 men and 8 women, were between the ages of 21-35. All participants were volunteers and did not receive payment or additional credit for participation in the study.

2.3 EGM Interview

This study used EGM to extract the motivational factors of design competitions. Evaluation grid method (EGM) is proposed by the Japanese researcher Sanui (1996), which is the method of collecting personal psychological information and drawing hierarchical diagram (Sanui, 1996). This technique is through the paired comparison between two objects to discuss similarity and difference of the object to sort out the target object of individual qualities via personal interviews. EGM has two processes. In the first step, people were asked to answer what was good or bad about the objects and what they liked or disliked about them when comparing objects to be evaluated. Second, additional questions clarified the meaning or conditions of their answers. This makes it possible in a hierarchical structure to codify the mechanism of their reasoning. This method is called the Evaluation Grid Method (Ma & Tseng, 2012). EGM was used in this study to gauge the motivational factors of industrial design competition, and the hierarchical diagram of the motivational factors was built (Tseng). Due to the large amount of information contained in the design competition, the researchers set 35 electronic versions of the sample to the 16 participants before the interview began to let them know about the design competitions, in addition to the participants did not disclose any questions and information about the interview. In the EGM process, the entire interview process will be recorded. The specific interview method and process are described below:

First, each of the 16 participants was asked to select a sample poster for the industrial design competition that they would very much like to participate in. And then, based on the selected preference sample, participants were asked why they chose these industrial design competitions. In other words, the motivation factor for participants to participate in these design competitions. For example, participants replied: Because they like the jury of the competition. The participants’ answers are recorded as the original evaluation item (OEI) in EGM. The researchers then pressed the participants on their concrete reasons for each OEI. For example, could you tell me the exact reason for liking the jury in this competition? participants may answer: every time the jury of this competition invites a famous master of industrial design, I hope my work will be appreciated by them. The jury has a well-known master of industrial design that can be used as a concrete evaluation item (CEI) in the EGM structure, that is, the lower item. Finally, the researchers could ask them what the psychological feelings of the participants are, which can be used as an abstract evaluation item (AEI) in EGM, that is, the source of the upper item. For example, the researchers asked: how would a jury of renowned industrial design masters in a design competition make you feel? Participants may answer: it makes me feel a sense of sense of authority. The sense of authority can be recorded as AEI. After the
Motivational Factors for Participation in Industrial Design Competition

interview, the researchers should immediately sort out the notes and recordings of the EGM interview and clearly divide them into three levels: OEI (middle), AEI (upper) and CEI (lower). Next, each participant’s motivational factors were organized into an EGM hierarchical table. Finally, the EGM table of all participants was integrated, and the factors with repeated statements were combined to simplify overly complex statements. The number of mentions of the subjects was marked on each charm element, and the connection lines were made according to the interview. The final EGM hierarchical table of the motivational factors of the design competitions was then obtained.

2.4 Statistical Analysis – Quantification Theory Type 1
Quantification theory type 1 (QTT1) is a branch of multiple linear regression which is proposed by the Japanese researcher Hayashi (Hayashi, 1950). This technique predicts the relationship between a response value and categorical values using the statistical analysis method. In the situation of independent variables for qualitative variables and dependent variables for quantitative variables, QTT1 builds the mathematical model between them using multiple regression analysis to solve the problem of the dependent variable forecasting, revealing the inner connection and the laws of things. (Hayashi, 1950). Hayashi’s quantification theory type 1 also could be used to evaluate the weight between the factors from users’ preferences, psychological information or motivation factors. In order to quantify the range of items and score of categories for the motivational factors of industrial design competitions, the quantification theory type 1 method was used in this study. QTT1 was used to analysis the results and determine the weighted relationships among the upper level (participants’ psychological information), middle level (motivational factors of design competitions), and lower level (concrete design competition factors). This facilitated the understanding of the motivation values of design competitions. Previous literatures have involved research on architectural design competitions, engineering design competitions, and art design competitions, but few have analysed the motivation factors for industrial design competitions. Therefore, this study only covers industrial design competitions in the context of design competitions.

For the second purpose, this study used quantification theory type 1 method to analyse the relationship between motivational factors and attributes of industrial design competitions extracted from the EGM interview. Firstly, Likert scale was used to make questionnaire to evaluate the importance of the OEI. The participants were then asked to select one of the most important CEI according to each OEI. In this study, 236 questionnaires were issued through the online questionnaire website, among which 211 valid questionnaires were recovered. The results of the questionnaire were used to calculate the influence weight between the motivational factors through quantification theory type 1.

3 Results and Discussion

3.1 The Result of EGM
The final EGM hierarchical diagram of motivational factors of industrial design competitions is shown in Figure 1.

The result in Figure 1 shows that the motivational factors of design competitions contain 9 abstract reasons (AEI) On the left side of the diagram. 14 of the original reasons (OEI) were listed in the middle column of the chart. The 33 concrete reasons (CEI) associated with each original reason were listed on the right side of the chart. The Numbers in each bracket represent the times number of mentions. In the stage of statistical analysis, we selected AEIs with more than 10 times for analysis, they are shown in white squares in the AEI list of Figure 1.
3.2 The Results of Quantification Theory Type 1

3.2.1 Weighting the Motivational Factors of the “Sense of Authority”

Through the EGM diagram and results of QTT1, excellent jury, fairness of the evaluation and strong influence organizer are likely factors which will bring participants with sense of authority. The determination coefficient R2 from Table 1 was 0.738 (R2 > 0.7) which was high correlation, it showed that the sense of authority had a high correlation with design competitions. As you can see from Table 1, the highest value of 0.836 in PCC means excellent jury (X1) has the greatest influence on sense of authority. CS values show that famous master of industrial design has the greatest influence on excellent jury.

Table 2. QTT1 results for “sense of authority”

<table>
<thead>
<tr>
<th>Original reasons</th>
<th>Concrete reasons</th>
<th>Category scores</th>
<th>Partial correlation coefficients</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>X1: Excellent jury</td>
<td>21: Famous master of industrial design</td>
<td>0.734*</td>
<td>0.836</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>22: Regular replacement of members of the judges</td>
<td>0.305</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>23: Regular replacement of members of the judges</td>
<td>0.239</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X2: Fairness of the evaluation</td>
<td>23: Diversification of jury structure</td>
<td>0.465*</td>
<td>0.449</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>24: Quantitative scoring according to criteria</td>
<td>0.213</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>25: Voting-based evaluation</td>
<td>0.134</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X8: Strong influence organizer</td>
<td>26: Jury comment System</td>
<td>0.063</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>29: Award-winning Certificate design</td>
<td>0.071</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>30: Award ranking system for individuals and institutions</td>
<td>0.071*</td>
<td>0.712</td>
<td>2</td>
</tr>
<tr>
<td>Constant</td>
<td></td>
<td>0.769</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

R=0.859  R2=0.738
3.2.2 Weighting the Motivational Factors of the “Sense of Fairness”

Under the association of sense of fairness, excellent jury, fairness of the evaluation and diversity of award settings are likely factors which will bring interviewees with sense of fairness (Table 2). The determination coefficient $R^2$ from Table 2 was 0.745 ($R^2 > 0.7$) which was high correlation, it showed that the sense of fairness had a high correlation with design competitions. The PCC of fairness of the evaluation (PCC=0.856) is highest, which means fairness of the evaluation ($X_2$) has the greatest influence on sense of fairness. CS values show that voting-based evaluation has the greatest influence on fairness of the evaluation.

Table 3. QTT1 results for “sense of fairness”

<table>
<thead>
<tr>
<th>Original reasons</th>
<th>Concrete reasons</th>
<th>Category scores</th>
<th>Partial correlation coefficients</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>X1: Excellent jury</td>
<td>21: Famous master of industrial design</td>
<td>0.263</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>22: Regular replacement of members of the judges</td>
<td>0.714</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>23: Diversification of jury structure</td>
<td>0.763*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X2: Fairness of the evaluation</td>
<td>22: Regular replacement of members of the judges</td>
<td>0.643</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>23: Diversification of jury structure</td>
<td>0.452</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>24: Quantitative scoring according to criteria</td>
<td>0.368</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>25: Voting-based evaluation</td>
<td>0.912*</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>26: Jury comment System</td>
<td>0.013</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X5: Diversity of award settings</td>
<td>23: Large Award Coverage</td>
<td>0.316*</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>24: There are special awards set</td>
<td>0.234</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>25: High Prize money</td>
<td>0.465</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Constant</td>
<td>0.863</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$R=0.863$ $R^2=0.745$

3.2.3 Weighting the Motivational Factors of the “Sense of Self-Realization”

Under the association of sense of self-realization, entry theme settings, commercialization of design works and participatory design are likely factors which will bring interviewees with sense of self-realization (Table 3). The determination coefficient $R^2$ from Table 3 was 0.783 ($R^2 > 0.7$) which was high correlation, it showed that the sense of self-realization had a high correlation with design competitions. The PCC of commercialization of design works (PCC=0.843) is highest, which means commercialization of design works ($X_4$) has the greatest influence on sense of self-realization. CS values show that help authors contact sponsors has the greatest influence on commercialization of design works.

Table 4. QTT1 results for “sense of self-realization”

<table>
<thead>
<tr>
<th>Original reasons</th>
<th>Concrete reasons</th>
<th>Category scores</th>
<th>Partial correlation coefficients</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>X3: Entry Theme Settings</td>
<td>27: Entry topics in line with social hotspot issues</td>
<td>0.784*</td>
<td>0.695</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>28: The theme of the competition is directional</td>
<td>0.162</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>29: Entry topics for solving practical problems</td>
<td>0.694</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X4: Commercialization of Design Works</td>
<td>29: Entry topics for solving practical problems</td>
<td>0.632</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>29: Helping authors apply for patents</td>
<td>0.813*</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>30: Help authors Contact Sponsors</td>
<td>0.803</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X7: Participatory design</td>
<td>29: Entry topics for solving practical problems</td>
<td>0.635</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>30: Helping authors promote their work</td>
<td>0.512</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>29: Involve end users in the entry process</td>
<td>0.684*</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Constant</td>
<td>0.819</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$R=0.85$ $R^2=0.783$

3.2.4 Weighting the Motivational Factors of the “Sense of Honour”

Under the association of sense of honour, diversity of award settings, strong influence organizer, strong propaganda and award ceremony design are likely factors which will bring interviewees with sense of honour (Table 4). The determination coefficient $R^2$ from Table 4 was 0.797 ($R^2 > 0.7$) which was high correlation, it showed that the sense of
honour had a high correlation with design competitions. The PCC of strong influence organizer (PCC=0.892) is highest, which means strong influence organizer (X8) has the greatest influence on sense of honour. CS values show that host institutions with high social influence has the greatest influence on strong influence organizer.

Table 5. QTT1 analysis results for “sense of honour”

<table>
<thead>
<tr>
<th>Original reasons</th>
<th>Concrete reasons</th>
<th>Category scores</th>
<th>Partial correlation coefficients</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>X5: Diversity of award settings</td>
<td>Z13: Large Award Coverage</td>
<td>0.031</td>
<td>0.587</td>
<td>4</td>
</tr>
<tr>
<td>X5: Diversity of award settings</td>
<td>Z14: There are special awards set</td>
<td>0.135</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X5: Diversity of award settings</td>
<td>Z15: High Prize money</td>
<td>0.762*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X8: Strong influence organizer</td>
<td>Z19: Market-Recognized Contest logo</td>
<td>0.716</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X8: Strong influence organizer</td>
<td>Z20: Host institutions with high social influence</td>
<td>0.881*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X10: Strong propaganda</td>
<td>Z23: Preaching &amp; training</td>
<td>0.011</td>
<td>0.732</td>
<td>3</td>
</tr>
<tr>
<td>X10: Strong propaganda</td>
<td>Z24: online exhibition</td>
<td>0.851</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X10: Strong propaganda</td>
<td>Z25: Publication of competition Portfolio</td>
<td>0.897</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X10: Strong propaganda</td>
<td>Z30: Award ranking system for individuals and institutions</td>
<td>0.903*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X12: Award Ceremony Design</td>
<td>Z28: Award-winning Certificate design</td>
<td>0.863</td>
<td>0.815</td>
<td>2</td>
</tr>
<tr>
<td>X12: Award Ceremony Design</td>
<td>Z29: Specially designed award Process</td>
<td>0.894*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td></td>
<td>0.856</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R=0.893</td>
<td>R²=0.797</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4 Conclusion

Design competition is an effective way for design students to apply knowledge to real society. The motivation of the participating students is a kind of psychological activity based on preference, which has complexity and uncertainty. Clarifying students’ motivation factors can help students succeed in participating in the competition. It provides theoretical references to students, educational institutions, competition sponsors and organizers.

In this study, the industrial design competition was analysed, and the most representative samples were selected for qualitative and quantitative analysis to determine the relationship between the participants’ motivational factors in various design competitions. Motivational factors were divided into the original evaluation item (OEI) abstract evaluation item (AEI) and the concrete evaluation item (CEI) through EGM process. and through the quantitative category of these motivational factors to establish a mathematical weight relationship model. These studies reflect the relationship between the attributes in the design competition and the motivational factors of the participants. The study found that participants wanted to compete in design competitions with a sense of authority, a sense of fairness, a sense of self-realization and honour. Most of these abstract motivational factors are determined by the original motives of the excellent jury, the fairness of the review process, the theme setting, the commercialization of the design works, the diversity of the award setting, the pre-evaluation score, the participatory design, the influential organizing committee, the strong publicity and the design of the award ceremony. The corresponding specific motivational factors were included under each original motive, most of which were the attributes of the design competition, which were mentioned by the participants more frequently. In addition, individual design competitions have some creative operational experience. For example, get pre-reviewed scores in advance (X6), participatory competition, which were mentioned by the participants more frequently. In addition, individual design competitions hold some creative operational experience. For example, get pre-reviewed scores in advance (X6), participatory design (X7), Publication of competition Portfolio (Z25) and direction AI theme (Z8).

Design competitions and award can provide several benefits to various stakeholders (Brunswicker & Seymour, 2006; Sung et al., 2009). For participating students, choose the design competition that suits them in order to develop their professional ability. The most important reason for students to participate in the competition is to obtain sense of authority (Y1), sense of fairness (Y2), sense of self-realization (Y3) and sense of honour (Y4). The most influential factor in sense of authority (Y1) is excellent jury (X1), in which famous master of industrial design (Z1) is the most valued motivational factor. The most influential factor in sense of fairness (Y2) was fairness of the evaluation (X2), in which voting-based evaluation (Z5) was the most valued motivational factor. The most influential factor in sense of self-realization (Y3) is commercialization of design works (X4), in which helping authors apply for patents (Z10) is the most valued motivation factor. The most influential of sense of honour (Y4) is strong influence organizer (X8), of which host institutions with high social influence (Z20) is the most valued motivational factor. The results show that students pay more attention to the external factors of the competition, including jury, fairness of the evaluation, commercialization of design works, and host institutions with high social influence. Although the results of the competition can affect the motivation of the competition, the purpose of the design competition is to enable students to accumulate experience and apply knowledge. This study suggests that the students should pay more attention to the internal factors of the
Motivational Factors for Participation in Industrial Design Competition

competition, attach importance to the process of the competition, and regard the participation in the competition as a learning process, which will also avoid the negative effects of the unsatisfactory results of the competition.

For teachers and educational institutions that organize participation, understanding the motivation of students to participate helps to integrate appropriate competitions into the curriculum. This study suggests that teachers and educational institutions should pay attention to the authority of the organizers, the influence of the jury, the fairness of the evaluation mechanism and the commercial service of the design works when selecting the industrial design competition. At the same time, it can guide students to balance the proportion of the process and results of the competition in order to improve their professional knowledge. In the process of participating in the competition to take care of the psychological status of students, to avoid the unsatisfactory results of the competition to bring negative learning effects.

For the organizers and sponsors of the competition, understanding the motivation of students is very helpful to the successful operation of the design competition. This can bring considerable economic and prestigious benefits to sponsors and organizers. The motivation factors among the various motivation factors in the results of this study and the weight relationship between these factors can provide a theoretical reference for the organizers.

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Participatory Design Methodology in Design Competition Practice

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Abstract: More and more companies are trying various external design resources to meet their innovation needs. For example, design competitions can bring many innovative design ideas to enterprises, but leading, managing, and assessing innovation from a design competition is difficult for an enterprise and there are limited reference materials and research available on the topic to help enterprises take full advantage of this resource. By studying the Thermaltake Creative Design Competition for six years and combining a literature review, empirical research, and interviews, the authors of this paper explore how to use design competitions as an effective resource for commercial design research and innovative concept exploration. The findings indicate that: 1) The company, using participatory design methodology to manage design competitions, needs to have sufficient R&D ability to assist the organiser and contestants to execute their objectives; 2) the subject of the competition and the consumer needs should be defined and transferred clearly to the contestants by the instruction or presentation at beginning; 3) a design seminar is a helpful co-design process, which allows the organiser and participants to work on design together; 4) mutual benefit is important in participatory design competitions, for example, while the company explores innovative design concepts through the competition, the entrants earn design practice and design cooperation. This study puts forward some practical and theoretical findings in the field of innovation management, which can be a reference for enterprises to use design competitions as an effective innovation design method.

Keywords: design competition; design methods; participatory design; design management

1 Introduction

According to a listing from Ming Chuan University, there were 25 creative product design competitions sponsored by companies in Taiwan in 2015 alone (Ming Chuan University, 2015). There are many practical cases of companies holding creative design competitions as a research platform for product innovation. The growing popularity of design competitions suggests that they are a firmly established innovation strategy (Lampel, Jha & Bhalla, 2012). The use of design competitions to access external innovation resources is not new, but the increased power that comes with
combining this approach with the rich innovation ecology has just emerged over the past several decades. An additional change in current design competitions is the emphasis on collaboration (Love & Hubbard, 2007). There are various purposes for companies to organise design competitions, as well as different structures and governance practices. For example, most sponsors do not participate in the entire design process of the contestants, but some enterprises take active part in some phases to transfer and provide information and assistance, such as subject introduction, technical seminars, and assessment meetings. Also, some companies have held design competitions for many years, but some have stopped due to limited results. The serialised competitions delivered by dedicated juries give sponsors greater opportunity to learn and refine the architecture of such competitions, while also improving the alignment of participant motives with the objectives and interests of the design competition, as well as the organising and sponsoring institutions more generally (Lampel, Jha & Bhalla, 2012).

The following research focuses on how to apply participatory design methodology in design competition practice to lead, manage, and assess this external innovation resource and serve companies’ innovation strategies. This paper is based on Participatory Design theories and the study of the Creative Design Competition sponsored by Thermaltake Technology Co. Ltd (hereinafter called Tt Competition and Tt Company), a serialised competition which has been held for six years. It is a good case to study to explore how to use design competitions as a platform for innovation design to achieve creative results. Through an analysis of their results and experiences in holding design competitions, we can determine effective applications of competition architecture and governance methods and expand the current research of design competition management to the event evaluation phase. The Tt Competition explored in this paper is organised in partnership with Tt Company and local universities and has been refined over the last six years. As of 2018, the number of universities involved has increased from the original two universities in the first design competition to six. The principal investigator (PI) has been involved in all these events, beginning as an organiser in the first two years and then shifting to collaborating institutions, and has been studying it for five years. Therefore, the PI is familiar with every phase of the competition and understands different perspectives, from the sponsors to the jury to the participants.

### 1.1 Design Method: Participatory Design

In the design methodology described by Hanington and Martin (2012), participatory design is a complete design process involving exploration, derivation, and evaluation. Participatory design is a human-centred design approach based on collaborative design activities. Participants include designers, users, and non-designer professionals associated with design projects. The term “non-designers” refers to potential users, other external stakeholders, and/or people on the development team who are from disciplines other than design, such as those in marketing, engineering, and sales (Sanders, Brandt & Binder 2010).

Participatory design is a design method and concept. Designers need to understand the objectives and perspectives of users and other stakeholders. Three main issues have dominated the discourse in the participatory design literature: (1) the politics of design, (2) the nature of participation, and (3) methods, tools, and techniques for carrying out design projects (Kensing & Blomberg, 1998). In his paper, The Methodology of Participatory Design, Spinuzzi (2005) proposes three basic stages in participatory design: (1) Initial exploration of work, the stage in which designers and users get to know each other; (2) Discovery processes, the stage in which designers and participants constantly exchange design ideas, stimulate each other, and identify needs and expectations; and (3) Prototyping, which provides a basis for designers and participants to repeat, joint, and explore further.

### 1.2 Design Competition: Purpose and Components

As a design method, a design competition is a type of “search” strategy (Banerjee & Loukaitou, 1990). Earlier, Alexander, Whitting, and Casper (1987) showed that there is a clear difference in the organisation and use of “concept” versus “implementation” competitions. With demands on product innovation concepts, some companies use design competitions to convey their innovation values and policies, such as the “Great Design Competition” held by GIGABYTE since 2003, while others explore potential new product ideas in design competitions and transfer winning entries into commercial products, such as Japan’s KOKUYO Design Award and Ilan Chair Design Award.

Füller, Hutter and Faullant (2011) introduced the “virtual design competition” as a new means of opening up the innovation process and enriching companies, and Lampel et al. (2012) have explored the competition phenomenon according to the development of open innovation, showing the relationship between innovation agendas and design competitions. The agendas rooted in immediate concerns and future aspirations shape the competitions’ goals and processes. These authors believe that design competitions with narrowly-focused innovation agendas provide
Participatory Design Methodology in Design Competition Practice

innovative solutions to business problems, and at the opposite end of the spectrum, design competitions reflecting broad innovation agendas accelerate or even reshape market development.

1.3 Design Assessment
Design assessment methods can generally be divided into sequential assessment method and quantitative assessment method (Baxter, 1995; 1998). Chen (2004) divided design conception evaluation decisions into two stages: conception scanning and conception rating. Scanning is a quick and concise assessment on some feasible applications. Rating is a more careful analysis on these shortlisted ideas to choose the most successful design solution.

Banerjee (1990) mentioned that the composition of the jury of a design competition should be diverse rather than uniform. Each jury member has his own perspective on design criticism; therefore, the design juries should consist of multidisciplinary and unpredictable perspectives, not one “line of thought”. Lampel et al. (2012) have revealed three distinct methods of competition assessment: (a) expert assessment by a jury of individuals selected on the basis of their specialist knowledge and/or public profile; (b) peer assessment by innovators from the same knowledge or practice communities as the participants; and (c) vox populi assessment rendered by popular acclaim or voting of participating audiences or the public. These methods can be used separately or in combination.

2 Research Methods
The research methods for this study are divided into two phases. The first phase, case study, includes data collection and analysis of the Tt Competition. The second phase is the expert interviews and participant interviews, with the relevant personnel and entrants involved in the Tt Competition. Furthermore, an analysis of the results and suggestions are presented in this case study.

2.1 Tt Competitions Data Collection
The data collection section includes the background of Tt Company and materials from the first to the sixth Tt Competition, covering the competition introduction, objectives, theme setting, entry assessment, and competition results. The collected data is then analysed to understand the company business strategy and how the Tt Competition is executed, as well as the results of the competition. Data collection items and content refer to Table 1.

<table>
<thead>
<tr>
<th>Item</th>
<th>Competition related</th>
<th>Company related</th>
</tr>
</thead>
</table>
| Competition objectives | 1.Competition introduction  
2.Competition governance methods explanation | 1.Business strategy  
2.Company creative strategy |
| Subject setting     | 1.Competition subject setting process  
2.Competition subjects                                           | 1.Company product lines  
2.Company product development road map                           |
| Entry assessment    | 1.Competition judging process  
2.Jury setup  
3.Judging criteria  
4.Quantity of competition entries | N/A                                                           |
| Competition outcomes| 1.Creative concept application  
2.Design proposal commercialisation | Feasibility evaluation process                            |

2.2 Interviews and Discussion
The second phase of the study comprises interviews with sponsor personnel and participants from universities. The interviews were conducted in a “semi-structured interview”. The goal of the interviews was to collect the organisers and entrants’ feedback and evaluate the competition, test existing theories in design competition management, and explore new findings. The interviewees included the CEO, project director, product manager, design manager, product designers, and marketing department manager of Tt Company, as well as the winners in the design competition. The interviewees were required to have participated in two or more creative design competitions. The interview time set for each interviewee was about 30-50 minutes. Interviewees are listed in Table 2.

The interviews were accompanied by a questionnaire, including closed- and open-ended questions to state personal opinions. The content of the questionnaire is listed in Tables 3 and 4.
### Table 2. Interviewees and their Positions

<table>
<thead>
<tr>
<th>Department</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Board of Directors</td>
<td>CEO</td>
</tr>
<tr>
<td>Project Team</td>
<td>Project Director</td>
</tr>
<tr>
<td>Creative Design Centre</td>
<td>Design Manager</td>
</tr>
<tr>
<td>Creative Design Centre</td>
<td>Senior Designer</td>
</tr>
<tr>
<td>Business Department</td>
<td>Marketing Manager</td>
</tr>
<tr>
<td>Business Department</td>
<td>Product Manager</td>
</tr>
<tr>
<td>Lunghwa University of Science and Technology</td>
<td>Winner from the entrants</td>
</tr>
<tr>
<td>Datong University</td>
<td>Winner from the entrants</td>
</tr>
<tr>
<td>Taiwan University of Science and Technology</td>
<td>Winner from the entrants</td>
</tr>
</tbody>
</table>

### Table 3. Questionnaire of Expert Interviews

#### A. Performance of design competition

<table>
<thead>
<tr>
<th>A-1 What are the objectives of the competition?</th>
<th>Public benefit</th>
<th>Brand promotion</th>
<th>User comprehension</th>
<th>New concepts</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-2 Have the objectives been achieved?</td>
<td>Public benefit</td>
<td>Brand promotion</td>
<td>User comprehension</td>
<td>New concepts</td>
<td>Other</td>
</tr>
<tr>
<td>A-3 What is your advice on how to improve the performance?</td>
<td>Demand on new product development</td>
<td>Customer demands</td>
<td>Investment cost</td>
<td>Technical advantages in R&amp;D</td>
<td>Other</td>
</tr>
</tbody>
</table>

#### B. Competition subject setting

| B-1 How is the competition subject set? | Demand on new product development | Customer demands | Investment cost | Technical advantages in R&D | Other |
| B-2 Does the competition result match the subject setting? | Demand on new product development | Customer demands | Investment cost | Technical advantages in R&D | Other |
| B-3 What is your advice on how to set the competition subjects? | | | | | |

#### C. Competition assessment

| C-1 The appropriateness of the competition judging process. | Design concept |
| C-2 The appropriateness of the jury setup. | Product market |
| C-3 The judging criteria. | Feasibility |
| C-4 Do the winners meet the expectations? | |
| C-5 What is your suggestion for the assessment? | |

#### D. Feasibility evaluation of the competition winners

| D-1 The basis of the proposals commercialisation. | Awards ranking | Demand on new product development |
| D-2 Commercialisation Evaluation content. | Design concept | Investment cost |
| D-3 Does the proposal commercialisation result meet expectations? | Technical requirements | Market demands |
| D-4 What is your suggestion for the feasibility evaluation? | | |
The following discussion is based on understanding of the collected data and comparing the feedback and suggestions from the interviews. Through analysing the relationships between planning and results of the Tt Competition, including theme setting, entry assessment, design process participation, and how to deal with competition outcomes, it is possible to learn lessons from Tt Company’s experience in holding a design competition.

3 Tt Competition’s Data Analysis

3.1 Thermaltake Company Product Innovation

The subject of this case study is Thermaltake and its creative design competition. Tt Company has the capability and experience for innovation research and development. Its Creative Design Centre is in charge of industry design. In addition to using its internal design department, the company also takes active part in cooperating with external design resources on new product design concepts and new product development projects.
Due to the wide range of products, and in order to maintain its market competitiveness, the company promotes continuous innovative product development, which needs to be nourished with a steady stream of innovative product ideas and concepts. Aside from the new product proposals from internal design departments, the company began to cooperate with BMW Designworks USA in 2009 to develop the new computer chassis, Level 10 (Figure 1). Based on this good experience of collaboration with external design resources, the company started to continuously seek new product concepts from external design resources to accelerate its innovation development and show its positive image for innovation.

![Figure 1. Computer Chassis Level 10 (Thermaltake Technology)](image)

3.2 Thermaltake Creative Design Competition Introduction

In 2012, Tt Company held the first invitational design competition, which was carried out in two universities. The initial purpose to hold the competition was for public benefit and to enhance the company’s brand image at the same time. The company also hoped to increase communication between industry and academia. As a public benefit of the design competition, the company provided design students with a platform to demonstrate their creativity and help them to understand industry practice through these competition activities.

3.3 Subjects of the Tt Competition

The subject of the Tt Competition has been adjusted annually. From the first year to the third year, the themes were defined as the best equipment for game players, and the design scope included computer chassis, power supply, CPU cooler, mobile device accessories, e-sports keyboard, gaming mice, and gaming headsets.

In the fourth and fifth years, the subject was narrowed to a single product category, gaming mouse, to align with business strategies and requirements in the gaming market. In the sixth year, the subject was related to the application of innovative products and IOT (Internet of Things), which was expected to provide new inspiration for IOT concept applications from the competition entries.

3.4 Participatory Design in Tt Competition

The participatory design in Tt Competition includes three stages: subject introduction, entry assessment, and technical seminars.

**Subject Introduction:** At the start of the competition, the organiser holds a presentation of the competition subject in each participating university. The presenters include the design supervisor, project manager, engineers, and users.

**Entry Assessment:** The Tt Competition judging process includes two stages: preliminary assessment and final assessment. The jury set-up for the preliminary assessment comes from the company’s internal professionals, including the design manager, senior product designers, product manager, and R&D engineers, which are committed according to their professional backgrounds and positions within the company. Prior to preliminary assessment, the competition organiser holds a meeting with jury members to demonstrate the competition target setting and administration rules by which the participants will be judged.

At the phase of final assessment, the objects to be judged are the prototypes of the entries. The jury set-up for the final assessment combines internal and external experts, including the CEO, design manager, and senior designers of Tt Company, as well as design professors from the Industrial Design Departments of universities and external product
designers. Before the final judging, the organiser explains the value setting of the competition and the judging criteria to the jury. The final judging is conducted through participants’ presentations and work demonstrations. The final statistical average scores of the jury decide the winners.

**Technical Seminars:** From the 100 to 200 total submissions received, 15 to 16 entries will be shortlisted for final judging. Every single shortlisted entry will be presented with prototypes or models for final assessment to decide if it will place in the competition. After the preliminary assessment, Tt Company arranges for all the shortlisted winners to visit its headquarters and participate in the technical seminars, in which Tt senior designers and engineers communicate with the participants and provide suggestions on improving their entries.

### 3.5 Winners of the Competition

Since the first Tt Competition, the company has launched two products which were developed from the concepts of the winners (Figure 2), and three entries are currently under market evaluation. If an entry is selected to be commercialised, its entrant will be invited as an intern to participate in the whole process of the design development and the commercialisation work. In order to respect the rights of the inventors, participants whose works are selected for commoditisation will be provided a prize.

Aside from commercialisation, the winning concepts and ideas can be transferred into innovation value in other ways. For example, the company established the IOT (Internet of Things) R&D Department in 2015, inspired by the winner’s idea from the third competition, and it also motivated the sixth Tt Competition subject, which was the application of innovative products and IOT.

**Figure 2. GOrb II Ball Type Laptop Cooler (Thermaltake Technology)**

### 4 Interview Data Analysis

The purpose of the interviews was to understand the execution goals, execution methods, and implementation effectiveness of each phase of the design competition and to obtain expert advice and entrant opinions on the design competition. Through the analysis of the interview content, the motivations to hold the Tt Competition are revealed, and the organisers’ and contestants’ expectations on the competition results are clearer and summarised.

#### 4.1 Competition Objectives

Through the analysis of the interview content, the company motivation to hold the Tt Competition is to provide an innovative design platform to allow design students to participate in design practices, increase their understanding of industry, and accumulate design experience with target-setting missions. Another benefit of the design competition for design students is that the contestants are the users of computer peripheral products and have rich user experience as e-sport players. They can use their creativity and enthusiasm and combine their own user experience in the design competition to create new product concepts or product improvement proposals, which will cultivate and nurture the product innovations at the company.

From the contestant side, another motivation is to improve design skill and experience in practice, as well as the hope to win. As an industry-university cooperative design competition, Tt Competition provides the contestants professional instruction from professors, designers, and industrial practitioners.

#### 4.2 Competition Subject Setting

In regard to the subjects of the competition, the expert interview data suggest that the subjects should be the product category in which the company is successful, and the subjects should meet market demands. They believe that, with
narrowly-focused subjects, the quality of design proposals submitted by the contestants is more in line with sponsor expectations. With broader innovation agendas, although the proposals are diverse, the entries lack design rationality and market demand due to the participants’ limited understanding of products and industries. With narrowly-focused subjects, the entries are easy to compare and assess their innovativeness, and jury members’ perspectives are more uniform. Also, from the marketing perspective, the data suggest that by defining the framework of technical requirements and specifications of the subjects, the winner concepts are more likely to be commercialised.

4.3 Competition Participation
From the internal product development perspective, the design proposals in conformity with the subjects and in higher degree of completeness will be selected in the preliminary assessment stage. In the final assessment stage, the human factors of engineering and technical feasibility will increase in the assessment on the design proposals.

Through the design competition briefing session, contestants can understand the competition theme, market positioning, and user experience. With the information conveyed, design surveys are conducted, and creative ideas are inspired, defined, and refined. However, the understanding of technology and the trends of market are lacking with design students. Therefore, entries of the finalists will be invited to the technical seminars coordinated by the organisers to get advice from professionals and estimate the feasibility of their work. The professionals include senior designers, engineers, and marketing and sales professionals. Entrants will get suggestions on design feasibility and human factors from designers and engineers. In addition, marketing and sales professionals will provide advice on product positioning and user expectations.

4.4 The Competition Achievements
The product manager says that, although there are a lot of innovative entries in the competitions, they lack alignment with the consumer market. Most of them are just new concepts or ideas. From the sponsor’s perspective, if the winner is selected to undergo feasibility evaluations, the market needs must be considered. The marketing evaluation, technology confirmation, and cost analysis all need to be carried out before the decision on the proposal’s commercialisation.

Another factor of feasibility evaluation is the market analysis, including market size, market demands, and user acceptance. The Tt Company CEO suggests that participants should make a preliminary analysis of their entries’ market and user behaviours, and the entries submitted should comply with the company’s existing product lines that have precise marketing positioning to lower market risk. The marketing manager describes the phenomenon of the commercialised winners gaining attention in the market due to the winners’ creative concepts. However, the products do not have good sales return because the products cannot meet the functional requirements.

From the design students’ side, to obtain the suggestions on product design practices in the concept exploration phase, is not only helpful for concept development, but also for design development by improving feasibility with advice from engineering and marketing professionals.

The Tt Competition’s assessment process is different from other competitions. The jury also provides their suggestions of design integrity on the design proposal and tips for the presentation. For students, the whole competition process is a project-based practice experience.

5 Discussion

5.1 Participation in Design Competition Subject Setting and Effect
In the first three sessions of the Tt Competition, the subjects were broader for the original goals setting of the competition, which were public benefit and brand image promotion. Two winners were selected to be commercialised and transferred into new products launching in the market, resulting in attention in the market, but not a good sales return. The Gold Award in the third competition was a concept in IOT, which motivated Tt Company to establish a new department in 2015, the IOT R&D Department. Although the winning innovators under the broader subjects could not be successfully developed into new products, they may be applied to a new product line or market.

With the competition development, participatory design methodology is more and more applied in its process. This change has shaped the competition subjects from broader new concept design to narrowly-focused product design based on the company’s innovative development strategies. With the subjects becoming more narrowly focused since the fourth competition, the participants are poised for in-depth exploration of user experience and behaviours. For
example, there were three new concepts from the users’ point of view in the fourth competition, and one of them was a woman’s perspective, which enlightened the company to evaluate the market demand of this customer group. These creativities are more likely to be feasible based on the company’s existing product lines and more likely to accelerate the company’s new product development.

5.2 Participation in Design Competition Governance and Effects
The methodology of participatory design of the Tt Competition correspond to Spinuzzi’s (2005) three basic stages: (1) Initial exploration of work; (2) Discovery processes; and (3) Prototyping. Tt Company holds brief sessions at the beginning of the competition to introduce the design subjects, its marketing position, and the collected user experience, to let contest participants know the proposed users as much as possible.

In order to constantly exchange design ideas and stimulate each other, the competition assessment is carried out in two phrases. The preliminary assessment is to filter the proposals with internal experts from different departments using their professional background in products and industries. Before the final assessment, technical seminars are held for finalists to get technical support and suggestions on their entries’ feasibility and improvement from the company’s designers, engineers, and marketing professionals.

At the final assessment stage, in addition to the final briefings, design prototypes are produced by the finalists and sponsored by the company as a necessary condition to make the innovative design concept complete, allowing the review committee to have specific communication with the participants.

Different from a general design competition, the Tt Competition provides subject introduction at the beginning, and technical seminars after preliminary assessment for top participants to get technical support and suggestions on the entries’ feasibility and improvement from the company’s designers, engineers, and marketing professionals. Also, the jury provides feedback on the participants’ proposals in the final assessment. As a collaboration-orientated competition, the design proposal development phase starts from the technical seminars, not after the winners are revealed, which is also beneficial to the company for design proposal feasibility. On the other hand, these technical seminars have another important value for entrants. They benefit from education and professional development, and even have a chance to develop the entries into a product. With a mix of benefits, the promotion of a participatory design competition can be sustained, and it can increase the willingness of external resources to participate.

5.3 Participation in Design Competition Evaluation
Proposals from the design competition are different from internal design proposals in regard to professional industrial background, time cost, and design orientation. The time spent on assessment is much shorter than the time spent on assessing the company’s new product development.

In general, the internal new product development is based on the company’s existing and familiar product lines, which have enough market research and technology support, but the creative concepts raised in the competition may be a totally new field for the company, which requires cost in regard to market research and investment evaluation. This means that the feasibility evaluation of winner commercialisation comes after the competition assessment. Therefore, the winning proposals alone cannot determine if the products will be commercialised.

As a participatory design project, the design competition is part of the research phase. Completed with the development phase, this innovation resource can be transferred to valuable innovation output. For the participating students, the complete and multi-faceted expert advice helps to understand the role of the designer in the design project, how to cooperate with the relevant personnel to complete a creative design, and how to implement innovative design from the corporate practice perspective.

6 Conclusion
In summary, if certain guidelines and requirements are met, a participatory design competition is a benefit for the organiser and the participants. Below are a few highlights of the findings from this case study.

1. Through holding design competitions, enterprises can integrate external and internal participatory cooperation results into innovative value. However, since the design competition focuses on the idea or solution search phase, these external design resources cannot be effectively transferred to innovation values without the development phase. Through the study and analysis of the Tt Creative Design Competition used as
participatory design, the competition subjects need to be transferred thoroughly through subject introduction, based on a company’s strategies, in line with the existing product lines or the innovative product line under planning.

2. A sponsor participating in a design competition needs to define the theme of the competition, but it should avoid limiting the design concepts. In order to not interfere with the design concepts, the design seminar should be held after the initial entries are reviewed. During the seminar, the feasibility and market-side recommendations are helpful for the design proposal.

3. The technical seminars after the first assessment stage provide participants technical support, which reflects collaboration and mixed-goods benefits for public and private entities. Through the design competition, Tt Company benefits from increased brand awareness and external design resources, while the design students benefit from design practice and education.

4. In line with a company’s strategies and with complete planning and execution, serialised design competitions can be an effective innovation method for enterprises to search for new concepts. In addition, through participatory activities, students can understand the innovation strategy of the company and gain familiarity with the context of the consumer market and submit a more suitable design.

In general, the Tt Creative Design Competition is a good example with its principle of integrating internal and external resources and mutual benefits, ensuring that the competition is ongoing.

From this study, there are many points worthy of further in-depth analysis in design competitions used as an open innovation method. For example, how to enhance the innovation value of design competitions is a worthwhile research direction. As Don Norman (2010) says, "We should have contests, but we should do them properly."

References


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Section 2

Educational Milieu
Tacit Learning in an Extended Interior Design Studio

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Abstract: Tacit knowledge, an important component of design is widely researched. However, its acquisition in design education still remains unclear. Its difficulty in transference and articulation suggests that it is constructed and thereafter internalized by the student. The social environment of the design studio scaffolds and further shapes the acquisition of tacit knowledge. But as the boundaries of the physical studio are extending to the virtual, how this extension facilitates the acquisition of tacit knowledge is the aim of this study. Constructivist theories are applied to study the above in the Environment and Interior Design programme at the School of Design, The Hong Kong Polytechnic University. Methods of data collection were focus group interviews and studio observations. Participants in the study include students and tutors in various years of the programme.

Keywords: tacit learning; constructivism; blended studio environments; extended interior design studio

1 Introduction

Studies in design education are sites for experimentation, application of knowledge as well as act as simulations for the real-world design practice. The active and dynamic nature of the studio also facilitates the acquisition of tacit knowledge, an important component of design (Schön, 1985). Aesthetics, intuition, spatial perception, problem-solving, and sensibilities that are considered examples of tacit knowledge in design are difficult to transfer compared to explicit forms of knowledge. Tacit knowledge is instead constructed by the student, facilitated by the tutors and the interactions in the studio, a characteristic of the studio learning pedagogy.

Adoption of online platforms to support tacit learning gains prominence as it affords access to knowledge beyond the studio, thereby impacting learning behaviour. Though a lot of e-learning subjects allow for the learning to extend, online learning such as a Learning Management system is seldom used in design schools because of the inefficiency of the platform (Ma and Chan, 2016). This paper documents the findings of an empirical research done in the interior design studio by using constructivist educational theories to study the acquisition of tacit learning. An objective is to study the potential of using blended learning for tacit knowledge construction. Blended learning in this study refers to combination of physical, digital and online environments as well as social media environments that also serve as
learning environments. How blended learning helps in extending tacit knowledge construction from the physical to the virtual is the aim of this study.

2 Literature Review

2.1 Tacit Learning

2.1.1 Definitions and Theorizations

Wong and Radcliffe (2000) attempt to gather various definitions of tacit knowledge which may be summarized using the following words: implicit, non-verbal, inarticulate, uncodified, intuitive, embodied, unexplained, and knowledge that is difficult to transfer (p. 494).

Michael Polanyi’s frequently cited definition that “we know more than we can tell” (1966, p. 4) suggests a difficulty in communicating certain types of knowledge termed as tacit. Though such knowledge can be demonstrated, it relies on the learner’s ability to catch the meaning of the demonstration (p. 5). Polanyi mentions the concept of indwelling where the tacit is embodied and interiorized within the knower (p. 16). He further argues that the indeterminacy of problem-solving is based on the concept of indwelling, and not on positivist philosophies.

Drawing from Polanyi’s concept, Donald Schön (1985) questions the application of technical rationality in teaching artistry in architectural education. Acquisition of artistry is difficult to describe because according to him:

Our knowing is ordinarily tacit, implicit in our patterns of action and in our feel for the stuff with which we are dealing. It seems right to say that our knowing is in our action (Schön, 1985, p. 21).

When design practitioners encounter surprises in the act of problem-solving, it triggers the process of ‘reflection-in-action’ (p. 23) which explicates their ‘tacit-knowing-in-action’ (p. 21).

Schön cites the unique setting of the architectural studio to formulate his theory, where the studio master and student engage in a “reflective conversation with the situation” (1985, p. 26) resulting in reframing of the problem. The studio master uses the design language to demonstrate the act of designing through a web of moves (p. 52).

2.1.1 Explicit Knowledge

Explicit knowledge is regarded as knowledge that is effable, articulable, communicable, transmittable, static, and a manifestation of tacit knowledge (Wong & Radcliffe, 2000; Koskinen et al., 2003; Schindler, 2015). Wong & Radcliffe (2000) argue that design knowledge has elements of the tacit and the explicit that are intertwined or can lie in varying degrees of a spectrum. They identify the need to access tacit knowledge in order to apply explicit knowledge.

The discourse on tacit knowledge has also gained prominence in organizational studies. Nonaka and Takeuchi’s widely applied SECI model identifies the models of knowledge conversion from the tacit to the explicit as: 1. Socialization - tacit to tacit, 2. Externalization -tacit to explicit, 3. Combination -explicit to explicit, and 4. Internalization -explicit to tacit (Adloff, Gerund and Kaldewey, 2014, pp. 10-11). New knowledge is constantly created in this dynamic conversion process.

2.1.1 Cognitive and Social Dimensions

Central to the notion that tacit knowledge is individualistic and internalized is the role of the body, from which we come to experience a situation (Polanyi, 1966, p. 15). When the experience is embodied, the sensory systems, emotions and motivations produce conceptual and perceptual representations of the situation (Ignatow, 2007, pp. 120-121). Due to the subjectivity of the experience and its representations, the verbalization of sensuous knowledge is limited (Schindler, 2015, p. 17). From a cognitive perspective, new learning occurs when the mental representations are constantly changed due to environmental affects (Koskinen et al., 2003, p. 283).

Mareis (2012) observes that emphasis on tacit knowledge as an innate ability of designers overlooks its socio-cultural dimension. She refers to sociologist, Pierre Bourdieu’s concept of habitus which refers to a structure of sensibilities, dispositions or tastes that are ingrained in an individual gained through collective experience and determined by existing social or cultural conditions. (p. 69). Loenhoff (2014) states that tacit knowledge is collective, differentiated and context-specific. It is “socially shared, because it is the result of agents’ successfully coordinated and co-produced action” (p. 25).
Koskinen et. al (2003) have explored kinds of social engagements that provide tacit knowledge acquisition in a project work context. They conclude that trust, language, corporeality, face-to-face interaction, situation and context are factors that affect, facilitate or enhance acquisition and sharing of tacit knowledge.

### 2.1.2 Online Applications

Yi (2006) studied the externalization of tacit knowledge to online environments by analysing online course management data. Findings reveal that while knowledge in the physical environment is externalized through learning by doing, sharing of experiences is most effective in online environments. Sharing in the form of story-telling and metaphors generates new mental models and new knowledge (2006, p. 670). Another example is where Ma and Chan (2016) investigate the effectiveness of an eLearning platform in the blended learning approach of project-based subjects. The utilization of discussion boards in the projects allowed students to broaden their knowledge through sharing, exchange and debate of ideas. Self-reflective blogs that facilitated the reflection of students’ learning process may have also aided in explicating tacit learning. Their research is based on Kolb’s Cycle of Experiential Learning.

Building on social constructivist theories, Oztok (2013) explores the potential of online learning for leveraging the tacit knowledge of individuals in a community that could provide opportunities for situated learning. He reasons that by sharing knowledge, experiences, as well as values and beliefs, individuals develop an identity and a sense of belonging to the community. He proposes the utilization of tacit knowledge through the concept of social capital that contributes towards bridging, bonding, and making meaningful collaborations amongst the members (Oztok, 2013, p. 31).

### 2.2 Knowledge Construction

#### 2.2.1 Definition and Perspectives

According to constructivist theory, knowledge and meanings are constructed from the interpretation of experiences, reality is constructed through the interactions of people and their world in a social context and that these constructions change with new experiences and in new situations (Mertens, 2010; Guba & Lincoln in Denzin & Lincoln, 2005).

From a cognitive perspective, construction of knowledge is an internal activity in the mind of the learner. In Jean Piaget’s model, experiences that are interpreted are either adapted or altered to pre-existing schemas. Schemas, meanings and world-views are unique to an individual (Fosnot & Perry, 2005).

Seymour Papert’s theory of constructionism focuses on the contextuality and the dynamics of change in constructing knowledge structures (1980). Considered to be a pioneer in Artificial Intelligence, Papert regards computational environments as new ways of thinking, learning and interacting.

Well-known socio-cultural perspectives of constructivism such as Vygotsky’s Zone of Proximal Development and Bruner’s Scaffolding theory highlight the effect of social interactions on learning (Fosnot & Perry, 2005). Knowledge that is co-constructed in a social process is contextually situated in the learning environment (Kurt, 2011).

The following are the conditions of constructivism outlined by Driscoll (2005, pp. 393-402):

- Embed learning in complex, realistic and relevant environments – dealing with ill-structured problems and in multiple contexts
- Provide for social negotiation as an integral part of learning – communication and collaborating in learning using computer technologies
- Support multiple perspectives and multiple modes of representation – using hypermedia to provide a flexible knowledge base through multiple sensory modes
- Encourage ownership in learning - students are active producers of their knowledge, teachers act as facilitators and guides
- Nurture self-awareness in the knowledge construction process – reflexivity as an attitude helps students to be critically aware and defend their beliefs that helps them understand multiple perspectives

#### 2.2.2 Online and Digital Applications

Driscoll (2005) is convinced that the use of online and software systems can empower a constructivist learning environment (p. 404). Similarly, Kurt (2011) promotes the intense use of digital technologies such as databases, virtual...
Aruna VENKATESH, Henry MA

realities and the internet to foster a student-oriented approach in an architectural studio. She further proposes a hybridization of “traditional and constructivist attitudes in studio environment” (p. 3983).

The relationship between the constructivist educational theory and tacit acquisition was studied by Andjomshoaa, Islami and Mokhtabad-Amrei (2011). They empirically tested constructivist applications in an architectural studio project by utilizing computer-aided design. The incorporation of computer-aided design in all stages of the design process aided the construction of more meaningful learning and deeper understanding (p. 221). In turn this led to the retention of knowledge for a longer time resulting in the generation of tacit knowledge (Andjomshoaa et al. 2011).

To summarize the literature review, the embodiment and internalization of tacit knowledge is effectuated by social interactions and collective sharing of experiences. The social aspect of tacit learning also has a bearing on stimulating its cognitive aspects. Since tacit knowledge cannot be taught it is constructed through the act of doing, which also explicates the tacit. But it must be emphasized that tacit knowledge is co-constructed in a social process which is then internalized by the student. It therefore includes both the act of doing as well as sharing of experiences. Online platforms and social media can broaden the sharing of experiences beyond the physical boundaries of the studio.

2.3 Conceptual Framework
A conceptual framework was developed based on the literature review which also serves as criteria for the facilitation of tacit knowledge construction in a studio:

- Learning by doing – knowing how to design through the act of design
- Explicating the learning – demonstration of knowledge through representing in different media
- Cognitive skills – generation of new mental models through multiple sensory modes and exposure to multiple perspectives and representations
- Sharing experiences – collaborating and critically reflecting other experiences to generate new understanding and sensibilities
- Situated learning – learning in a context and co-constructed in communities of practice

Figure 1. Conceptual framework

2.4 Research Question
Therefore, the research question developed through the literature review which the study attempts to answer is:

How can a physical interior design studio that facilitates tacit knowledge construction be extended to online and social learning platforms?

3 Research Design
The qualitative study was conducted using six focus groups in the Environment and Interior Design programme of the School of Design, The Hong Kong Polytechnic University. A focus group comprised of 2-3 students. Year 2 students and Year 4 students and their respective tutors were observed and interviewed in two design projects as part of the studio
subjects. The Year 2 project required students to research and submit a proposal for an existing site in Hong Kong. The Year 4 project was a Capstone research project. Observations were also conducted by being members of social media groups organized by the tutors. Audio and visual recording was used after obtaining the consent of the participants. The transcribed data was initially analysed using the conceptual framework. Names of participants have been altered to maintain privacy.

4 Findings and Discussion

4.1 Students Actively Construct Tacit Knowledge Through an Experiential Learning Process

Intrinsically, the tacit and explicit components are interwoven in the act of design. Whether these acts require the physicality of the studio is a point of discussion. Studio observations reveal that issues of designing brought up during desk reviews are often resolved through the physical acts of sketching and modelling (Figure 2, Left). Students expressed this preferred way of discussing their design with the tutor, concurrent with Schön’s explanation on design moves. Tutor Paul finds a “physical confrontation” more exciting. A case in point was when he made Year 2 students participate in a studio workshop to finalize their design proposal (Figure 2, Right). Both students and the tutor found this method successful after having failed through verbal and textual feedback in the desk review. The act of designing then requires the physical setting to provoke a spatial design conversation mediated by design representations.

Tutor Cory opines that, “teaching tacit knowledge digitally and the level of physical specificity required for critique is unlikely to translate well digitally”. But he adds that digital reviews are possible if students have the cognitive maturity to visualize the design by having a foundation of physical design. It implies that when students can visualize and conceptualize their design, they can also participate in online design conversations.

More than the act of doing, it is the engagement in an experiential learning process in either the physical and online setting that constructs tacit knowledge.

4.2 Cognitive and Sensory Experience May Not Be Easily Replicated in an Online Studio

Though the use on online platforms for desk reviews is not new, tutor Lloyd expresses his frustration over the limitations of the screen to demonstrate spatial understanding through drawings. In his words:

If a student sits in front of you and draws a line and I draw over it and by looking at the same drawing we come to a different realization that can have another application then in the end no online platform will be actually able to explicate that.

The connection between the hand and cognitive development has been well-researched on. Suwa, Gero & Purcell (2000) add that sketching can lead to new conceptual discoveries. Encountering with the visuo-spatiality of illustrations can trigger the tacit knowledge of an architect (Suwa et al. 2000, p. 562). The pedagogical implications are that the studio environment has to allow for such encounters to happen. The tutor’s knowledge and expertise are articulated in the encounters.
Likewise, tutors in design projects emphasize to students the need to explore new learning possibilities through the medium of modelling. Models are not only translators of students’ spatial ideas but also provide the haptic engagement with material and form, emphasizing the aspect of learning by doing. Seen as a craft, it is a source of experiential and emotional knowledge that develops material sensibilities, haptic perceptions and human values (Niedderer and Townsend, 2014).

Conversely, Andjomshoaa et al. (2011) argue that computer-aided modelling tools and simulations encourage students to develop spatial abilities as well as evaluate their spatial designs through multiple viewpoints (p. 221). It promotes critical discourses of their work resulting in efficacy of learning (Andjomshoaa et al. 2011). Nevertheless, the use of simulations in early stages of design is questionable as it privileges simulation over abstraction (Ambrose, 2012), having cognitive consequences.

According to tutor Yao, the virtual environment cannot replace the spatial and material experience and understanding provided by the physical studio. However, tutor Jackie envisages that the future of spatial designers would lie in their unique ability to blend handcrafting skills with powerful computer visualizations. An overlap of the physical and digital can lead to newer ways of understanding and constructing tacit knowledge.

Cognitive and sensory stimuli activated through the physical environment in the studio play an important part in tacit acquisition of design knowledge. While the digital media may be easily adopted into online studios, the physical interactive experiences may not be replicated on an online studio.

4.3 Misconceptions and Reluctance in Using Online and Social Media Platforms

4.4.1 Online Platforms

Student Rachel realized that discussions in the physical studio opened new opportunities for discussions about her thought process. This was not afforded by online platforms like Skype as she had to structure her discussions to suit a certain purpose of design review. Some students found Skype discussions distracted them from having clear and focused arguments as they tend to open multiple tabs while discussing.

The use of websites such as YouTube and Google are frequently used by students and tutors as referencing tools. Tutors however do not consider them as learning platforms. Tutor Cory is considering the use of web-streaming to let students observe his research work. This could expand students’ understanding of real-world practices.

Tutor Lloyd asserts that critical thinking that is developed from hearing, comparing and understanding discussions of analysis, and that synthesis cannot be learnt in an online system. On the other hand, tutors do not use platforms such as the existing Blackboard Learning Management System because students seldom access them, preferring the faster interface of Whatsapp.

4.4.2 Social Media

Motivation that leads to an active construction of knowledge (Ma & Chan, 2016) is in turn mediated by the participatory learning environment of the studio. Social media groups formed by tutors and students already find their presence in the milieu of the studio. Instagram and Facebook are often used for disseminating or promoting students’ works whereas WhatsApp groups are for scheduling meeting. It was also observed that social media was used for casual and not critical discussions.

Most students and tutors commented that texting often resulted in misinterpretation and misunderstanding of thoughts, ideas and feedback. Delay in replying also affected the quality of discussions. As mentioned in chapter 4.1, students prefer a face to face discussion of drawing and modelling-related issues as the tutor is able to quickly demonstrate the fixing of these issues. Students are thus able to observe the tutors’ reflection-in-action. Likewise, student Ben finds that the use of social media is restricted to solving simple problems and not suitable for conceptual problems.

Students in an Y2 focus group mentioned their reluctance in arguing among peers in larger groups organized by the tutors. This is indicitive of a cultural influence especially relevant in Asia. Y4 students revealed that sometimes they value their classmates’ opinions more through critical discussions that take place beyond studio hours in either the physical studio or social media groups. These informal settings organized by students themselves were not accessible for observation.
Unfamiliarity or lack of technological resources could be some of the reasons for misconceptions and reluctance to use the above platforms. For example, collaborative online drawing software used along with instant messaging or with video conferencing can extend critical and participatory discussions to an online studio.

5 Conclusion

Construction of tacit knowledge though an internalized process is facilitated by dynamic interactions in the studio. Evidence shows that the physicality of the studio offers engagement in spatial design conversations through the tangible and tactile act of engaging in sensory and embodied experiences, and development of cognitive skills. On the other hand, digital interfaces provide new dimensions to learning by doing by providing a different interactive experience through digital artefacts. Blending of the physical and digital offers multiplicity of experiences required for tacit knowledge construction. Conversations can be extended to online platforms depending upon the cognitive maturity of students.

Though evidence reveals that not all of the physical experiences can be replicated in an online studio, it offers readily available platforms for critical discussions and networked collaborations even across various design communities. The social media facilitated by tutors or initiated by students provides easier access and alternative platforms for prolonging these discussions beyond the physical studio. Currently these resources are not being used for critical discussions owing to their perception as sites for casual conversations.

Collaborations at a multiple level not only add to the repertoire of students’ knowledge but also broaden their knowledge base (Ma & Chan, 2016). In particular, they strengthen critical reflective skills which are crucial in the tacit learning process. Sharing of knowledge that is explicated online and through social media may be converted into knowledge artefacts that are time-stamped, easily accessible, retrievable and available at all times.

This study is limited in that it covered only two projects and a limited number of participants conducted mainly in a physical studio environment and a few social media groups. But it offers insights into how tacit learning may be extended from the physical to online platforms by using a blended approach. The blending of both the environments in the experiential cycle of learning enhances tacit knowledge construction. As an attempt to answer the research question, Figure 3 proposes a framework that can help extend learning from the physical to the online environment.

Technologies such as augmented and virtual realities that have been not been mentioned in this study are already creating new frontiers in the learning and designing of interior environments. Secondly, interior spaces and activities are increasingly taking place in the virtual. Thus the implications of these frontiers bring into question the redefinition of interior space.
In the future, the capitalization of such technologies and newly developed haptic interfaces can develop new kinds of cognitive skills for spatial understanding. Along with the potential of the online to extend the social dimension of the studio, it serves to enhance the acquisition of tacit learning in the design studio through newer forms of understandings and discussions.

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References
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Abstract: Little is known about how design learners experience competence development in alternative, hybrid design studios. The research reported here explored the development of learners’ competences in distance design education in a longitudinal qualitative study. Learner biographies were recorded through repeated interviews and analysed using a narrative, grounded theory approach. The paper discusses emergent themes such as phases in development, roles of learner autonomy and learning groups, crisis situations, and expert dialogue. It presents the hybrid studio as an intersection of internal and external factors in distance design learning. The paper goes on to suggest a taxonomy of virtual design learning, teaching, and educational theory that may aid educators in the design of hybrid design learning spaces. It suggests a design didactic concept that combines the theories of creative processes with the media didactic contexts of a development-centred design pedagogy. The work concludes with the proposition that study programmes should be developed based on competence and personality. This experience-centred didactic is a prerequisite for the success of digitised educational systems.

Keywords: virtualisation; design didactics; hybrid studios

1 Introduction

In the educational biographies of designers, there are a multitude of key moments that leave their mark on the self-concept of the designer and thus on the styles of their designs. One such key moment for many designers is the first crossing of the threshold into the Art Academy after passing the entrance examination and the architectural impression of the university building. Project discussions with lecturers in the workshop or in the studio are further moments that have deep effects on designers.

But what are comparable moments of such threshold experiences for design students in a virtual setting? How does the creative learning process change when designers study at a distance? Has the creative process as such changed under a virtual framework?

The German educational landscape in the design sector is still characterised by classical studio learning. Teachers and learners come together in the physical framework of a university. In most cases, training is provided towards a practice-oriented bachelor’s degree.
The didactic principles of design education lead to learners’ personal development beyond technical and artistic competencies. This multidimensional pedagogical goal is expressed in the German term Gestalterpersönlichkeit (best translated as design personality). This personal development is the basic idea behind the courses offered at German design universities. Thus, the educational challenge of design teaching is to develop learners at a personal level in parallel to developing the creative repertoire of the learner. In this respect, developing the designers’ design actions is an essential goal of German study programmes.

In contrast to the traditional design education settings, distance learning in design is a small niche in Germany and offers design education to a smaller group of atypical students. But we don’t know how the Gestalterpersönlichkeit develops in these programs. For the first time in history, it is possible to observe whether and how competence development and personal development takes place in a virtual design learning environment.

This has led to the following research questions:

- What are the internal (intended by the curriculum), external (informal as well as self-study) factors that influence design competence development in virtual design education?
- What specific requirements does hybridisation of physical and virtual learning spaces bring to design didactics in part-time design studies?

The following sections describe a qualitative study that has been carried out to address the above questions on personal development and development of competencies of distance design learners in Germany. The findings contribute to our understanding of the impact of alternative studios on design competence development.

2 Methodology

2.1 Setting

The setting for this research was the Diploma University in Germany. The Diploma University was created in 1994 as a distance learning university in Germany, where the principle of distance learning represented a core concept of teaching and learning for more than 20 years. Since 2012, students have been taught digitally using a blended learning model. Currently, 800 students study Graphic Design (BA) and Creative Direction: Management in the Context of Creative Processes (MA) in the Department of Design. The bachelor’s program in graphic design is offered both face-to-face and virtually; the master’s program in creative direction is offered exclusively through a virtual model.

The virtual courses at Diploma University are delivered synchronously. Presentations or lectures are transmitted in real time. Learners contribute to discussions and can get directly involved, ask questions, comment, discuss, and collaborate. In self-study mode, study books and video tutorials replace the classic lecture, while project work is the central teaching format in any mode. Teacher–student contact time comprises about 20–30 percent of their study hours; contact usually happens in virtual lectures and seminars on Saturdays and evenings.

2.2 Data Collection and Analysis

Since 2015, guideline-based interviews have been conducted within the framework of evaluation research in the bachelor’s degree course in Graphic Design at Diploma University, and since 2016 in the master’s degree course in Creative Direction as well.

1 The aim of the course of study is to prepare the student for a professional field of activity and to impart to them the necessary specialist knowledge, skills, and methods for the respective course of study in such a way as to enable them to carry out scientific or artistic work and to act responsibly in a free, democratic, and social state governed by the rule of law’ (Framework Act for Higher Education, published 19 January 1999, (BGBl. I, 18), last amended by Article 2 of the Act of 12 April 2007 (BGBl. I, 506); § 7).

2 This atypical group of students who are not of the classic type, defined as “between 19 and 24 years old, Abitur, childless, coming from Germany and studying full-time in attendance” (Jens, Müller & Röwert 2017, p. 7) accounts for 6.7 percent of students studying at a private university in the winter semester 2014/2015. Within this group, the field in question represents a group of a maximum of 1,000 persons. This niche is filled by private providers with distance learning models tailored to the needs and opportunities of professionals, persons with family responsibilities, and other people with a desire for qualifications and a professional or family background. The providers surveyed solved the profile of part-time study with a significantly high proportion of self-study, in which study books and video tutorials replace the classic lecture and project work is the central teaching format. A small part of 20 percent of the total workload time is added to the contact times in the form of virtual lectures with the Adobe Connect software on Saturdays and evenings.
A qualitative methodology was used to answer the research questions. Interviews investigated the effects of the curricular and didactic environment of the then-new virtual design study on the personal development of novice designers. Using a biographical survey approach, the evaluation research sought insights for the optimisation of the study program. Since these biographical conversations could be used to develop concepts beyond evaluation in an educational-theoretical sense, the interviews became the doctoral research project "Virtualised distance learning in design disciplines".

Figure 1 shows a graphical overview of the research process. Narrative data from guideline interviews (Mayring, 1999) were collected from 18 informants in 30 encounters during their studies. The recordings of the conversations were transcribed literally according to uniform rules and evaluated using qualitative content analysis with the aid of the MAXQDA software (MAXQDA 2017). The main analytical approach was that of condensation. In the research style of grounded theory (Strauss, 1998), the narrative interviews were evaluated and examined for the concepts of design actions. Codes were developed from implicit concepts in the informants’ utterances. The development of personality cannot be investigated through direct questions. The students merely notice changes in their patterns of perception and action. Therefore, the study looks for changes in internal and external behaviour that are reflected in the biographical reports. Additional memos with first reflections and between-the-lines observations were recorded for each individual appointment.

To triangulate the findings, we asked two other universities with comparable degree programmes for interview partners. The Open University in the United Kingdom was one partner. Interviews with seven participants from the Design & Innovation programme at the Open University were conducted in 2019. This program is structurally comparable and offers the possibility of a counter position in theory building.

3. Findings

_We’re all sitting in our little bubble. The other fellow students aren’t in my life and vice versa._
(Transcript 4-1, par. 5)

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3 An overview of the informant structure can be found in Appendix 1.
In this quotation, the general distance and isolation of the students can be read. The observations are essentially concerned with how the students perceive this isolation and utilise it to inform their designing.

3.1 Phases in Virtual Design Learning

Different phases of competence and personal developments can be seen in the first three years of study.

3.1.1 Initial Study Phase

The nature of distance learning makes it necessary to rededicate times and spaces for learning that were previously used primarily for family and private purposes. In this sequence of spatial and communicative changes in the student’s environment, a status passage arises. In this status passage, the students acquire their new role as students through a high level of personal activity. This is a distinction from traditional study systems in which the status passage is assigned via external symbols such as award acts, celebrations, or other initiation rites.

...about 25, just over 25 years ago, I started a degree course in a bricks and mortar university. But I didn’t finish it. And so, I felt that I would like to go back, and I was, ja, still in design. (Transcript 17-1, par. 6)

In this phase, the students gain a self-concept as students. This process is a communicative and symbolic challenge due to the heterogeneity of the study groups. Students with hardly comparable professional backgrounds and study motives, as well as age, meet each other and have to form a group identity.

Table 1. Dimensions of the identity construction of learning actions in design distance learning

<table>
<thead>
<tr>
<th>Condition</th>
<th>Interaction</th>
<th>Tactics</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>There is a mutual interest within the virtual learning group.</td>
<td>Members exchange and acknowledge developments that influence their mutual images.</td>
<td>Works are made visible and a reciprocal registration of ideas can be observed.</td>
<td>There is solidarity among the group. The learners become part of a virtual community.</td>
</tr>
</tbody>
</table>

At this point, the distance of the study proves to be an opportunity. The learners contact each other through the visualisation of their work using digital media. So, they get to know each other independently of the traditional social processes through a subject-specific exchange. In this way, learners become part of a “community of practice” (Wenger, 1998, p. 19). Here, a high level of individual activity can be observed, because this integration is largely achieved through media visibility. The heterogeneity of the group, together with the differentiated inner professional exchange, brings about the first social benefit, about which many informants express their surprise:

...people felt they’re not [the only ones] doing it in their bedroom—other people are doing it, and just a sense of camaraderie sort of thing, that we’re all in the same boat. You can then recognise people on the forum and put a face to a name. (Transcript 20-1, par. 46)

Relevant in this status passage is the contrasting ambition towards design studies: on the one hand, the cold ambition is noticeable in the reports, in which students primarily strive towards a qualification. On the other hand, a warm ambition is visible, which is more driven by emotional motives of self-realisation.

The progression and complexity crisis falls in the first year of studies. The concept of crisis takes on an important second meaning in this research. At the centre of a conception of the creative process, crisis is an experience of rupture ‘at which movements break in or out and something new opens up’ (Waldenfels, 2002, p. 239). This newness is an artistic response and thus a reaction to the initially passive exposure to this experience. In this sense, crises are a necessary prerequisite for the creative development of learners. Here, too, it can be seen that design learning at a distance depends on a high level of activity and learners’ ability to structure design activity themselves; students are often on their own when it comes to creative questions. Due to being geographically distant from the instructors, students are forced to base their designs on their own creative decisions. Their ideas must be visualised so that they

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4 The process of group formation becomes an important criterion for the social development of the creative repertoire in the following two academic years.

5 In agreement with the research on the non-design introductory phase of studies.

6 Κρίση, the ancient Greek word for decision.
can be discussed with a lecturer or fellow students. Due to this isolation, an important first creative competence is created.

3.1.2 Second Academic Year
In the phase of the second academic year, the cold ambition focused on gaining the university degree is not sufficient to motivate a student for a part-time course of study. To counteract this, students create a warm ambition of ideological significance to continue to meet the study requirements and to pursue their studies further. This change in mentality goes hand in hand with the crisis of progression and complexity. The students are confronted with an increasing creative challenge. In their second year of study, they can no longer meet these increased demands with just their intuition; they have to take other paths.

This experience of tension creates a break in the self-concept formed in the first year of study (Bosse & Trautwein 2014, p. 49) and represents the second major crisis after the first year of study.7 This crisis is necessary to enable the reconstruction of identity; the students find new solutions for creative problems through this crisis, which results in an extension of creative-solution competence and thus an extension of the creative repertoire.

In the perception of the students, this new construction of identity runs parallel with the creative and formal-aesthetic extension of competence. Here, too, we can see the scheme of an extension of competence resulting from the self-organisation of learning. It should be emphasised that the experience of an ideological significance is the trigger for this personal development. The ability to self-reflect thus becomes the central concept of creative distance learning.

3.1.3 Third Academic Year
The experience of meaning as a result of crises is also evident in the third year of studies. Due to the renewed increase in design complexity, students are confronted with a further need for adaptation. In addition to the internal complexity of coordinating design projects with several people and across disciplines, a new challenge arises. This tension arises from questioning the designer’s identity. In the final year of the course, students ask themselves whether and to what extent the project topics coincide with their self-concept, which they have acquired in the meantime.

What is relevant here is that the phase of undirected creativity and the unconscious creative phases (Dewey, 1998, p. 41) play a role in the third development crisis.8 The fit between the self-image and the works created is critical. Practical relevance plays a role here, as well as the simple question “Is it good enough?”. The learners negotiate these subjective areas of tension in the self-organisation of their learning. The students compare the professional applicability of the learning content with the adaptation to their self-image as designers that has been constructed over the course of the previous two years. The response to this need for development is perceived as self-care. In the following section, this is described as expansive learning (Holzkamp, 1992, p. 8). This special form of design learning is highly autonomous.

3.2 Need for Expert Dialogue

So…I would like to be told by someone who has been doing this for a long time, “Watch out, graphic artists do it this way and that!” (Transcript 8-1, par. 30)

It is the nature of distance education that the competences acquired in self-study are afflicted with uncertainty. Students want to reduce this uncertainty in their own learning within the institutional framework and this is achieved through dialogue with teachers.

Students evaluate the media for dialogue according to how helpful it is for their design projects. Students find conversations with teachers and fellow students particularly helpful. The more specifically the learning media resolves design questions, the more relevant the students consider the respective learning medium to be. From this finding, it can be interpreted that the creative action itself is the centre of the acquisition of inner professional competences—thus, individual reflection and own activity are decisive in the dialogical negotiation of relevance.

7 This “first-semester crisis” coincides with findings from other departments and is a typical “complexity crisis”, according to Bosse and Trautwein, 2014, p. 49.
8 This connection coincides with the concepts of the creative process, which emphasises the central role of the unconscious in the creative process through concepts such as diastasis.
The comparison between classroom teaching and virtual distance learning in design disciplines reveals a further difference. The dialectic between intuition and methodology, which has been established in design didactics since the Bauhaus era (Itten, 1931, as quoted in Buchholz & Theinert, 2007, p. 74), is also evident in these self-organised distance-educational processes. Interesting are observations of how the experience of meaning and the unconscious part of creative processes are used in passivity to produce ideas appropriate to the respective self-image of the learners. In this crucial creative phase, students retreat inward, a behaviour that is a reaction to the complex design requirements.

3.3 Virtual Design Learning Follows Traditional Creative Concepts

This passivity is called *diastasis* (Waldenfels, 2002, p. 174) in the theories of creative processes and appears in the hybrid studio as a creative phase consciously produced by the learner. The motif of suffering, which also plays an important role in the theoretical concepts of creativity, is added to this phenomenon.

I already have the feeling that yes, I am somehow constricted, that something is around me, like a bowl like that and I have to break it, which is unpleasant, which is stressful, which is exhausting, but then I have more space again to just unfold in a creative way. (Transcript 5-2, par. 115)

What is historically new about this observation is that the sensation of a negative tension occurs without a social friction, which is usually experienced and practised in studio teaching through regular corrective conversations (*crits*).

By this observation, the design didactic learning process emerges in harmony with learning theories from other subject areas. This consciously produced subjectivity carries the characteristics of 'incidental' learning (Birkenbihl, 2013, pp. 29-44), a casual learning process, which is often experienced as trial and error. However, this in turn is the basis for a self-developed competence expansion, in which the individual learning need is determined in a design project and the required competences are developed, practised, and consolidated in an equally self-responsible learning action.

3.4 Virtual Design Learning as Educational Autonomy

...this freedom leads to... that the head or, yes, that the head is freer and therefore less pressure and therefore also the perception of graphic things, what happens in everyday life around, becomes bigger. (Transcript 3-2, par. 2)

From a purely linguistic point of view it can be stated that up to this point, the prefix of *self* (as in *self-organisation* or *self-responsibility*) has gained great importance in our empirical observations. Thus, independent design learning becomes a central differentiation from traditional studio learning. In fact, it must be noted that the development of the designer personality is the result of a high degree of educational autonomy. A specific signature of the virtual creative distance learning can be seen in educational autonomy. Through distance education, learners have to make their own creative decisions, and they have to follow through with them and continue making new decisions throughout the course of a design project. For this reason, there is a great opportunity for design didactics, because in comparison to traditional studio learning, students gain greater creative decision-making authority. In this respect, early achievement of personal responsibility is a central creative competence developed within this framework. Last but not least, the decision-making competence in an increasingly virtualised and hybridised working environment of design is an essential cross-sectional competence.

3.5 In the Hybrid Studio, the Virtual and the Physical Learning Space Overlap

The hybrid studio becomes a design didactic metaphor in which the internal factors of design learning overlap with the external factors, as seen in Figure 2. It becomes clear that the subjectivity of design learning also plays an important role here. The interaction with the outside becomes relevant only at the higher taxonomic levels. The narrative interviews show how aesthetic education proceeds without institutional influences. The self-organised study shows the status passage, and the crises of complexity and progression are also visible. What is relevant here is that the social processes play a central role in the formation of the self-image. The creative development with and within a

---

9 The process of appropriation and processing described as *maturing* and *diastasis* is also modelled as pre-reflective and intuitive. Here, too, different paraphrases can be found in the theory formation, which describe the temporal and spatial shift of the received impulse. This inner process emphasises the conception of aesthetic perception as primarily pre-reflexive and as unwillingly controllable and constituted as bodily. See Waldenfels 2002, p. 174.
Educating Designers in Virtual Space: A Description of Hybrid Studios

A learning group is therefore essential in a virtual framework. This is surprising insofar as these developments take place in a largely self-organised framework in hybrid studios.

![Diagram: Hybrid studios in the intersection of internal and external factors of design learning](Image)

**Figure 2.** Hybrid studios in the intersection of internal and external factors of design learning

4 Discussion

4.1 Change in Self-Concept

An important insight gained from this empirical work is that self-care as ‘expansive learning’ (Holzkamp, 1992, p. 8) has the greatest effect on personal changes in virtual distance learning (Figure 4). This self-competence develops particularly in the second year of study as a result of adaptations to the increased study requirements. In contrast to traditional studio studies, students do not receive any external references to this status passage but have to produce them through their own reflections. This change is reflected in the interaction with the teachers. But mainly it is developed from their own, internal reflections. In addition, the changes are socially constructed—for example, by interacting with the members of the learning group or the social environment who provide feedback. In this respect, there is a duality between the internal and external factors in this change. The main part is formed by internal factors resulting from artistic actions and aesthetic experiences. These educational effects have impacts on the self-image of the person. These development goals should therefore be anchored at the module level as personal learning goals.

The smaller part is taken up by external factors that emerge as social constructions. These competence extensions arise as a result of expansive learning with increasing project requirements. Therefore, these are best formulated in explicit learning objectives so that the students can establish their overriding importance.

![Diagram: Changes in the self-concept](Image)

**Figure 3: Changes in the self-concept**
4.2 Quality Criteria in Virtual Design Learning and Teaching

Drawing on these findings, I propose the following advice to educators. In the conflict situations in the creative development of the biographies presented here as examples, it is helpful to announce the respective learning goals and the associated tensions in tutoring as part of the cognitive process. Anticipated in the taxonomic stages the tensions of the complexity crisis in the first academic year, the crisis of fitting self-image and external image in the second academic year, and the practical discourses in the third academic year. The learning counselling of the teachers plays a purely accompanying role.

In this respect, it can be generalised that there are asynchronous learning processes that have their own rhythms in each individual learner, even in a virtual framework. From a certain complexity, which then becomes important for the identity of the learners, the interaction with the group and the teachers is relevant.

From this observation it can be further deduced that the learning objectives, with increasing taxonomic levels, require a necessary social framework. According to the narrative interviews, it is irrelevant whether this framework is physically or digitally mediated. This connection is the real innovation for hybrid design learning.

The factors of virtual design learning and design teaching are summarised for the three levels (micro level of learning, meso level of teaching, and macro level of education theory) in Table 2.

<table>
<thead>
<tr>
<th>Phenomena and concepts</th>
<th>Micro level of learning</th>
<th>Meso level of teaching</th>
<th>Macro level of educational theory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Status passage</td>
<td>Space–time re-dedication</td>
<td>Anticipating symbolic changes</td>
<td>Virtual design study as an autonomous act</td>
</tr>
<tr>
<td></td>
<td>Social communication</td>
<td>Encouraging exchange</td>
<td></td>
</tr>
<tr>
<td>Events and crises</td>
<td>Experiment</td>
<td>Accompanying Passiveness</td>
<td>Learning as inwards</td>
</tr>
<tr>
<td></td>
<td>Autodidactic</td>
<td>Anticipation of the necessity of self-organisation</td>
<td>Passivity as a design didactic principle</td>
</tr>
<tr>
<td></td>
<td>Self-reflection and self-care</td>
<td>Supervision</td>
<td></td>
</tr>
<tr>
<td>Remoteness</td>
<td>Decision</td>
<td>Moderation</td>
<td>Self-sufficiency of a personal development process</td>
</tr>
<tr>
<td></td>
<td>Expansive learning</td>
<td>Shaping discourse</td>
<td></td>
</tr>
<tr>
<td>Hybrid studio</td>
<td>Push–Pull</td>
<td>Coaching</td>
<td>Semipermeability</td>
</tr>
<tr>
<td></td>
<td>Diastasis</td>
<td>Anticipation of diastasis</td>
<td>Passivity as a design didactic principle</td>
</tr>
<tr>
<td>Identity formation</td>
<td>Expansion of the creative repertoire</td>
<td>Communicating the learning objectives</td>
<td>Co-production of identity and meaningful experiences</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Empathy and authenticity</td>
<td>Social construction of identity</td>
</tr>
</tbody>
</table>

For the educators, this means restraint on many levels. Educators and tutors should know about the self-organisational development phases. This also means that the typical crises must be accompanied empathetically as triggers for creative developments and that these crises must be understood as integral and productive parts of the studies. The study also highlights the development of decision-making competence as a personal contribution by the students themselves. *Diastasis* is an inner and deeply subjective process that paradoxically (Lotz et al., 2018) demands a kind of active restraint10 from the teacher. Furthermore, it follows that educators in virtualised distance learning11 need specific competence in coaching artistic and design processes (Truniger, 2019, p. 32) in design disciplines. The study can only suggest this need as a desideratum, as this research has focused on the students’ learning actions only.

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10 The importance of silent social learning processes has been empirically highlighted in a study by Lotz et al. (2018). In this paper, under the research question of social engagement in design studies, it is stated that there is a strong correlation in the upper third of a course, which is expressed by a high communicative activity in the digital learning spaces. This suggests highly communicative people achieve a high level of learning success. In addition, the study found another slight positive correlation: those who regularly view the work of others but do not comment on it also benefit from the passive follow-up of this work. What is relevant for the overarching research question is that this effect does not only affect the upper, high-performance third of the course but also affects the entire performance spectrum.

11 In this respect, this micro-level of design didactics remains unchanged, because *speaking, asking, and intervening* remain the principles of consulting in creative and artistic processes: “This symbolic communication is about the ‘continuous exchange of values, attitudes, organisational and structural questions, production processes, quality standards and terminologies’. In the broadest sense, the raison d’être of the system, the meaning and content of the grouping (...) are thus ‘linguistically understood and socially shared’”. Truniger 2019, p. 32
Therefore, there is a need for research to empirically elaborate the quality criteria of virtual coaching of artistic and design processes in the future. Further empirical work should be based on the findings presented here, and counterparts in teaching actions should be found.

5 Conclusion

For the design didactic conception of distance learning design courses, there must be a sequence of aesthetic experiences at the end of which personality development takes place. This is a consequence of the internal acquisition of competence, which is socially constructed by the students through interactions with fellow students, teachers, and others during their distance learning. Experiences of tension and crises are necessary factors in the creative processes that trigger this learning and adaptation, which naturally bears the signature of the virtual learning space that, as a hybrid studio, represents the specific style of study. This characteristic style produces self-confident and reflective designers. The distance of the hybrid studios brings with it an almost classical humanistic self-training that illuminates the central potential of virtual design theory. The design didactic framework presented in this study makes its integration into traditional design theory promising and desirable. Researching alternative design learning spaces has relevance to building new design pedagogic theories. These new design didactic principles may also enrich traditional classroom teaching.

References


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Virtual Learning Spaces: Designing Learning and Learning to Design

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Abstract: This paper argues the pedagogical positioning of video gaming spaces in art and design education as alternative studios. It serves as an analytical formulation for understanding gaming spaces as studio spaces. During the introduction, the paper argues the qualities of studio learning goals and related assessment approaches. After that, it explores studio spaces and their position in learning through a constructivist approach. It uses the theory of four pillars of education during this exploration. It continues with a structural analysis of video games. It approaches this structure and its elements as enablers of a unique spatial experience. Later, it discusses how studio and gaming spaces are in tune with one another, by arguing the resemblances between studio education and game structure. Lastly, it suggests using studio evaluation methods due to this similarity and concludes with further research suggestions.

Keywords: video games; virtual art and design studios; art and design education; alternative studios; transfer in informal education

In any discussion paper, it is important to understand how the author positions themselves in relation to the subject. As the author of this paper, I am a gamer, a designer and an educator. I strongly believe that, especially as a designer, teaching, playing and learning at the same time gives me a unique perspective to discuss the relationship between learning and playing. In addition, through my thesis studies I observed that there is a strong mentoring-teaching relationship within the gaming subculture. Through a small sample size study (n=6), I had a chance to observe 6 different gaming clans and their behaviors regarding their cultural interactions including the pedagogical potentials of such exchange (Yolac, 2017). As a result, in order to make education the center of my research, I focus on game studies in my PhD where I specifically work on art and design education.

1 Introduction

We take it as completely natural that you would be at an algebra class for twelve weeks and then I would give you a test on algebra, maybe one design of some other state to see whether you learned in algebra. We take that as natural, we do it every day. So let's say a kid plays Halo on hard and he takes 30-40 hours and he finishes Halo. Would you be tempted to give him a Halo test? No, not at all. You'd say the game already tested him. So let's think why is it that we're not tempted to give him a Halo test but we are tempted to give that algebra test and use that
as the judgment. Well it’s because you actually trust the design and learning of Halo better than you trust the design and learning of that algebra class (Gee, 2011).

It is important to acknowledge the value of video games in ever-evolving technology and informal learning settings. As Gee states in an interview (2011), it is crucial to question why the design of video games and their teachings are trusted better than our educational system. In this paper, this question will be discussed as a critical analysis based on literature review of other games in dialogue with educational theory and reflection of my own pedagogical practice. This will serve as a theoretical piece, an analytical formulation, a discussion of pedagogical potentials, and a preparation for future work. First, the studio spaces will be critiqued from the lens of the four pillars of education to highlight the constructivist properties of studio spaces. Then, the making progress structure of video games and the way they create the gaming experience will be discussed. Finally, the paper will discuss where video games and studio spaces have parallels in relation to the attitudes they develop and the pedagogical levers of these similarities.

In game studies, it is a known phenomenon that testing, and assessment usually happens through STEM oriented methodologies. According to the meta-analysis by Clark et al. (2016), although there is a rise in more qualitative learning outcomes, the majority of expected learning outcomes are accustomed to be in quantitative disciplines. Therefore, learning that is associated with video games is considered to be transferrable as long as they have a promise of teaching quantitatively measurable matters such as mathematics, physics etc. In many cases, such as reports from Best (2014) and Barnett (2014), the findings are classified as vague and unsatisfying. Such approaches that consider both transfer and evaluation, clash with the educational outcomes that are targeted and valued in art and design studio spaces. Beattie (1997), one of the important figures of studio assessment, explains that the tools we measure with, should not become the learning goals themselves. A good test score might not be an indicator of scientific thinking, yet it passes as a successful acquisition because of its convenience. As art and design educators, our practice, teaching and assessment methods are unique and valuable at a multidisciplinary level. Beattie provides 57 assessment methods and strategies that can take place in a studio space. Some of these are playful methods that involve role playing, mystery solving, self-evaluation through journaling and creating rating scales of criticality. She explains that early studio assessment methods, which many of the strategies are derived from, include portfolios, journals, diaries, logs, integrated performances, group discussions, exhibitions, audio tapes, video tapes and digital portfolios.

In addition to Beattie’s early work on assessment, De la Harpe et al.’s (2009) meta-analysis, which covers prominent assessment methods in architecture, art and design studios, highlights interesting facts. It explains that these methods that are used in art and design studios value the process above everything else which falls in line with the argument of unique testing methods and process-oriented assessment. This prioritizing is different from most STEM oriented testing methods. While such process- oriented methods are not dominantly used, the structure of gaming spaces requires an approach that primarily considers studio-oriented assessment which is the main focus of this paper.

As mentioned, the successful acquisition of teaching through video games is seen questionable in terms of transfer into formal testing methods. However, they have the potential of transforming the way players think and how they learn to transfer between different contexts. An example of such approach can be seen in Black et al. which explains while the research on the widely known history-oriented game Civilization “did not seem to increase knowledge of history”, it served at a cognitive level in terms of experiencing the historical dynamics. Therefore, the study showed that students had a significantly higher success rate reading future difficult history chapters which they see as experience building. (Black et al., 2014, p. 299).

With such an approach, transfer is seen as experience building and not a dry knowledge gain. Zimmerman (2014, p.66) sees the issue of transfer similarly: “If we are aware that the educational goal is to transfer learning from one situation to another, we must teach for transfer.” Thus, transfer is a way of thinking; a skill and it is a significant part of the studio space experience. In that sense, Marshall and Donahue’s (2014) “artistic thinking” is close to design thinking approach, experience building and transfer of those experiences in both studio education and further design problems. They explain that this way of thinking is “largely an amalgam of logical reasoning and associative thinking.” (2014, p. 3). Therefore, again, it is a way of thinking and problem solving and not a method of efficient memorization.

2 Properties of Studio Spaces According to the Four Pillars of Education

Design studios are the physical spaces that connect different entities of art and design education. A considerable portion of these entities/agents are the physical space, the instruction, instructors, peers, the experimentation, playfulness and simulation. In combination, they generate the overall culture of the studio space. Due to the
multiplicity of these agents, studio learning is not a mere “delivery of content” (Squire, 2006, p. 20). Instead, agents of culture and space that bring them together enable the education of design, design thinking and criticality. As Donahue and Marshall explain, “...in a culture, knowledge, practices, and ways of thinking are thoroughly interconnected and they have a purpose-first and foremost, to sustain the system and, second, to perform in concert some kind of action.” (2014, p. 4). Therefore, the pedagogical leverage of studio comes from the agents’ connectedness at the educational and community levels. They all exist through each other’s presence and connections; which is exactly how the education occurs.

2.1 Peer to Peer Learning and Building Experiences

Peer to peer learning is not a new concept in education. However, in conventional settings, this type of learning is very much monitored with pre-assigned roles. The learning that happens with assigned roles is not very organic, which is why they are not always sustainable or fruitful. On the other hand, in studio environments, the time students spend with their instructors does not form the entirety of their in-studio learning interactions. Beside the dedicated time, there is always a critique, asking for advice and a continuous process of seeing and observing within the space. This generates an ongoing peer to peer learning experience without the non-organic performance of formally assigned roles. Therefore, the roles of peers, agents are ever-changing and moving. A student might exist and perform as the learner, the teacher and the critique within the same space which creates a unique on-spot informal learning moments among peers. In addition, as it is in studio-based teaching practices (Beattie, 1997, p. 67), communal critiques are one of the core elements of the formal part of learning. While communal critiques appear to serve a set power relationship, the content that is critiqued is the product of a mixture of formal and informal learning moments. Hence, the formal feedback is based on a collaborative learning process, a compilation of the overall spatial experience. Peers and their interpretations and their ways of thinking become the instruction and the built experience themselves. Educational philosopher John Dewey, in his influential book *Experience and Education* writes: “Every experience is a moving force. Its value can be judged only on the ground of what it moves toward and into.” (1997, p. 38). In that sense, the studio space and its agents are ever moving and changing identities while building experiences as moving forces which their value judged using studio assessment methods. This dynamic environment builds the way learners exist through their own and shared experiences within the system that they learn from and contribute to. In addition to Dewey’s emphasis on building experiences, studio spaces generate a unique way of crafting and utilizing those experiences through the peer to peer learning they enable.

2.2 Active Learning

The term “active learning” has started to be used more and more by educational scientists (Pickard et al., 2004) especially as a part of the transition from instructionism to constructivism. Jean Piaget is seen as the father of constructivism and development of hands-on, multi-directional education. (Hirsh-Pasek et al., 2015). Especially, his approach towards students as “little scientists” (Piaget, 1936) is the crucial point to emphasize here. Putting students ‘behind the wheel’ and allowing them to learn by developing their own experience is a significant part of studio education. This translates as students’ direct impact on their own educational process. In other words, students have agency in the space of the studio system. The dynamic change of identities and ever moving learning moments allows students to be active agents, being present and contributing to the overall system while learning from it. Therefore, this agency in learning is not only experimenting by practicing “hands-on” activities through making but also becoming linked to the overall space through learning from multiple instances that generate dynamically changing learning moments.

2.3 Engagement and Motivation and Meaningful Learning

Engagement is related to intrinsic motivation and meaningful learning. While it is hard to assess engagement, the motivation that comes with it can be measured through results and overall responsiveness to, and of, the agents of environment (Zusho et al., 2014). In this paper, all emotional, cognitive and behavioral engagements (Frederick et al., 2004) are mentioned together while making the connections between engagement, flow and meaningful learning. Hirsh-Pasek et al. (2015) explain that David Ausubel (1968) distinguishes meaningful learning from rote learning. They explain that rote learning occurs when new information doesn’t have anything prior to hook onto. They reveal rote learning as the main reason for lack of meaningful learning. (Hirsh-Pasek et al., 2015)

A part of studio practice and engagement is related to the experience that is continuously being built. Multiple agents of the space allow various types of engagements to happen through meaningful learning moments which generate an overall motivation while building on the communal system. As these are a part of the overall dynamism of the studio space, they are closely connected to the concepts of previous sections. It is inevitable to mention the theory of flow by Csikszentmihalyi while addressing where pedagogy, motivation and engagement meets. According to his well-known
theory, “flow is the optimal experience whereby a person's body or mind is stretched to its limits in a voluntary effort to accomplish something difficult and worthwhile” (Csikszentmihalyi, 1990). Figure 1 is a visual representation of flow theory and its elements. Coming from this point of view, it is unrealistic to aim for a constant state of flow, however, the self-directed environment of studio spaces allows students to effortlessly balance the relationship between challenges and skills which is the key to stay in a flow channel.

Figure 1. Flow (Schell, 2015, p.140)

Therefore, the dynamic experience of studio and the self-directed learning experience are considerably important fits for keeping students in flow for higher achievements as well as higher levels of engagement.

This analysis of studio spaces focuses on one stream of educational practice. There are many other valuable educational theories that can be used as a perspective to look at video games from. The theories above are chosen due to their wide usage in educational technology analyses in order to form a bridge to connect both video game and studio spaces.

3. The Structure of Video Games

For the organization of this section, the structure of McGonigal’s (2011, p. 21) “four defining traits of a game” will be used. Although these traits are successful in terms of understanding and analyzing video games, they don’t include the subculture of video games. Before moving on to the traits, it is important to highlight the social aspect of video games spaces. Gaming subculture had strong relations in both in and out of the game spaces (Yolac, 2017). In this paper, the nature of this subculture will not be explored due to the scale of the issue. However, it is crucial to point out the existence of such a social network and its agents in addition to the traits that will be discussed in this section.

3.1 Goals

In most games there are series of goals that are set for the players. My early field work showed that these goals have a hierarchy, where bigger goals are assisted by smaller ones. To exemplify, one video game that uses goals in a
Hierarchical manner to successfully motivate the player is *Broken Age* (Figure 2). *Broken Age* is a point and click adventure video game. At the initial stages of the game, presented goals are shorter and easier; focused on assisting the player in understanding game mechanics and controls. When the game narrative escalates in complexity, the player is then presented with the main goal, which is to beat a monster and escape from a space ship. As a part of the narrative and the hierarchy of goals, the player is gradually eased into the main goal by the assistance of smaller goals. These are not pointlessly created solely to implement a feeling of achievement; they train the player for the main goal which generates a positive self-image and motivation. Reflecting on these qualities of video game goals, three main categories can be constructed:

1. **First level goals**: They are necessary but smaller-scaled achievements that are important for navigating and enabling interaction with the game.
2. **Second level goals**: These are goals to raise confidence and slowly ease into the bigger challenges. They help with gaining skills and building a positive self-image without putting a lot of stress into achieving the main goal.
3. **Main Goal**: This is the main solution to the problem; what is to be achieved through the whole narrative structure and challenges.

In such a hierarchy, encountering the main goal is an acknowledgement of success in previous goals. In addition to this acknowledgement, many video games allow revisitation of the smaller goals. This aids to refine playing skills and reinforce both the way of thinking and embodiment that the game requires, without putting pressure on the player. This way, goal design can be made to support risk taking as a “promise of achievability” (McGonigal, 2011, p. 21) through practice.

### 3.2 Rules

In a game, there are main rules that form the mechanics and construct what is available to players. Schell (2014, p. 174) explains rules as follows: “They define the space, the timing, the objects, the actions, the consequences of the actions, the constraints on the actions, and the goals.” Usually, there is a designed world, a space, where game logic is implemented through those rules. In fact, Anthrophy (2014) defines these as the language of a game. For example, a player can’t cast a spell in a *Super Mario* game. This rule creates a limitation in the designed *Super Mario* environment that guides player behaviors. Definition of main rules is necessary for creating a balanced game and game mechanics. Through this definition, the player knows how to navigate in and interact with the space throughout their gaming experience. This interaction gets further developed making the players’ reactions second nature. In most cases, game genres have common interactions for an easier transfer of gaming skills (Yolac, 2017).

Beside the rules that create game mechanics, and sometimes determine and determined through the game genre, there are in-game rules that also affect the game experience. Such rules are different from the shared genre and overall mechanic rules and sometimes they help maintain a dynamically personalized challenge system. An example of such use of rules can be found in one of the most popular Massively Multiplayer Online Roleplaying Game (MMORPG), *World of Warcraft* (*WoW*). In *WoW*, there are towns and cities that require travel through woods or obsolete areas. These areas are inhabited by creatures that usually attack the player on sight. The initial mechanics require a player to engage with those creatures every time they travel, which might interfere with a goal at hand. However, those creatures are also helpful for gaining experience points and in-game fighting skills which can fall under small level goals. When the player reaches the highest level, they can acquire a mount (a creature to travel on) that flies over such areas that are inhabited by hostile creatures. Unlike other mounts that players can have prior to the highest level, it saves time from interacting with hostile creatures unnecessarily. By providing a flying mount to the player, the game acknowledges that player completed the challenge of beating creatures and doesn’t need the experience that this challenge would normally provide. Consequently, the rule of traveling on the ground gets altered to eliminate involuntary, and now, unchallenging work. Similarly, in most cases if the player travels between two habited areas, they can find an alternative travelling route that allows them fly in between two points without encountering previously defeated hostile creatures. In that sense, even the issue of travelling is partitioned in smaller (travelling between two areas) and bigger (travelling the entire map) goals; rules and mechanics that first teach and challenge (travelling on ground) later acknowledge (enabling to fly).

Lastly, in most games, players can find an interface that allows them to review their characters’ skills, how to use them, and rules that define interactions. Such interface designs and lists allow players to understand how to interact within, and with, the designed environment at any needed moment.
3.3 Feedback

One of the most important parts of the design is a constant feedback in the games. Most of the times, there is accessible information provided through the interface elements which is connected to the rules, goals and the game narrative. Consider a hypothetical shooter game with the goal of eliminating 50 targets. During such game play, it would be habitual to have information on the target process. As it might be expected, there should be a hierarchy of the way information is presented. For a shooter game, while the data on ammo, health and hostile characters are the primary focus; the number of games that the player has completed might be the secondary. Therefore, those two feedback items would be presented differently and at separate frequencies. If the game is well-defined in terms of goals and rules, necessary feedback is easier to determine. In that sense, feedback is closely related to those aspects.

Additionally, feedback also affects the self-image positively as a result of constant information on player progress. In most games, this type of feedback delivered through the interface is customizable. For instance, World of Warcraft, is known to have user created feedback systems (Figure 3). In a way, the player pulls what they need from the readily existing data and present it in a way that would fit their individual needs. As a result, the feedback can become personally tailored according to the demand. The way available information it is refined, depends on individual players’ understanding of what is necessary for succeeding in their goals.

3.4 Voluntary Involvement

Although intrinsic motivation is not a new concept, it is important for analysis of the reason behind players’ dedicated hours and how they keep themselves motivated to continue (Pickard et al., 2004). Maybe an outdated answer to how motivation occurs might be fun. However, the promise of fun is not enough by itself to generate a designed space that would evoke the wish of multiple visits overtime. Koster (2005) explains the patterns and the sweet spot between repetitiveness and overloading the mind with new information. “When you feel a piece of music is repetitive or derivative, it grows boring because it presents no cognitive challenge” (Koster, 2005, p. 42). Coming from that, the fun that is provided should keep the players in a zone of flow (Figure 1).

As an extension of this argument, there is a lot to learn from how games aim to appeal to a diverse audience. There are a number of gamer profiling theories that exist and continue being formed in the area of game studies. One of the most famous and earliest theories is Bartle’s (1996) taxonomy (Figure 4):
It is an exemplary guideline for tweaking a game to appeal multiple player groups. Such studies conducted since the early stages of game studies, help us to understand the diversity of players. Every “big” game tries to be attractive to more and more users. At times, in-game content can get so rich that the game contains a narrative tree that can’t be explored by a single user. This generates a series of choices to make, a personalized gameplay through a dynamic gaming experience brought by the narrative to keep the player engaged. As a result, understanding the nature of user diversity is a crucial step of keeping players interested. This is a continually researched area for generating more personalized gaming experiences.

Another way feedback, rules and goals merge is dynamically changing difficulty. In most games, the level of difficulty is adjusted according to the way the player progresses. The way goals are presented, required skills and which other users play with change dynamically to keep the player in the game. This is a crucial element of how games keep their players in the state of flow.

4. Discussion and Future Work

In order to showcase how games help practicing behaviours which later transfer into ways of thinking, Figure 5 provides a playful example. It is a sample of a “meme” type that circulates within the out-game spaces of gaming community. These memes associate the visual game design language, which evokes game-like thinking, a certain literacy, with real life contexts. The mere existence of this subculture item is a support for the overall argument that is presented throughout this paper; games teach thinking. As long as we are aware of the tools that we possess as educators, through intentional design decisions, game spaces can serve as studio spaces.

Throughout this paper, I discussed the multiple agents of studio spaces and video games. As I researched during my previous field study (2017), gaming culture exists inside and outside of the game. Even single player games have a socially uniting existence for their players. Just like it is in a studio space, the roles are in a constant change within the system of game. Players become designers, tutors and peers. In that sense, even a simple act of sharing an alternative interface design (Figure 3), shifts the roles and generates a space of learning, sharing and experiencing together just like it is with studio spaces.

The social and the peer to peer learning that studio spaces enable as a way of experience building can be found in video games. The way studio spaces generate student agency and create experiences are things to be put in use for educational purposes. As one of the important researchers in pedagogy and game studies, Squire (2006, p. 19) explains; “video games offer designed experiences in which participants learn through a grammar of doing and being”. In addition, he sees learning as a performance which is a similar approach to the way this paper positions studio students as performers of multiple identities within the system of the studio spaces. Plus, the feedback systems are highlighted in both spaces previously, while students are exposed to a constant feedback from both their peers and peer generated critiques, video game players also receive constant feedback from multiple sources within the game. This feedback is tweaked according to personal needs. If the natures of those feedbacks are considered, studio and game spaces are synced successfully.
In addition, as a part of the designed structure of video games, rules and goals are mentioned. In relation to Squire’s (2006) argument of designed experiences, he sees both video games and curriculum as designed environments. The transition of such an approach to studio spaces are easy to make. If rules are the tools that enable experimentation in a stress-free manner, the way studio spaces leave room for active learning and experimentation would not be any different. In their paper, Hsiao- Cheng (2011) looks at Second Life (an online roleplaying and simulation game) as a potential art education studio to experiment with 3D sculpting tools without economic or physical difficulties. Although Hsiao- Cheng’s utilization isn’t formed around the game’s potential beyond their convenience, it is still a promising early example of the collective academical search for pedagogy though video games. It is a good example of using and expanding the tools of active learning in the studio spaces.

On top of using rules as potential enablers in gaming spaces, setting goals are very similar to the way educators approach curriculum. An example of a goal-oriented approach in studio using challenges of both skill and cognitive levels can be seen in Thulson and Marshall’s (2014) article. They see challenging students as a strong instrument for teaching them to be creative with finding their own solutions and developing individual experiences. In that sense, the way in-game challenges develop players’ understanding and skills are promising for mirroring the studio learning goals while enabling their creative problem-solving abilities.

Another quality of games that is highlighted is voluntary involvement. This is the most luring quality of games when game studies and pedagogy are considered together. As presented in the previous section, the design of games aims for an inclusive player group and researchers, social scientists continually theorize what different types of players are found in games. An extension of that issue is the way video games keep generating personally tweaked, dynamically changing difficulty levels. This helps players stay in the flow channel which is again a part of the studio education as well. While the challenge remains, the way students engage with those challenge is conducted through their self-directed learning as it is in studio environments. Therefore, similarly, the studio education creates a unique learning environment for each student to thrive on their own pace, almost in a dynamical, personalized way. In that sense, the way video games and studio spaces keep students engaged are essentially very similar.

As discussed, the educational theories that studio spaces fall under; peer to peer learning, active learning, meaningful learning and engagement can be matched with the qualities of video games; the structure of goals, rules and voluntary involvement. The way this correspondence is enabled is through the way both spaces are built with and around communities with multiple agents that enable both diverse and collective experiences. At the very beginning of this paper, the unique assessment methods that are used in art and design studio spaces were highlighted. According to the critique and analysis that this paper presented so far, the video game spaces are significantly similar to the pedagogical approach of studio spaces. Therefore, my argument is that, the learning outcomes, success and transferability of qualitative skills should be evaluated using the ways of art and design studio spaces. Such an approach would bring studio-like outcomes into view and enable a more intentional use of video games in education using the lessons studio education demonstrates.

In this paper, the similarity of video game and art and studio spaces are discussed in terms of pedagogical approaches. While this discussion is based on existing studies, educational theories and game studies theories, the natural next step is to put this discussion into multiple field studies to create guidelines. This is a presentation of a research study at the theoretical level. The future work will include assessing success of existing video games through studio methods. In addition, the planned future work will include producing a video game using design decisions that would gather the highlighted pedagogical aspects of video games with the intention of creating an alternative studio space for mirroring the design thinking teachings of studio spaces.

References
Virtual Learning Spaces: Designing Learning and Learning to Design


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OpenDesignStudio: Virtual Studio Development over a Decade

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Abstract: This paper presents a case study on OpenDesignStudio (ODS), an online, virtual design studio used to support the Design and Innovation qualification at The Open University (UK). The case outlines the main design and development iterations to ODS over a period of nearly 15 years and presents recent usage data of large-scale student populations (3000+ students). As such it is one of the largest and longest-running online, distance design studios, representing a unique longitudinal study of virtual design studio use. The case highlights the importance of learning design, social learning mechanisms, and induction into studio culture.

Keywords: virtual design studio; online design studio; studio pedagogy; alternative design studio

1 Introduction

Over the last 10 years, the development of a Virtual Design Studio (VDS) at the largest distance higher education institution in the UK has generated an interesting question: Can we create a distance design studio that, whilst different in terms of modes of learning design, student behaviour and use, could still be considered to embody the signature pedagogy of a ‘traditional’ design studio (Crowther, 2013)? And following from that, is the same tool adequate to support learning at different levels of study or even across different subjects?

Since the late 90’s, scholars have written about the development and use of virtual design studios for education (Maher & Simoff, 1999; Broadfoot & Bennett, 2003; Arvola & Artman, 2008; Robbie & Zeeng, 2012). Many of the early virtual design studios were experimental and have long since ceased to exist (Lotz et al., 2015; Broadfoot & Bennett, 2003), but, today, increasing numbers of virtual studios are used alongside physical design studios (Bradford, 1995; Richburg, 2013; Rodriguez et al., 2018; Elisa Navarro Morales & Londoño, 2018). Studios might be employed to teach a specific course, or to run collaborative projects with partner universities in distant countries (Schadewitz, 2009). Very few bespoke studios have been developed since the first few attempts and many of these were only used for short
periods of time or have been replaced completely. In more recent years, the shift in focus has been towards peer and social aspects of studio pedagogy, aligned to the rise of social networking tools and services and their direct applicability to studio practices (Schadewitz & Zamenopoulos, 2009; Schnabel & Ham, 2012; Robbie & Zeeng, 2012; McCarthy, 2013).

This case is unique in reporting the longitudinal development, over 15 years, of a bespoke virtual design studio for students who study design at a distance learning institution, The Open University (OU) in the UK. Studying at a distance offers few opportunities for face to face tuition and the student demographic can be very different to traditional universities: students tend to be employed (and have less time for study) and the policy of open entry at the OU means there are higher percentages of students with particular learning support needs. OU design modules present and teach general design skills, processes, and behaviours rather than any specific subdiscipline of design and this is reflected in the mix of qualifications OU design students take. Students study modules, each of which is about a semester’s worth of learning material (60 CAT/REF (UK) points of study) and three design modules can be completed as part of the OU Design and Innovation BSc/BA Qualification. The other modules studied come from a range of pathways, such as Business, Computing, Art History, Sustainability or Engineering (Lloyd, 2013).

There have been several papers on aspects of this studio (Holden, 2009; Hart et al., 2011; Jones & Lloyd, 2013; Lloyd, 2013; Lotz et al., 2015, 2018) but none has described the development of the studio in its entirety, the focus of this case study paper. The case follows the development of an online design studio tool called OpenDesignStudio (ODS) – from the creation of the studio to provide a safe environment for novice photographers to share and critique their work, to a tool used across a Design and Innovation Qualification and in over 20 modules in other disciplines across the University, used by tens of thousands of students. The case is built from observational and interview data, as well as statistical analyses of its use over several years. It attempts to summarise the decisions and learnings from developing the possibly largest virtual design studio in higher education.

2 The Case: Developing a Virtual Design Studio at the Open University

OpenDesignStudio is part of a suite of learning tools developed for students studying at The Open University in the UK (OU). Lloyd (Lloyd, 2013) describes the OU’s teaching model in which students study module material independently at a distance, consisting of readings, activities and assessments structured to support incremental learning. This is hosted on, or supported by, a Virtual Learning Environment (VLE). Figure 1 shows a collage of one of the main VLE websites, where learning tools and additional resources can be found. These materials are studied independently by the students at a distance. Learning is supported by tutors in small tutor groups (about 20 students) using a range of different communications and support systems in a model called Open Supported Learning (Ison, 2000). Tuition and support take the form of asynchronous (written and audio) feedback on assignments, face-to-face and online tutorials, and peer-peer or peer-tutor interactions, as well as email, phone and other communications contact. Learning is also supported by a variety of other social, communication and collaboration tools, central to which is ODS, highlighted in Figure 1.

The traditional studio has always been conceptualised as a hybrid spatial, pedagogical and social environment (Crowther, 2013). This is no different in distance design education – the OU’s Virtual Learning Environment, OpenDesignStudio and the Supported Open Learning model, all contribute to what makes the studio at the OU.

The learning materials and bespoke tools, such as ODS, are designed by a team of academic and support staff over a period of years before use by students. A typical module designed in this way can be in use for about 8 years. User feedback, technologies, policies and practices do change over time which influences the decisions to adapt some of the learning designs and tools. Between 2010 and 2017, ODS underwent a series of changes, the learning from which is discussed in this case.
2.1 The First Studio

OpenStudio was first developed along the lines of the original Flickr online service in 2004, with the aim to develop an in-house social networking environment for photo sharing for a Digital Photography module (Figure 2). The University felt the need to be independent of commercial tools, which can change dramatically over a short period or even cease to exist. It was recognised that student photographers required a safe and closed environment to post their work and learn to give helpful critique.

The learning design for this module supported by the OpenStudio tool divided a typically large cohort of around 1000 students into smaller groups with a weekly photography task. Students were asked to share work with their group and comment on others work, but they were also free to look at and comment on other groups’ work. Students could also save their favourite images in a virtual album (Kear & Jones, 2011). Immediately, the advantages to using OpenStudio were obvious, offering increased engagement, socialisation, collaboration, community building, awareness of learning and skill development, among others (Minocha, 2009). These factors highlight a critical affordance of the tool – its ability to initiate, support and develop social learning in a distance education context.
In 2010, a new level 1 module on Design thinking was being offered for the first time. During the production of the module, the OpenStudio used in the Digital Photography module was developed as a core social learning tool and renamed OpenDesignStudio (Figure 3). The core requirement for the new OpenDesignStudio was to support a more active and social learning environment akin to traditional design studio spaces. It was developed for a single module but also to be used across a qualification and to support the increased complexity of works shared, as well as represent students, tutors and tutor groups. The tool also needed to allow the learning designers to structure learning into manageable and easily identifiable blocks and chunks. Consideration was given to allow users to find and view other students’ work in order to comment on it. The issue of scalability and technical robustness was seen as a key challenge for the University as student populations frequently exceed 500 per module (Hart et al., 2011).

In its design and development phase, the OpenDesignStudio underwent several iterations, each tested by the module and technical development teams and potential users. During its first presentation, students and tutors further contributed to its development, providing feedback in use. Lloyd (2013) reported that two-thirds of the student population of the 1st level module were satisfied with OpenDesignStudio during its first presentation, a figure that reflected early problems in making the tool operational at scale. This improved significantly after this first presentation and currently (still) regularly exceeds 95% satisfaction, demonstrating the maturation of the tool’s use through improved learning design and tuition approaches. Feedback (and data) in early presentations indicated that students used ODS far more than predicted and that they did so to support their study by comparing themselves to peers, checking progress, and validate their learning. In other words, it worked because students recognised an intrinsic value in using the tool.

Initially, when users joined OpenDesignStudio they created a personal profile where they added information about themselves and uploaded a profile picture, similar to other social networking websites. Engagement with ODS was structured into predetermined uploads to the Portfolio area, representing activities students were asked to complete in the module materials. Unstructured, or informal, student-determined uploads could be uploaded to the Pinboard area. Figure 3 shows the Portfolio of a student on U101 and their uploads in the first few weeks of study in Level 1. The module materials encourage exploration of others’ work in ODS using the Group (tutor group) and Community (whole module) space. A tagging facility was provided to find students who have approached the task in similar ways. Student participation, the number of upholds and commenting on the work of others, is tracked and rewarded. A green progress light appears for a completed upload (top right in Figure 3). Interacting with other students’ work more than their own was rewarded with a smiley and a comment on an upload was indicate by a coloured speech balloon.

Each of these features was designed in order to facilitate and encourage interaction and engagement with the tool. On their own these features do not necessarily do this but, as noted later, in combination with a learning design and alignment with student goals, they can be particularly successful in initiating social interaction and engagement.

In 2011, the module team received an award for Innovation in Training Services from Institute for IT Training for the Design Thinking module and its tools, including ODS. This innovation in teaching and learning diffused quickly in the university and other subjects, such as in Engineering and Computing, became interested in using ODS (Thomas et al., 2016). Three years after its first use in the first level design module, the second level design module was rewritten and
ODS was included in its learning design in 2012. Due to its rising popularity across the university, the studio tool underwent a significant re-design in 2013.

2.2 OpenDesignStudio 2.0

A major limitation of the first version was its lack of integration within the main Virtual Learning Environment (VLE) – at The Open University. The OU VLE (Figure 1 top) is a heavily adapted version of Moodle, the underlying platform for which bespoke tools are developed in-house. These are added around this central organising core as seen in Figure 1. When version 1 of ODS was created, full integration was not possible and this required a technical environment independent of the main VLE. This resulted in students having to navigate and use a separate site, losing other links and tools available to them in the VLE, as well as any cognitive or conceptual links. For example, the profile creation feature noted above was a consequence of this separation, requiring a duplication of student data, and a repetition of student activity. The consequences of this separation created a series of small barriers, reducing the ease with which students could engage with the studio. This observation came to be a condition of future development – that any design decision should make student interaction as ‘frictionless’ as possible, essential in supporting student engagement with any software environment (Wang et al., 2013). Briefing the design team using these types of ‘conceptual metaphor’ became a useful practice in the design process, allowing discussions to take place that de-focused from specific (software) actions and concentrated on the qualitative experience required (Jornet & Jahreie, 2011).

The removal of these barriers through the technical integration of the studio became the highest priority for version 2 of ODS. It was recognised that this would be a significant institutional investment but the case for support was argued by having a successful proof of concept and working prototype. By this time, ODS was also beginning to be used successfully in other subject areas (e.g. Education, Technology, Computing, and Arts) and at all undergraduate study levels.
In addition to developing responses to limitations of the first version, two further design drivers were identified: 1) a refresh to the User Interface, User Experience/Interaction, and 2) a desire to further develop the pedagogical potential of the studio, primarily the exceptionally high levels of student engagement and how these might be improved. The development team, including the client side, was initially comprised entirely of experienced designers, meaning that working in the intersection between interface, experience, technical and pedagogical design was possible. This allowed key decisions to be planned appropriately by ensuring that the timing of implementation of features did not force solutions without some genuine design decision-making taking place. For example, early pressure to create a fully detailed Functional Requirements Document were resisted to ensure that design and prototyping processes could be applied.

An example of using a conceptual approach was in the development of the structure and navigation in the studio. This is a *slightly wicked* design problem since it can be arranged along several different dimensions of information (type, intent, author type, time, etc.). The first version of ODS established the habit of referring to parts of the studio using terms such as *portfolio*, *groups*, and *pinboard*—physical concepts used in a virtual setting—so development of the second version continued this and developed it further. Figure 4 shows an early sketch layout setting out the spatial arrangement of a student's work according to architectural concepts of private, semi-private, semi-public, public, which proved to be a useful way to communicate requirements the learning designers identified to technical designers in a way that both parties could relate to.

The other major design decision was around the social networks and connection opportunities. Again, this could be considered a *slightly more wicked* problem in that predicting what will enable, support and create a successful social network is effectively impossible. We can bring to mind many examples of successful online social networks, but rarely
consider the thousands of failures that are a necessary accompaniment to this. Similarly, students had reported finding the social functions of the first version exceptionally limiting and difficult to use, so we knew there was a problem to resolve. It was also clear that there was significant student demand for these features, which we could now link to engagement and student success, meaning this was also a significant opportunity.

Once again, we used conceptual metaphors to brief this work and decided very early on to use simple, iterative prototypes to create a responsive design solution, rather than try to predict everything and hoping it works. We planned to support as many easy ways to connect with other students and then maintain those connections in ways that students would find useful. Figure 5 shows an early mock-up sketch to explore different interactions and ideas, in particular the different levels of interaction considered early to encourage student engagement with the environment.

As the project developed, the large technical team reduced in size once a stable product was available (when the majority of the larger technical challenges had been resolved). Continuity was maintained by retaining a smaller core design team, which helped respond to the iterative process used to confirm and then further develop the final solution. As with version 1, testing and development continued through live student use, where it could be carefully monitored and problems resolved quickly. The team had experience of working in this way both technically and professionally as well as acting as designers and educators.
This type of student feedback and testing was a vital part of responding to the social networking problem identified above. Using student feedback, the team were able to identify specific studio activities students found most useful socially and educationally. For example, notifications of interaction are a common feature in many social networks but being able to return to particular instances of interaction easily to refer to them for an educational purpose is not. Hence, a focus on search and filtering as well as social interactions was required – all developed responsively to student feedback. Figure 6 shows an example of activity notifications developed in version 2.

Figure 6. Activity notifications developed in ODS version 2.

The final stage of the development project was the integration of ODS into the core modules in the Design and Innovation qualification. Each of the three core Design and Innovation modules has a bespoke learning design. While the first and third level module are entirely online, the second level has printed module books with supporting online activities. The third level module is integrated into a wider number of qualifications, hence the population on this module differs to levels 1 and 2. Some level 3 students might not have used the virtual studio before starting this module. These differences at different study levels have a significant influence on the success (or otherwise) of the online studio.

2.3 Engagement and Progression in ODS

In 2015, a quantitative and qualitative study of ODS on Level 1 revealed a correlation between engagement and student success and identified that forms of social learning through peer comparison were taking place in ODS. The qualification team wanted to understand if this finding was replicated across the qualification and a large-scale study to investigate how students’ progress through the qualification in ODS was instigated in 2015 and ran for 2 years. The full details and results of this study are available elsewhere (Jones, Lotz & Holden, 2019 (in review)) and the following results are presented as summary points.

The analysis of engagement data from five Level 1, three Level 2 and one Level 3 presentations suggested that ODS is indeed used differently across the Qualification. All modules run for roughly 30 weeks and carry 60 credits and the numbers of students on each level vary. Level 1 usually attracts between 300-600 students (it is presented twice a year), Level 2 has around 300, and Level 3 up to 600 students. Engagement with ODS varies by level, too, as can be seen in Table 1.

Table 1. Average numbers of engagements per student by level of study (** no data available)

<table>
<thead>
<tr>
<th>Level</th>
<th>Studio slots completed (Number of slots required)</th>
<th>Slot Views</th>
<th>Comments (own)</th>
<th>Comments (other)</th>
<th>Feedback Requests</th>
<th>Pinboard Slots</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td>25 (34)</td>
<td>255.8</td>
<td>10.66</td>
<td>32.24</td>
<td>3.68</td>
<td>22.50</td>
</tr>
<tr>
<td>Level 2</td>
<td>35 (82)</td>
<td>**</td>
<td>6.00</td>
<td>12.95</td>
<td>3.05</td>
<td>3.15</td>
</tr>
<tr>
<td>Level 3</td>
<td>14 (88)</td>
<td>14.0</td>
<td>4.50</td>
<td>10.90</td>
<td>3.90</td>
<td>2.60</td>
</tr>
</tbody>
</table>
Table 1 (column 1 Studio Slots Completed) shows the number of uploads students are required to complete for the module materials and the average actual uploads per student. It can be seen that that the engagement students are instructed to show increases, while the actual engagement decreases. Not only does the number of uploads increase, the kinds of work that are uploaded changes too. Level 1 tends to ask students to upload the outcomes of quick, fun, and meaningful activities, where students can show their work, compare it to, and with, others’, and gain confidence in knowing that they are not alone and are making progress. Over two-thirds of level 1 students complete the majority of uploads that they are asked to do (a high proportion given the distance education context). The uploads in Level 2 focus more on demonstrating student’s skills in sketching and modelling and tend to take longer to produce. Half of the students share the work as instructed. The use of ODS in the third level module changes yet again; the work shared is part of the large design project students undertake and tends to be less visually engaging, with more text-based activities uploaded to the studio space. Due to their complexity, these uploads require more time to engage with appropriately. Only about one sixth of students do as instructed. At Level 3, students view and comment on fewer uploads compared to lower levels, but the ratio is such that nearly every uploaded work is commented on in Level 3.

Overall, there were reasonable correlations of students’ success in Level 1 across all presentations for different measures of engagement, such as numbers of slots completed, viewed, and commented on, and pinboard slots created. The study confirmed that, at Level 1, the single strongest correlation is between Views of uploads of other’s work and Student success (Jones et al., 2017; Lotz et al., 2015). This indicates that the seemingly passive activity of lurking in the studio is an important social learning mechanism for students that are successful in their studies at Level 1. We consider this to be analogous to the activity of ‘listening in’ (Carruthers et al., 2014) in a traditional, proximate studio environment.

Figure 7. Perceived value of OpenStudio across the Qualification

We could not find such a correlation in any measure of student engagement with ODS and student success at higher levels of study. Also, the perceived value of ODS decreases with increasing levels of study (Figure 7), with students at level 3 not seeing the value of the tool or activities around it. Given that the tool itself is identical across all study levels, it is clearly the learning design of modules and how the studio is integrated into each that is particularly critical in supporting (or not) student engagement.

An analysis of the rated quality of posts by expert and the conversations around these uploaded artefacts revealed surprising findings (Lotz et al., 2018). Commenting behaviour for students on the entry level module was positively related to the aesthetic qualities of the artefact. Comments like “looks good” or “professional looking” were frequent (Figure 8). For more experienced, higher level students the behaviour seems to be the opposite. At Level 2, students comment on content that is not of the highest quality as assessed by experts, but their comments are more critical and draw on learning and content for the module. Comments interwove positive feedback with critique, for example, “lovely drawing, but I wonder if ...”. The data from this study were not sufficient to make any consistent observations about Level 3 commenting behaviour. Students feedback suggested that the ODS integration currently does not support the social learning need at this level of study. Students carry out longer and more complex specialised innovation projects, which need time to engage with in detail. A project-topic-based or peer-review approach at level
might be a more appropriate ODS learning design. However, this is currently not well-supported by the learning design and tool integration.

Figure 8. An example of informal and social comments in a Level 1 slot, typical of interaction at this level.
3 Discussion

If we attempted to characterise the different inflections of OpenDesignStudio at each level of study, one could argue that at Level 1, a social engagement and ‘listening in’ promotes social learning (social comparison, social presence development, engagement, etc.) and the building of a ‘sense of community’. It provides room for enculturation into design education at a distance. The decreasing quantity, but increasing quality, in engagement with ODS at Level 2 creates room for comparison of specific skills and more of a focus on a larger design process and effort. At level 3, the social learning need, which is demanded at lower levels, seems not to be desired at all, judging by the reduced engagement with ODS and student comments. Some of the reasons for this are discussed in Jones, Lotz and Holden (2019, in review), but it is very likely that distance design students mature as they make progress and that this does have to be fully reflected in the maturation of the studio, just as it is in a proximate studio.

ODS works well by relying on social aspects of learning and practice to draw students into enjoyable activity they then make meaningful and valuable in their learning. When introduced to this habit in early levels of study it has demonstrated significant success. But, with the exception of a strong stable core of users in each cohort, the level of interaction remains social and doesn’t develop as fully into design dialogue as it could do. There are a number of possibilities for this.

Firstly, there is currently no support for using specific design ‘support tools’ in the studio – the use is primarily a social media model applied to a design cohort and it works very well in supporting this. But to augment and build on the social aspects it may require additional tools and affordances not currently provided (for example: markup tools, more advanced communications, synchronous discussion and interaction tools, digital prototyping spaces (e.g. BIMs), etc.).

Secondly, the equivalent of the design (or desk) crit and end of term crit are currently conducted ‘outside’ of the studio. None of the design modules assess student interaction within ODS, and assessment is still direct between student and tutor. This has significant advantages, particularly in terms of personalising student learning (Jones, 2014), but it does mean that a valuable learning event is isolated, reducing contact with experts or expert dialogue, both of which are identified as key aspects of any design studio. This is also a feature regularly requested by students in any feedback on ODS – to have regular, expert feedback.

Thirdly, there are structural issues around the development of communities of practice (Lave and Wenger, 1991). Each OU module is a self-contained unit of learning, meaning students develop a strong network and then often study another module on their own, leaving their network behind. Similarly, on the Level 3 module, many of the students entering it have had no experience of a studio of any kind, meaning they have to make sense of, and find value in it very quickly (and without the benefit from the enculturation that takes place at lower levels of study). These discontinuities of studio engagement are specific to the OU and how we currently organise teaching material. In a traditional studio this effect might still exist but it would be far less obvious and spread over a much shorter period of time.

A fourth and final reason is that there may be a limit to what can be achieved in this type of alternative studio. Different levels of study seem to require different types of studios. We are increasingly doubtful that one tool could cater for all social learning needs as students develop their individual needs as learners. And there seems to be some sensitivity to subject-specific needs and demands, although these are very often perceptions of discipline rather than actual needs. For example, the use of the studio in design engineering subjects has had mixed results with some students not accepting its relevance to what they view their specific sub-discipline to require. Conversely, the use of OpenStudio in other subjects, such as Arts and Languages, has seen good responses from students and been successful in allowing active learning to take place (and at all study levels. What this suggests is that we do not yet know what might be achieved with these modes of learning; that the limit does not necessarily lie with the tool but with the ways in which we are using it.

It is in these boundary questions that we hope future research is conducted. The track for Learn X Design 2019 was titled “alternative studios” for a reason – the term virtual studio suggests there is some real studio upon which the virtual one is based. Similarly, online studio suggests a static place that only exists online – as if there is no offline practice involved. But, just as with a physical studio, the contents and boundaries of an alternative studio are at least as complex – providing they are designed and allowed to be. That starts with a much higher expectation of what the alternative studio can do. If it is seen as an addition to something else, it will always be such an adjunct. If it is considered to have a limitation in some subject, then it will never be tested beyond these starting assumptions.
But if we consider the alternative studio to be an idea – a conceptual metaphor with all the complexity of a socially, professionally and personally enriched traditional studio – then we change our expectations as well of those of our students. The conception of the studio becomes what it needs to be in order to meet the needs we identify for it, just as it does in a ‘real’ studio.

4 Conclusion

We end with a summary of the lessons we have taken from developing ODS and we think might be useful for learning designers.

1. The studio is not just the ‘thing’ (the tool, the software, or the place). The success of a studio is due to the complexity of interaction and behaviour it allows to emerge, an implicit property of the studio we can take for granted sometimes as design educators. The success of ODS at Level 1 is due to the learning design, tuition support, and student engagement as much as it is the software tool itself.

2. Induction and enculturation is critical. Students have to learn to use a studio, just as they do any other mode of learning or working. Very often this learning is assumed and implicit in traditional design education where enculturation can take place synchronously and contiguously. But in alternative studios such continuity may not be possible and studio enculturation may have to be considered explicitly in the learning design.

3. Designing the design studio is essential. Design processes involving users, iterative prototyping, and conceptual briefing allow more responsive and emergent solutions and our findings suggest that they are a necessary condition for the successful implementation of any socially-mediated tool. Similarly, realising that a single solution is not possible to such a complex design problem is essential – there may be instances of solutions, but these must continually change and develop just as both the curriculum and the studio do.

4. Learning is only represented by interactions and behaviours. It’s human nature to focus on what we can measure but in doing so, sometimes we miss other valuable activity taking place (see Jones, Lotz and Holden (2017), for more on this). In all our studies, simply ‘listening in’ (being in the studio) was shown to be the single, strongest predictor of student success. Then question here is: what else are we not measuring?

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The Evolution of the Design Studio: Hybrid Learning Spaces

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Abstract: This paper discusses an innovative pedagogical initiative that is currently the subject of ongoing development at Coventry University in the School of Art & Design - the Hybrid Learning Space (HLS) project. The HLS delivery paradigm originated in response to recent shifts in the tertiary education landscape: The need to meet the challenges of growth in student numbers; and the growing emphasis on international recruitment and the development of internationalised curricula. Fundamental questions need to be asked that challenge entrenched notions of what constitutes a learning space, and, the future role for the traditional design studio in internationalised design course frameworks. The imperative is to design integrated mechanisms of design course delivery that can meet these challenges without compromising the academic integrity and quality of the student learning experience. Methodologically, the paper draws upon thematic analyses of student survey and interview responses to uncover common pedagogically-relevant themes in the context of student participation and attainment. These analyses are correlated with direct observations of student behaviour within conventional and disrupted learning spaces. A case study review illustrates the HLS model in action. It draws upon active research initiatives, interventions and delivery practices from several institutions in the UK and in China. The objective is to explore the effects of learning space topologies on design student participation and to propose a conceptually alternative notion of the design studio as praxis-based learning environment. The paper concludes by summarising the potential benefits of the case study while pointing the way forward to the ongoing evolutionary development of the HLS experiment.

Keywords: hybrid learning space; design pedagogy; internationalised learning; alternative studio; student participation

1 Introduction

The School of Art & Design at Coventry University (CU), in common with many design schools, references a Bauhausian model of design education that positions the design studio as its core learning space and philosophical beating heart. Within that environment, students engage with and perfect their vocational skills while gaining insights into the theoretical underpinnings of their discipline. The ultimate educational aim is that design students are prepared for professional practice by developing a “whole way of understanding the world and responding to it...characterised...as ‘the Designerly Way of Knowing’” (Tovey, 2015, p. 52). While not being a true atelier system in which novitiates learn and collaborate within the studio under the guidance of a master, nevertheless, there are some commonalities with the atelier model. For instance, there is an expectation that course teams should include design tutors with practitioner experience who are able to impart their real-life expertise, professional credibility and

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commercial understandings to students. It also the case that the studio space is the primary arena in which concepts are conceived, discussed, visualised, prototyped and tested. Above all else, the studio remains a collaborative, active place in which ideas are fertilised and brought to life. Yet, the expansion of internationalised cohorts in wider tertiary education over the last 20 years or so is beginning to reveal structural fault-lines that may threaten this long-extant delivery model:

The global landscape for higher education internationalisation is changing dramatically. What one might call ‘the era of higher education internationalisation’ over the past 25 years (1990-2015) that has characterised university thinking and action might either be finished or, at least, be on life support. (Altbach & de Wit, 2018)

If these premonitions are true of higher education in general, then it is reasonable to deduce that these same factors are also beginning to test the limits of the traditional studio-centric model of delivery. The studio as a learning space serves a particular role that is qualitatively unmatched in classroom and lecture theatre-based courses. Its longevity as a specialised design learning arena is testament to the entrenched perception that it is somehow innately essential. Arguably, it is this particularity that is its vulnerability. Ambitions for cohort growth expose its critical weakness: finite occupancy limits. If strategic ambitions for growth are not to be thwarted by capacity constraints, then the hitherto assumed centrality of the design studio as a key component in design course frameworks must come under scrutiny.

2 Methodology

From the Author’s work with international design students stretching back some seven years, a working familiarity with some of the challenges faced by them has led to the identification a number of factors that have been shown to affect their academic progression and cultural assimilation into the world of tertiary design education in the UK. The findings reported here are drawn mainly from a combination of two research approaches: thematic analysis of coded survey and interview data; and direct first-hand observation together with video analysis of students’ participation in routine studio and classroom activities and in interventions designed to disrupt student behavioural within studio and classroom learning spaces. Upon completion of their course, students were asked to complete online surveys and to participate in interviews that sought to cast light on their learning journey, and in particular, the issues that they felt that they had found challenging. These survey and interview data were subject to thematic analysis by coding responses to identify common themes or patterns. Two predominant themes have emerged from the data: 1) That English language limitations, as reported by the students themselves, can have serious negative consequences on student participation and attainment (which is also borne out by pedagogical observation and examination of attainment grades). These challenges, in effect, amount to conceptual learning thresholds that students can struggle to overcome. 2) The power-distance relationship between teacher and student also has a strong bearing on the quality of the student learning experience. These findings suggest that affected students can find themselves struggling within conceptual liminal spaces that they find extremely difficult to escape from and progress. Interestingly, students themselves don’t specifically identify learning space dynamics as having an influence on their learning experience. However, by correlating the observations of actual student participation within conventional learning spaces and during the test interventions with the findings of the thematic analyses, it was possible to construct a schematic of the relationship that tie together many of the identified factors that have been shown to affect student participation and performance within the learning spaces, including the design studio (Figure 1).

2.1 The Challenges of Internationalisation of Design Education

The factors that have driven a globalised need for UK universities to adopt an internationalised perspective are a combination of shifting demographics, a contraction in the numbers of home students progressing to higher degrees (Wakeling & Hampden-Thompson, 2013), and financial imperatives caused by changes to traditional, government-funded structures.

As institutional internationalisation has become an embedded and widely accepted part of the higher education sector, the development of strategies to develop and manage international engagement is increasingly taking place at the national and regional level as well as at the level of individual universities. The UK’s research funding landscape reflects this shift toward driving international engagement. (Griffith, 2017)

CU has, for many years now, wholeheartedly embraced the trend towards internationalisation, seeing it as a both a positive factor in its future financial security and for its enhancement of the student learning experience – both domestic and international - and preparation for the world of employment (Hilton, 2015). European institutions also report the same imperatives and benefits:
Most [Dutch] universities recognise that providing an international perspective to students is central in the 21st century. (Altbach & de Wit, 2018)

International classrooms lead to improved learning outcomes, foster intercultural skills and create international networks preparing both international and domestic students for living and working in a globalised world. (Reinold, 2018)

Yet internationalisation is not without its downsides and difficulties:

Despite the benefits...many challenges remain. For instance, international students are confronted with many challenges upon arrival in the host country, including issues of adjustment, integration, discrimination, financial costs, restricted access to the labour market and other administrative and legal hurdles. (Reinold, 2018)

While these overarching concerns are certainly valid, to some extent many of them are systematic or societal in origin and are arguably beyond the capability of any educational institution to materially effect any wholesale remedy. In the context of this paper and its specific focus on the delivery of internationalised design courses, the objective here is to highlight identified design-specific issues and to offer insights into pedagogical strategies that seek to address them. The key point is that for many international students, the barriers to successful attainment are already high even before they are subjected to the additional challenges and conceptual thresholds of having to adapt to a, literally, foreign learning environment (Reinold, 2018).

2.2 The Importance of Participation

“Participation is a way to bring ‘students actively into the educational process’ and to assist in ‘enhancing our teaching and bringing life to the classroom” (Cohen, 1991, p. 699, cited in Rocca, 2010, p.188). This author’s prior research (CU Ethics Approval Ref: P31299) has demonstrated that sub-optimal physical learning space configurations – topologies – can exercise powerful, deterrent effects on international students’ overarching learning experience (Hilton, 2018). This is a view supported by others (Kao & Gansneder, 1995). As far back as the 1970’s it had been noted that some conventional classroom layouts were detrimental to student participation and discussion, and even minor changes to the classroom layout, for example, changing grid desk layouts to U-shaped configurations, were shown to have a generally-positive effect (McCroskey & McVetta, 1978). Another key factor that has been shown to negatively impact upon students’ participatory willingness is large class sizes.

There are various reasons, both speculative and empirically supported, that students fail to participate in class. One reason is class size, with students being more willing to participate... less anxious about participating... and less likely to be able to ‘hide’ ...in smaller classes than larger classes; large class size tends to hamper communication... (Rocca, 2010, p.189).

Large class sizes seem to amplify performance anxieties among international students, many of whom have been culturally conditioned to adopt self-inhibiting behaviours within orthodox classroom settings (Cheng & Guan, 2012). An intimidating learning space that discourages participation is described by Kao & Gansneder as a “negative classroom climate” (Kao & Gansneder, 1995, p. 136), and it is within such negative classroom climates that Asian students in particular (though not exclusively so) find it difficult to overcome innate behavioural participatory reticence: “Sometimes I want to ask question and I think I will try but then I don’t have courage.” (student interview responses, the Author’s research data, 2015-2018). A further significant influence on student participation is the nature of the relationship that the student has with the teacher (Armstrong & Boud, 1983). Where there is a perceived high power-distance between student and teacher, participation can suffer:

“In China, this [teacher-student] relationship is more like a boss and employee in the workplace. A master tells you what to do.”

“Chinese students do not like to speak in class and only speak if teacher ask them.”

“Communication. Not only the language problems, cultural differences, the fear of making mistakes caused by misunderstanding.” (student interview responses, Hilton’s research data, 2015-2018)

Observation analysis of students’ engagement within a variety of learning situations, reveals a tripartite relationship that connects learning space topologies, English language ability and participatory engagement (Figure 1). Negative feedback cycles (shown in red) consequently affect international students’ learning progression and academic
attainment. Conversely, optimum reinforcement loops (shown in green) create a virtuous feedback cycle that can materially enhance student learning, progression and personal development. And in learning situations in which the student-teacher power distance relationship is also diminished, the beneficial effects are noticed by the students themselves:

“the tutors in UK, they are more like the character of friends, and the communication with my tutor is quite relax and comfortable.”

![Diagram of Hybrid Learning Space](image)

**Figure 1.** How observed international student learning progression is affected by an interconnectedness between English language skills, learning space topology and attitudes to participation. The left-hand flow, shown in red, represents a damaging combination for student progression and attainment. The right-hand combination, in green, is the ideal Hybrid Learning Space and shows the optimal mechanism for fostering student progression and academic attainment. (Hilton, 2018)

It is the Author’s development of pedagogical interventions (Hilton, 2015; 2018) that have been specifically designed to address these issues that has led to the construction of an alternative conceptual studio environment; the Hybrid Learning Space (the green side of the schematic in Figure 1). The HLS paradigm sees student activity taking place within an amorphous conceptual space that comprises a mix of physical spaces (both formal and informal) and digital environments that are contingently occupied according to shifting needs and circumstances. One of its central objectives is to create an overarching conceptual environment in which students are at ease and consequently more inclined to participate and actively, unselfconsciously, engage:

“The freedom is great, you don’t feel trapped and in a *school* environment.”

This quote is interesting because it reveals that the student is aware that within situations that feel like ‘school’ they are disinclined to participate because they have been behaviourally conditioned not to. Engagement and participation within the HLS is both physical and digital, is negotiated, strategically-contingent, and can be synchronous or asynchronous in nature. Students collaborate and communicate as individuals, or in groups and can even simultaneously interact in both physical and digital environments. The HLS model aims to overturn many of the physical constraints inherent in orthodox learning space capacities and topologies while giving students greater control in how they use these spaces – and indeed – any other non-formal spaces that they may care to appropriate as they see fit. There is a design truism; design for the weakest in society and everyone benefits. Thus, the HLS model, while originally designed to address pedagogical issues particular to international cohorts and most specifically, Chinese students, its key attraction is that it offers the prospect that all students, including those domestically recruited, might profit.

Note that under this framework, typically, students normally have little or no control over classroom topologies as represented in the red half of the schematic. Hilton’s E&PDE 2018 paper explores this issue in greater detail, but in essence, the more a learning space resembles an orthodox classroom topology, the more likely it is that students will
be reluctant to participate (McCroskey & McVetta, 1978; Hilton, 2018). Figure 1 shows how intimidating teaching environments serve to militate against a student’s willingness to participate (for underlying social and cultural reasons), which in turn means that affected students don’t gain the practise and confidence needed to improve their English. This can lead to a downward spiral in student engagement, progression and attainment. Thematic analysis of Chinese student survey responses suggests that underlying cultural dimensions are at the root of why they are often passive within orthodox learning space environments, especially those that conform to conventional classroom topologies. Such culturally-derived factors can stymie institutional assimilation and limit their understanding of teaching discussions and what is expected of them:

“In China students are taught from early age not to question teacher but sit still, be quiet and listen. Teacher tell us what to do. Some friendly teacher we can ask questions but mostly not question teacher.”

Other responses demonstrate students themselves are very much aware that language limitations, cultural differences and fear of loss of face can severely harm their learning experience and academic progression, as one Chinese student reported:

“The weakness of your language ability and professional ability will become the obstacle when you study here.”

The only way for students to improve spoken English and to develop confidence in front of their peers is to practise it, as students themselves recognise:

“Language is one of the problems, but I always wanna try my best to practice and keep talking. Otherwise, if I want to do a good design, I must understand more about the culture here.”

Yet learning spaces that conform to orthodox classroom topologies and role expectations have been demonstrated, both in China and in the UK (Hilton, 2018) to militate against willing participation from Chinese students:

“Chinese students do not like to speak in class and only speak if teacher ask them.”

“Sometimes I want to ask question and I think I will try but then I don’t have courage.”

It should also be said that this phenomenon has also been observed in students from other nationalities, including UK students too. This leads to a conundrum; to what degree is this behaviour due to national cultural dimensions (Hall, 1989; Hofstede, 2001, 2010; Sit, 2013) and to what extent is it due to other contributory factors? While the data and students’ own understandings do appear to point to a participatory reticence that is stereotypically characteristic of the Chinese learner (Cheng & Guan, 2012; Sit, 2013), a more nuanced reading of situated learning space behaviour reveals other, perhaps more universal explanations. In observations of UK student behaviour within learning spaces at Communication University of Zhejiang (CUZ) in which lessons were conducted in Mandarin, Hilton reports that:

Uniformly, they [UK students] retreated to a collectivist, passive attitude…uncannily like the behaviour of newly-arrived Chinese…students in UK classrooms…The implication seems clear; if students from differing cultures exhibit similar situated behaviour when exposed to culturally alien learning environments, then these observed responses cannot be explained in terms of cultural difference alone. (Hilton, 2016).

3 Case Study: COIL, Hybrid Learning Spaces and Student Participation

At Coventry University, one aspect of the drive towards an internationalised student learning experience is the participation in short-term activities called Collaborative Online International Learning (COIL) projects. COIL projects are collaborations between the University and international partner institutions that deliver comparable courses and are typically run over one or more weeks. The key characteristic of COIL projects is that they are orchestrated and delivered entirely online, while necessary background activities take place within physical spaces. The case study under discussion was run in January 2018 and involved design students at Coventry University and product design students at CUZ. At CU, the design students were a mix of both undergraduate and postgraduate from the disciplines of product design, interior design and design & transport. The participating students were from a diverse range of nationalities, including Korean, American, Polish, Indian, Lithuanian, UK and Chinese. This cultural mix, vertical integration of courses and cross-disciplinary engagement adds a richness and complexity that is generally not present in traditional discipline-specific projects. The brief was that groups from each cohort had to design a trophy that would be awarded to graduating design students of the other’s institution. So, CU student groups would design for
graduating students at CUZ, while those in CUZ would design for the students at CU. The brief made explicit the requirement that students from the two institutions would need to demonstrate that they had empathetically collaborated in their quest to discover the essential underlying cultural ethos of each institution as well as gaining insights into the wider, overarching national cultural differences. It was not enough simply to design a trophy based on superficial concerns, such as aesthetics, but rather, the design outcomes should clearly signal an empathetic and considered awareness of each institution’s cultural and philosophical values.

In COIL projects the involvement of academics is kept to a necessary minimum and the role is essentially that of a facilitator, guide and behind-the-scenes coordinator. In that regard, preparatory discussions between tutors from the two institutions revolved around the construction of the brief, how the project would be administered, monitored and outcomes delivered. For synchronous online meetings, it was decided to use Teamviewer, a browser-based conferencing and remote assistance tool, capable of Skype-like live-stream video discussions from course studios while also allowing participants to dynamically share computer desktops to access and exchange files (Teamviewer, 2019). For other synchronous and asynchronous communication, WeChat – a ubiquitous Chinese social media app along the lines of WhatsApp – was chosen, not least because course students at CU have also been using it for some years now and were already familiar with it (WeChat, 2019). Capable of simultaneous, multi-user video discussion and audio live chat, text messaging, in-built Chinese-English translation, image and micro-video posting, its versatility and connection resilience made its use especially suited for this project. More prosaically, both Teamviewer and WeChat, unlike some rival applications, are permitted communication tools under PRC Government internet access policies.

The week-long project was formally launched with an online Teamviewer meeting in which students and tutors from both institutions introduced themselves via a live video stream from each other’s studios displayed on large digital displays. Students were allocated to groups which were then paired up and then WeChat ID’s were exchanged. Almost instantly, while the meeting was still in progress, students began communicating with each other via WeChat sending messages, pictures and mini-video clips of each other, with some of this activity being visible on the studio display screen in real time (Figure 2). There was much giggling and good-natured banter as the students quickly set about getting to know each other and exchanging contact details. After a run-through of the brief and a question and answer session, the students were given final instructions and reminded of deadlines and expected deliverables. What was striking was that even at this preliminary stage, all students were relaxed and extremely keen to communicate and participate within this online paradigm. There was no evidence of any participatory reticence.

Over the course of the following days, it became clear that the students were evolving their own ways of working and collaborating with each other that suited their preferences and circumstances. This was most apparent in how they

Figure 2. Screen grabs of WeChat discussion showing communication between Chinese tutor (on left) and English tutor (on right). Note the in-app translation of the Chinese text and the English speaker’s use of Chinese characters to say goodbye. The right-hand image shows students in China live video-streaming themselves from their studio, while simultaneously using WeChat to exchange messages with their UK counterparts. (Hilton, 2018)
handled the time difference (China being 8-hours ahead of the UK). Synchronous WeChat discussions tended to take place either early in the morning or very late at night. Where asynchronous communication was enough, then questions, requests, messages, images and micro-video clips were posted to the WeChat discussion group to await later responses. In terms of the students’ use of physical space, it was striking that students didn’t necessarily choose to work in the studio. The stages of research, concept generation, design development and prototyping were all carried out wherever it was felt to most efficacious for them. Variously, this meant working from the studio, from home, in public University spaces, in the library or workshops. During these sessions, students would capture images and videos of themselves working in these environments and post them to their WeChat group discussion accounts. This behaviour seemed to serve two purposes. One, was that it kept the partner group up-to-date with developments and progress; but, perhaps more importantly, it seemed to serve a social function in helping to strengthen the bonds of friendship and collaboration. Certainly, for this media-savvy generation, this appeared to be for them an entirely natural approach. What was absolutely, strikingly clear was that all parties, regardless of nationality, were completely at ease and happy working this way. Indeed, almost all the video-streaming sessions were punctuated by the sound of laughter and no-one seemed reticent in participating (Figure 2). By taking complete control of where they chose to operate, in both physical and digital environments, students had eliminated any performance anxieties as they engaged with each other under their own terms. Without conspicuous oversight from tutors and the imposition of a concomitant power-distance dynamic, the students were spontaneous, gregarious and entirely without introversion in their dealings with each other. They simply got on with the task, taking full control and collaborative responsibility for their progress. No doubt the tools helped in this regard, especially WeChat. Perhaps most impressive was that the inbuilt translation function within WeChat really helped overcome language barriers and communication reticence (Figure 2).

![Web cam streams live presentation via Teamviewer run on laptop connected to room display screen.](Author, 2018)

A key characteristic of the HLS paradigm is that while certain key hardpoints of course delivery still necessitate face-face engagement within studios, workshops and learning space topologies, for other activities such as independent study, supervision, feedback, tutorials and content provision - these can be delivered within ephemeral, negotiated online environments. Central to the HLS model is that learning delivery takes place within a variety of contingently-suitable physical and conceptually-alternate online spaces while still having direct access to teachers and learning support. The shift between physical space and digital is often dynamic and students can find themselves learning, collaborating and operating concurrently within both physical and digital learning spaces depending on circumstances. Students themselves are key determinants of where, when and how these conceptually-alternate spaces are inhabited. The project design outcomes were delivered as an online Teamviewer session in which each group of students took it in turn to a 10-minute presentation of their proposals. The start was delayed due to a technical glitch affecting the video feed. Interestingly, because the respective tutors were still able to communicate via WeChat, this did not prove fatal and during the time it took to resolve the problem there was very little evident anxiety and both students and tutors continued to chat freely until normal service was restored. The atmosphere remained relaxed and
tension-free. In retrospect, what this demonstrated was that such was the strength of the bonds that had formed over the preceding days, the sense of familiarity with each other meant that there was no sense of panic. In many ways, it was a great test of the experiment. In overcoming the technical setback, it showed that all parties had developed an evident tolerance of uncertainty that had enabled them to take setbacks in their stride. The deliveries themselves – enthusiastically received web cam streams of the students presenting their work against a backdrop of PowerPoint slideshows - went without hitch, being live-streamed to studio display screens and laptops (Figure 3).

The implementation and delivery of the COIL project drew upon aspects of practices inherent in the delivery framework that characterises The Open University’s design courses – most notably, module U101, Design Thinking in the 21st Century. While the OU does not possess workshops or studios in which students can engage in the physical construction of design models and prototypes, it is still able to offer design-specific modules that are part of pathways towards degree qualifications. Design modules at the OU are delivered within a mixed-media online learning environment that includes a Moodle-based content delivery framework, a bespoke assignment submission application as well as online fora and a conferencing application (Adobe Connect) for synchronous and asynchronous, peer-peer and peer-student communication and tutorials. It also features a virtual studio - Open Design Studio (ODS) - in which students can post images of their hands-on activities and artefactual outcomes that they have created, usually within their own homes.

Additionally, students get the opportunity to meet with each other and with their tutors several times across the duration of their modules in classrooms contingently hired from schools and colleges. That said, the students don’t get to form close face-face working relationships with each other, though they do self-initiate the formation of discussion groups on social media (typically, Facebook). These discrete online groups are popular and sit outside the formal forum environment that forms part of the OU’s online learning environment. In that these moves are organised by the students themselves, this strategy has much in common with the CU and CUZ students use of WeChat as their preferred online collaborative environment and learning space. From the author’s direct experience of this framework, when it works well it is extremely effective and motivated students respond fruitfully to these modes of delivery. Aspects of the COIL paradigm also drew upon the delivery framework at Shanghai Open University (SOU). The only design course there is in graphic design, and the delivery differs in as much as the students do actually attend physical classroom sessions on site in which they learn and participate in the hands-on skills of their discipline. This is more akin to the traditional University paradigm than that of the OU’s. While much of the content is delivered and administered online, which the students consume at home, in discussions with the course’s tutors and administrators, their view is that with the particularities of teaching art and design courses, the tutor’s role and physical presence remains essential in imparting technical skills. Their view is that there is no substitute for the ability of tutors to be able to demonstrate and coach vocational techniques in the presence of students while offering direct pedagogical guidance. Simply, while technology and online systems can do much, for some things there is no substitute for a good teacher.

4 Conclusion

By common consent, both from the students’ and the tutors’ perspectives, the COIL project was hailed as a success. Notably, all students – both in China and the home students in the UK – reported that they had never previously worked in this way before and some declared it, ‘the best project we’ve ever worked on’. Similarly, the CUZ and CU tutors were impressed with the outcomes and the way the students collaborated and took responsibility for their own learning journey. The two institutions are continuing to collaborate on further projects. The project has demonstrated that notions of what constitutes a learning space – and that includes the design studio space – appear to be conceptually malleable if circumstances are propitious. Participating students have continued to use WeChat for their personal convenience and collaboration beyond the requirements of the COIL project. While the HLS project is still in its infancy, in broad overview, some conclusions from the COIL project can be drawn:

- In international cohorts, the relationship that ties together English language mastery, learning space topologies/dynamics, and student participation, can have a profound effect on student engagement and attainment. (Hilton, 2015, 2018)
- The use of appropriate technologies – and students’ freedom to use them under their own terms – can materially encourage unselfconscious and relaxed participation by reducing performance anxieties related to factors such as loss of face, perceived power-distance intimidation and an increased sense of control. With increased participation comes better chances of improved progression and attainment.
- Student participatory reticence is complex, especially in the context of perceived national cultural stereotype (Hall, 1989; Cheng & Guan, 2010; Hofstede 2010; Sit, 2013). But even where cultural factors do incline students
The Evolution of the Design Studio: Hybrid Learning Spaces

towards introversion, this project has demonstrated that reconsiderations of what constitutes a learning space and the judicious use of appropriate technology can significantly facilitate unselfconscious student engagement.

- The project has shown that while students did have access to their studio spaces, it became clear that they weren’t necessarily the spaces in which creative endeavour actually took place. Rather, the studio became more a contingent central meeting point at key strategic milestone stages.
- While the role of tutors during the project was more of that of mediator and facilitator, nevertheless, as the team at the OU and SOU also identify, it remains the case that the tutor occupies a key role in the delivery of a design education. While students did always have live access to tutors via WeChat, it was still the case that students wanted and valued face-face contact with tutors at key moments, especially during ideation and creative phases where work could be shown and discussed.

The pragmatic reality is that the COIL project, while it worked well, lasted only a week. The development and shaping of its underlying philosophy into a workable HLS schema that could eventually be deployed over the course of a semester or even a whole academic year is very much a challenge of a different magnitude. The next stage is how that transition can be made and this is the focus of a live research project that commenced in March 2019. Upon its completion, it is hoped that a further paper will document the outcomes of that research.

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References


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Dichotomous Tension: A Route for Self-Discovery in Architectural Pedagogy

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Abstract: This paper presents the initial findings of an ethnographic study that explores the different facets influencing the socio-cultural context and their impact on the flow of design knowledge between students and the instructor within a specific pedagogical architectural design studio in Cairo, Egypt. The study uses ethnography, where the first author of the paper joins the studio of the second author as a participant observer to be able to understand how the socio-cultural system within the studio influences the students’ experience. In this investigation, students and recent graduates of this design studio were interviewed regarding their perception of the studio, the instructor and the process. The analysis, which used grounded theory as its basis, started to reveal a series of themes that appeared to be working in tandems. In this paper we discuss the first two emerging themes that created The Push and The Pull dialectic. Their interdependent duality gave shape to a specific socio-cultural context for the studio, and appears to have played a role in shaping the students’ perception of the course while affecting the flow of design knowledge in it. The resulting state of dichotomous tension influenced students’ behaviour by pushing and pulling them towards a state of self-discovery that led most of the interviewed students to consider the studio under study as one of the most influential in their learning experience within their school of architecture.

Keywords: architectural education in Egypt; ethnography; architectural pedagogy; design process; design education

1 Introduction

In the 1980s Nigel Cross (1982) called for research into the ways by which architectural education plays a role in developing the innate cognitive abilities in design students. This to him appeared to be necessary for two reasons, first to understand how designers (students and professionals) know and think, and also to understand how to use design as means of developing students’ cognitive abilities even beyond architectural pedagogy. The focus on students and their instructors (people), how they learn to design (process), and the outcome of that design process (product) is necessary, from his point of view, to shed light on the nature of design knowledge and its role in the development of design abilities in individuals (Cross, 2001).
Research has been carried out to understand the cultural framework of architectural education and how it satisfies the demand for essential design knowledge and skills, and to explore students’ perception of the design process within the studio, depending on surveys conducted: to understand studio related problems from students’ point of view (Sachs, 1999); to evaluate different studio assessment and critique methods (Uraberta et al., 2013); or to quantitatively evaluate the best practices in design studios from the point of view of faculty members (Soliman, 2017). Önal and Turgut (2017) also carried out an experimental study to investigate the relation between the design activity and the designer’s cultural schema in the design studio, where they evaluated the interaction between the architectural design process, as a learning system conducted by the instructor in the studio, and the cultural schema.

The importance of understanding these socio-cultural interactions, especially the influences of the instructor, is highlighted by Schön (1987), as he sees the instructor as both coach and professional consultant. Simmonds (1981) adds that the instructor’s opinion is even sometimes appreciated more than the subject matter taught. The relationship hence established between the student and instructor is an emotional one that affects the dynamics within the studio (Austerlitz et al., 2002).

This focus on the socio-cultural dimensions is further validated by Mihaly Csikszentmihalyi (Csikszentmihalyi, 1988; 1999), who asserts that creativity of individuals cannot be isolated as a mental process from the socio-cultural systems in which they function. Csikszentmihalyi further explains that creativity is a process that results from an interaction among three main forces: culture, which stores and transmits the selected ideas, values and beliefs to the next generation; the social system, which selects behaviours, values and information that are worth preserving; and the individual, who transforms the social and cultural domain.

Only a few recent studies have tried to focus on studying the pedagogical design process within that socio-cultural context. By studying two different departments of architecture, Sachs (1999) identified how the studio does not only require students to complete a designed project, but also negotiate social relations with their instructors and fellow students. She identified in her study how social pressure could also lead to a state of stuckness that inhibits the students from developing their projects. Austerlitz and Sachs (2006) present how modifications to a studio project could influence communication between students, and hence enhance design as a social act within that studio.

Önal and Turgut (2017) indicated that the architectural design education depends on the cultural schemas and social interactions occurring between students and their instructor within the studio, where these interactions are interpreted as cyclical processes, in which the individual’s normative values are transformed into the behavioural mechanisms that allow for the emergence of relevant design knowledge, which is the most important outcome in the pedagogical design process. Austerlitz (2007) recommends that ethnography amongst other qualitative methods should be used for one to be able to research students’ learning experience within the social context of the studio.

2 Research Goals and Scope

This paper presents the initial findings of an ethnographic study of the 8-week summer semester of the course ARCH 454 / 4555: Architectural Design Studio 4, taught at the American University in Cairo (AUC), Egypt. The study focuses on what Cross (2001) considers as the three main sources of knowledge within design research, namely; the people (the instructor and students), the process, and the design product.

The study is based on the assumptions that design is not only a cognitive process, but also a social one (Kalay, 2001; Alexiou & Zamenopoulos, 2008; Oak, 2011), and that architectural pedagogy in the specific socio-cultural context of Cairo, Egypt while being understudied, could also reflect specific dimensions different from other cities and countries. Social interaction factors such as team planning, reviewing, prioritizing, persuasions, negotiating, and commitments to ideas and instructions, that are usually used within design processes to resolve or avoid conflicts (Cross & Cross, 1995), were analysed, and students and faculty members were interviewed to understand the reasons behind their actions.

Accordingly, the study was based on participant observation to allow the immersion in the day-to-day studio practices of the ARCH 454 course. The first author–hereafter referred to as the participant author–was actively involved as a participant observer, and therefore was acting as one of the teaching assistants in the team led by the course instructor who is the second author. The authors chose ethnography and participant observation as means to explore the inner workings of the course in its natural setting.
3 Research Method

Ethnography along with participant observation were selected as strategic qualitative methodologies in this study to comprehend the full technical and socio-cultural attributes of the design decisions under study and their specific context (Fischer & Finkelstein, 1991). Such an approach allows the study to understand the educational design phenomenon within its natural environment. It attempts to make sense of and interpret the phenomena under study in terms of the meaning people bring to them (Denzin & Lincoln, 1998).

The study also used open-ended and semi-structured interviews to collect qualitative data regarding the studied course and its history from students (enrolled in the studio at the time of the study and previous ones) regarding their experience, and faculty members (instructor and teaching assistants) regarding their insights.

The study used grounded theory coding as basis for analytic induction, where the emergent phenomena were identified from the observed data and respondents’ words through a series of steps that would guarantee a good theory as the outcome (Glaser, 1967). The process went through iterative cycles of coding to identify the thematic influences of social interactions on all aspects related to the design process within the studio. The basic idea in these steps involved the continuous examination, comparison and reading of multiple sources of data such as field notes, interviews and memos to arrive at a set of emergent phenomena (Strauss, 1998).

4 The Context

Following is a description of the context in which this ethnographic study took place.

4.1 The University

The AUC was founded originally in 1919 as an American-accredited private institution of higher education (Murphy, 1987). Its governance is very different from that of the secular government universities represented by the ESCU, as it attempts to provide a university education conforming to the American model, with its program rooted in the liberal arts education (Shann, 1992). The AUC has the highest fees when compared to all other state and private universities in Egypt, with its fees far above the means of the majority of Egyptian families (Richards, 1992). Also, AUC’s policy of admitting only students who have mastered the English language ensures that most of the students are of a certain socio-economic background (Murphy, 1987, p. 41).

The Department of Architecture at the AUC was first established in the School of Science and Engineering as part of the Construction Department in 2010, which became an independent architectural department in 2015. The course is part of the undergraduate Bachelor of Science program, which is completed in ten terms (five years) for full-time students. The program is recognized by the Egyptian Supreme Council of Universities ESCU as equivalent to Egyptian Architectural Engineering degrees.

4.2 The Course

The ARCH 454 is a 4-credit course that takes place in the fourth year of this five-year program. Architectural Design 4 presents a design process that maintains a dialectic feedback between the faculty members and the students, with focus on the role of structures on the development of architectural design concepts. The course instructor who has a Ph.D. degree has been teaching design for more than twenty-five years, and specifically this process-oriented design course for fifteen continuous years, the last eight years of which were at the AUC. For teaching assistants there was one senior adjunct teaching assistant with a M.Sc. degree, two junior adjunct teaching assistants, a student teaching assistant, and the participant author whose tasks included the documentation of the course, which was a task that the instructor has maintained for three previous years.

The class consisted of thirteen students, eleven females and two males. Consent forms were obtained from all student respondents, and they were informed along with the teaching assistants of the nature of the study from the first day of class.

The course is originally about 15 weeks, with six contact hours per week leading to a total of 80 hours of contact time in the fall/spring semesters. However, for the summer semester it is officially a six weeks course, with nearly 15 hours per week. However, for its demanding nature and due to an official holiday falling within its period it extended to eight weeks, leading to a total of nearly 69 contact hours throughout the term. Figure 1 below summarizes the contact time with the students where discussions, one-on-one feedback, group crits, juries and presentation took place.
Classes met three days a week between 1:00 pm and 6:00 pm with an average contact time of four hours. All 18 attended classes—except the first two—were held in the studio space shown in Figure 2.

![Figure 1. Timeline of the course](image)

![Figure 2. Top view perspective of studio](image)

**5 Data Collection Procedure**

The data collected was in the form of general field observation notes made by the participant author, audio recordings of nearly all interactions made between students and all faculty members within the studio, images of sketches, drawings, models and activities were taken throughout all the different stages of the semester. In addition, extensive digital video recordings were made capturing all general activities occurring in the class from start to end using one camera, while more specific and individual discussions occurring between instructor and students were recorded using the second camera. Also open ended and semi-structured interviews with six previous and all 13 current students of the course were conducted for durations ranging between thirty to sixty minutes and in the periods shown in Figure 3. Questions were mainly in English, but in answers and discussions English and Arabic languages were used. All the interviews were transcribed, and were archived in a database along with the field notes for convenient retrieval and access using Microsoft Office Excel.
6 Coding and Analysis

Three main methods of grounded theory coding were conducted in the analysis phase: open coding, axial coding, and selective coding. The main initial goal of the open coding stage was to identify how the students perceived and reacted to the instructor and his method and feedback throughout the process. CES313 for instance mentions in an interview that “We get to be asked ‘What do you think? What do you see?’”. For such interactions referred to by the students or observed and occurring within the studio conceptual dimensions were developed as memos alongside the transcripts, as abstract representations. The memo taken for the mentioned quote by CES313 was Transcending Subjectivity. Those concepts established from the memos were classified into codes, and for the mentioned concept the code The Convincer was given, as this view of the instructor as one who seeks to convince rather than instruct appeared to have manifested in different concepts and forms with different students.

Upon the recurrence of similar coded concepts, and cessation of new significant codes, the sets of concepts established in the open coding stage were refined and an in-depth study of the connections between them was carried out. This allowed for the emergence of clearer sets of codes, and more detailed subcategories for these sets, while allowing for the creation of higher main categories. Such main categories along with their corresponding codes, and concepts were all rearranged in a new list presenting the filtered codes. The code The Convincer along with other codes describing how the instructor engages the students fell under the main category of Engagement. After several iterations of transcript review, and parallel open and axial coding analyses, several codes and higher categories were developed, revised, added, and/or eliminated. This process continued till saturation was achieved, and no new information, properties, and/or dimensions were observed in the collected data. Higher patterns of relationships between the main categories allowed for the identification of several themes that described the socio-cultural context of the studio, once such theme that included the main category Engagement was the theme The Pull.

Table 1 illustrates the final nomenclature used identifying the hierarchy of the terminologies used hereafter. The table also shows the example of the emerging code presented in this section.

<table>
<thead>
<tr>
<th>THEMES</th>
<th>MAIN CATEGORIES</th>
<th>CODES</th>
<th>CONCEPTS / MEMOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Pull</td>
<td>Engagement</td>
<td>The Convincer</td>
<td>Transcending Subjectivity</td>
</tr>
</tbody>
</table>

This study used two different methods for qualitative validation; inter-rater reliability, and reprocessing raw data. The goal was not only to seek validation of methods and emergent findings, but also to use those methods as additional sources of data collection and insight. Typically, inter-rater reliability is a process where concurrence is established among more than one coder in the attempt to find rigor concerning the methods used to code and interpret the results. The goal of this process is to identify the degree of similarity in judgments between independent reviewers with a considerable agreement that indicates high inter-rater reliability (Touliatos & Compton, 1988). Reprocessing raw data was used by going back and comparing the final scheme against the raw data, thus conducting a high-level
Ramy BAKIR, Amr Abdel KAWI

comparative analysis. The theoretical emergent scheme should be able to explain most of the observed cases and events (Strauss & Corbin, 1998, p. 159), which was the case.

7 Emergent Themes

The narration of the analysis and findings of such a qualitative study is as complex as its data collection and analysis, where written language is not merely a method to communicate findings, but rather an analytical tool (Hammersley & Atkinson, 2007), that is why the writing of this paper has helped the narrative to further unfold textually, which has also led to another layer of rearrangement of the findings in a form that made more sense in regards to the events analysed, and to the authors. That final set of themes is summarized in Table 2.

<table>
<thead>
<tr>
<th>THEME</th>
<th>MAIN CATEGORIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>THE PUSH</td>
<td>Toughness</td>
</tr>
<tr>
<td></td>
<td>Serious Job</td>
</tr>
<tr>
<td></td>
<td>Unique Quality</td>
</tr>
<tr>
<td>THE PULL</td>
<td>Engagement</td>
</tr>
<tr>
<td></td>
<td>Studio Culture</td>
</tr>
<tr>
<td></td>
<td>Self-Learning</td>
</tr>
</tbody>
</table>

Two main themes emerged from the coding stage. Together they connect the emergent codes and main categories in a manner that provides a holistic portrait of the experience and process specific to the socio-cultural context of the course ARCH 454. The two themes are: The Push and The Pull. Each theme encompasses three main categories of codes that capture the different facets of the socio-cultural context.

7.1 The Push

The theme titled The Push evolved to connect the main categories and codes that describe the model by which the main and secondary tasks of the course were presented to the students by the instructor from the beginning of the course and throughout its different stages. That model created a certain state of immediacy and urgency for the students.

Three main facets capture how this theme manifests. First, the tasks were presented and evaluated with a certain level of toughness that pushed the students to work hard from the start. With the reputation of the instructor as a tough grader preceding the semester, the students knew that this was one of the few design courses where they could actually get a failing grade. That fear pushed the students to work hard from the start. The toughness also materialized in the rapid assignments in each week. The three times a week schedule was another factor since students were used to a twice a week schedule for fall/spring semesters.

The second facet captured how all tasks at hand were presented as a serious job. Once again, the reputation of the instructor played a role. Some of the students stated that previous students informed them that the instructor was a relentless one who would push them to their limits in terms of the workload, other students expressed how he stated the course requirements in a way that highlights the necessity of doing a lot of research and work from the start, while shifting from 3D to 2D tasks in each stage, and back again. The observations of the participant author also captured how the seriousness of tasks is underscored by the dense feedback given by faculty and sought by the students.

The third facet of that sense of push exerted on the students manifested in the unique quality they perceived in the assigned tasks, as well as in the methods of feedback implemented in each stage; a quality that was not evident to them in previous courses. One of these unique qualities revolved around the project concept, and how the instructor framed it and broke it down into tasks and questions. Together they highlighted the importance of the concept in the process of design. The course also allowed a longer period of time for concept formulation, and even longer time for
In terms of uniqueness, the students also noticed how the instructor did not place heavy emphasis on rendering and post production of drawings in the interim stages. CES11 says that the instructor “Mainly focuses on the plan and the sections”, which allowed the students to spend more time on details and development of their narratives, rather than the “poster design”. One of the unique characteristics of this course was its evident focus on 3D modelling as a design tool for capturing and expressing meanings and ideas. This surfaced repeatedly from the observations and interviews. Models of varying scales, intentions and materials were encouraged increasing gradually in refinement building on the gained experience of previous stages. The instructor also chose to always use models to demonstrate his feedback, where all student models were discussed collectively and comparatively, some getting disassembled and reassembled or modified in such a way that revealed ideas to students. There was a clear attempt to rattle the student’s tendency to see their models as a finished representation of the idea and not as an exploration and idea testing tool.

These three categories of codes came together to describe how the instructor’s method of announcing the tasks, reminding of their goals, following up on the progress, and giving his feedback created a push context that constantly gave a sense that the task at hand was tough and required a serious amount of work, while having a unique beneficial quality. CES6 mentions how that approach, although being hard, allowed them to take concepts more seriously, as “this term we are actually using the concept as a driver rather than adding it at the end”, and CES9 felt that “we are learning too much in so little time”.

### 7.2 The Pull

The theme **The Pull**, captured the codes describing how the context pulled the students through the different hard tasks by providing supporting techniques and methods. **The Pull** theme was developed in three distinct areas: **The Engagement, Studio Culture, and Self-Learning.** These three facets seemed to both independently and collectively operate in the different stages of the course to create a context that supports students in the ordeal they felt they were put in by being pushed into this rapid demanding task of designing a unique product using a unique and different process.

First, it was observed and mentioned by the students, that the instructor asks a lot of questions when presented with any designed product. It was mentioned in more than one interview that the instructor is “always asking why?” It was noticed by both the participating author and the students that his questioning is intended to allow him, and them, to better understand what they wanted to achieve, and as CES13 mentions “we reach common ground together due to him asking”. Then the instructor was noticed to follow up with further questions of “How can we make this better?” as CES5 puts it. The students seemed to notice how this was different from the feedback they were used to from previous instructors, and more importantly, they also appreciated how the instructor sought to put himself and them in a constant state of engagement. The continuous line of questioning every time he sat down with one of the students or in a group crit appeared to allow him to engage their products while allowing them to engage his process. CES13 saw the process to be more inclusive, as she noticed how that “Other professors don’t care if I am convinced or not, [He] however wants us to leave understanding and making sure by asking a lot about how the thing works”.

The **Studio Culture** created within the socio-cultural context of the studio was the second facet of the pull theme. One of the main contributors to the creation of that studio culture was the constant state of collective learning. The studio was turned from a space where students came to receive instructions and feedback from faculty members, to a stage where students have equal and collective opportunities to present, receive instructor feedback, receive collective feedback, and learn from collective mistakes. This studio culture also allowed students to collect diverse design knowledge presented not only by the instructor, but also by the processes and products presented by the other students. Constructive feedback took a new form that is beyond that provided by the instructor. Pointing out the mistakes in one model was more obvious and acceptable when discussed by fellow students. That open culture created in the studio allowed students to clearly understand where their development stands in comparison to the rest of the students, and push those who wished to excel further. Also, another perceived benefit of this studio culture expressed by one of the students was that being exposed to all the other projects with their different structural systems and challenges gave her a reservoir of ideas to use in future design projects in future courses even if she herself did not use that specific system in the AR454 course.

The third facet of the pull manifested as students felt they gained the tools required for self-learning. The instructor created such a context by doing three things. First, he announced from the first day of class that mistakes are welcomed in his studio, such a notion was brought up explicitly several other times that they were important learning
tools. This attitude was affirmed in instances when students were allowed to complete their presentations although several technical mistakes were presented, and the instructor only pointed out the mistakes in case other students did not point them out, while still appreciating the rest of the effort put in other parts of the presentation, which the students looked back on with appreciation. That encourages students to try out new ideas and/or present them while not being inhibited by their potential shortcomings.

Secondly, the instructor always asked the students to go and research what was missing or problematic in their proposals without providing them with the solution. This grounding of the process in the research allowed them to resolve whatever mistakes they made themselves, and instilled self-confidence and independence. Thirdly, this self-learning and research-based approach was enforced by information retention, as the instructor did not give any lectures other than the comments he made while the students made their structural research presentations in the beginning of the course, and then in his design feedback in the rest of the course. Only one student expressed experiencing elevated stress from not being told what to do specifically, which took her into a tunnel vision on that underdeveloped solution struggling to develop it further. However, with time she managed to emerge from that state and began to gain more confidence and control over her development.

These three conditions, of heightened engagement, open studio culture, and self-learning process appear to have together allowed the students to acquire enough design knowledge to be able to express their concepts and develop their ideas independently in the first two projects they were assigned, depending mainly on the general critique they got from the instructor in the group crits. More individual, one-to-one feedback was necessary to resolve more intricate details in the third and larger final project.

8 Conclusion

It appears that those two states of push and pull collectively contributed to creating a socio-cultural context for the studio that became perceived by the students as a unique course process. The context had already presented itself to the students even before registering to the summer semester course through the course reputation. The push attributes of the toughness of the process, the serious job required from the students, and the unique quality of the processes and products required in each stage, together emphasized the prevalent sense of urgency and propelled students ahead throughout the duration of the course. That sense of urgency appears to have been balanced by a sense of support that helped pull the students through their ordeal within the studio. That support presented itself in the form of the engagement the instructor achieved with them, the studio culture cultivating peer-learning, and the environment that encouraged self-learning.

This balance has created a state of the optimal load, which does not exceed the students’ abilities, nor fall short of pushing them to test their limits to gain beneficial knowledge and experiences. This balanced tension allowed the students to take risks and to make mistakes while feeling supported by the faculty and the context. Simultaneously, the persistent push for continuous development with each stage of the process and with each of the three projects gave the push-pull dialectic a progressive trajectory. This allowed the students to engage the course with a sense of exploration that is regulated by the seriousness of the process, ensuring the exploration of new design knowledge, by ensuring its efficient use in the project. This student-centred educational approach appears to have admitted different possibilities and generated new interventions as postulated by Önal and Turgut (2017).

A part of that acquired design knowledge—and one that played a major role in the course—was the understanding of how structural systems influenced architectural design, which is considered a kind of professional knowledge that is most effectively learned by students especially during states of engagement and participation (Cross, 1983). The interviews revealed how some of the students’ first-hand model assembly of structure-based experiences achieved what was identified by Nigel Cross as the tactile experience (Cross, 1983).

Such an experience appears to have accentuated their sense of structure in their following courses, and gave them a feel of how their structures work, rather than simply how to calculate its loads. The intensive model-making experience typically allows students to gain their structural design knowledge as tacit knowledge (Polanyi, 2009), hence raising their skills in using different structural systems. That model of teaching allows the students to appreciate directly the qualities of the materials and systems through the tacit sensations of the tool in the hand (Schön, 1987, p. 23). The ARCH 454 course achieves this via continuous first-hand model assembly of structure-based models, and the regular force-load testing that these models have to bear in each design jury, which acted as part of that push that the students anticipated to face in each class.
Dichotomous Tension: A Route for Self-discovery in Architectural Pedagogy

That socio-cultural context of the course places the students and their buildings under the stress of failure and breakdown. That breakdown brings about a moment of interruption of the habitual manners by which students design, which is essential for the development of their design skills. Such breakdowns are important positive cognitive functions that reveal to the new students the nature of design and buildings making them “present-to-hand” (Winograd & Flores, 1986, p. 77).

Engagement and critical inquiry tend to foster students with stronger grasp of the creative process (Callahan, 2017). With the constant critical feedback and pointing out the missed dimensions or potentials, students were pushed to explore more alternatives, which forced them to detach themselves from the anchor of that first design alternative that inhibits them from seeing other alternatives. The first alternatives are usually the obvious ones, and their development comes in the form of the limited tweaking of it, leaving the more creative alternative unreachable (Keeney, 1996).

Relying on his reputation as a tough grader, the course instructor was actually free not to prove that all the time, which allowed him to provide those methods of pull within the context of the studio as to foster competence in the students. It also seemed to free the students from focusing on the grades and instead they focused their attention on figuring out the next steps.

Furthermore, the instructor’s collective discussions created a platform of equality, where the opinions of students are as relevant as his. This manifests in his constant invitation to the students to evaluate and grade several of the products designed by their fellow students. With this, the instructor suspends the traditional hierarchical power structure within the design studio which contributes to the students’ sense of empowerment and encourages further exploration. An increase in the sense of democratization is considered important for the overall improvement of the quality of the architectural professional services and products at large (Ward, 1990). Such distribution of power in the studio and its positive influence of encouraging ideas and voices appear to correspond to findings of similar studies (Austerlitz & Sachs, 2006).

The continuous collective juries and discussions allowed students to benchmark their projects within the group’s output, thus developing a sense of their progress relative to the patterns within the whole student group. This pushed the students to change (Alexander, 1964, p. 54), especially when they perceived results of their work to be weak within the larger pattern of the class. Those collective juries also allow each student to publicize the output of their conceptualization in a public arena over and over, hence allowing them to feel comfortable exposing their new ideas, which is usually thought of as a risk (Adams, 1994). The instructor’s ability to initially accept all ideas allows the students to overcome that emotional block that keeps most students from sounding their ideas and trying to convince others with their validity, which decreases the emotions of fear of failure and embarrassment which usually puts students in a situation of stress (Austerlitz, 2007). This is assumed to be one of the reasons behind the feeling that many of the course students got after the course, namely the feeling of being designers. This also seems to have elevated the social pressure that tends to put some students in the situation of stuckness as postulated by Sachs (1999).

It appears that those special characteristics related to instructor and method contributed to shaping the socio-cultural context of the studio differently from the other studios in the same school, according to the students. The emergent context appears to be characterized by a state of dichotomous tension that leads the students into a process of self-discovery, which exceeds the specified learning outcomes of the course. This may also explain the perception by many of the architecture students in the AUC that there was something different, or even unique about the learning experience in this course.

9 Further Work

That dichotomous tension between the push and pull process appears to consequently allow for the emergence of another balance between two other phenomena within the studio. For the instructor to gauge and adjust the balance with the different temperaments of the different students, and the different stages of their progress, another balance between a state of obscurity and challenge from one side, and a state of hope and vision on the other appeared to play an important role in complementing the initially identified balance between the push and pull. These two new themes have emerged through the gathered data are yet not fully developed, and it is our intention to further explore those themes and their relation to the push-pull dialectic in another paper.
Although the paper represented the themes involved in the specific case of the studied studio, these themes do not present a specific recipe for a successful process-oriented structure-based course, since the interplay between them and the continuous evaluation and modification of the process according to the student performance in class remains the paramount issue achieving a successful mix.

The authors of this paper intend to further analyse and compare the findings of this study with other data collected regarding student individual project development and faculty teaching styles. It also intends to analyse the findings in relation to educational psychology in terms of factors related to the motivation of learning, engagement, self-directed learning, and effective feedback. By doing so, it is intended that further insights could be provided towards understanding the pedagogical values of studio-based teaching and learning and its potential effectiveness not only in architectural education, but in design education, and pedagogy as a whole.

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Dichotomous Tension: A Route for Self-discovery in Architectural Pedagogy


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The Outcomes of Collaborative Learning in Design Studio Courses

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Abstract: The most effective learning in industrial design education takes place in the studio courses, in which the students can explore, analyse, practice and observe the outcomes of the design project. In studio courses, occasionally, students are encouraged to take part in collaborative learning by working together in a group and submitting a joint project that results from the group work. The collaborative learning projects commonly end up with discussions, confusions and conflicts between the group members and the instructors. The basic problems are especially declared by group members as not choosing their partners by themselves, and working on a design project that does not interest them. In accordance with this information, a study was conducted by integrating the collaborative learning system to the industrial design studio course. In this paper, the outcomes of collaborative learning will be evaluated in light of the project conducted in a design studio course with undergraduate students. The study will be interpreted by the context of the dynamics of collaborative learning, the common problems observed during collaborative learning, and novice designer properties featured by the students.

Keywords: collaborative learning; studio course; design project; board game design; design education

1 Introduction

Industrial design education is usually conducted in an industrial design studio, which is the heart of most industrial design curricula and is a place where students learn to think as designers. In studio courses, students can work individually or as a part of a group. Thompson (2002, p. 42) states that collaborative learning or group-based assessment can be a practical, valuable and cost-effective strategy in design education, which is often used as an exigent strategy rather than an explicit development of the curriculum. Through collaborative learning experiences in studio courses, problems can be observed in the subjects such as the formation of groups, in-group communication and in-group assessments; therefore, a pilot study was conducted in the spring semester of 2013-2014, in order to analyse the collaborative learning environment dynamics and to enhance the collaborative learning process. The pilot study was evaluated and the common problems faced by the students were listed. In order to eliminate the problems, a second study was conducted in the spring semester of 2015-2016 by shifting the factors of the collaborative learning environment.
The aim of the research is to present the contribution of a collaborative learning environment to design studio courses, to eliminate the common problems observed in collaborative learning, and to form suggestions for conducting collaborative learning in design studio courses.

2 Characteristics of Collaborative Learning

Collaborative learning can be defined as a “situation in which two or more people learn or attempt to learn something together” (Dillenbourg, 1999, p. 1). Collaborative learning promotes the development of critical thinking skills, co-creation of knowledge and meaning, reflection and transformative learning (Palloff & Pratt, 2010, p. 4). Collaborative learning is a common method used in studio courses of industrial product design undergraduate education to bind students together, to gain different perspectives on the topic, to develop critical thinking and to gain experience of working with different people. Hocaoğlu (2016) refers to collaborative learning “as an improving learning system due to its character that allows students to negotiate and manage their design concepts with other group members. It is also a great opportunity for individuals to find solutions to the complicated problems in collaborative works” (p. 2). Lahti, Seitamaa-Hakkarainen and Hakkarainen (2004) state that collaborative design plays a particularly important role during the conceptual phase of designing, i.e., while generating and articulating design through searching for new information that would help to determine design constraints and produce a satisfactory design.

Cross and Clayburn Cross (1995) remark the importance of teamwork in professional design activity and also highlight the problems and possibilities concomitant to working as a member of a team as follows: roles and relationships; planning and acting; information gathering and sharing; problem analysing and understanding; concept generating and adopting; conflict avoiding and resolving (p. 144).

Slavin (as cited in Kreijns, Kirschner & Jochems, 2003, p. 337) states that collaborative learning has been used generally in ill-structured learning environments. As design action is inherently associated with ill-structured problems (Simon, 1973), collaborative learning appears to be an effective method for students to cope with these problems, but there are major problems in practice. One of the basic problems that occur during collaborative learning is the formation of groups. Hocaoğlu (2015) suggests that “if the instructor forms the groups and determines the group members, then the groups have to be determined at the beginning of the semester and enough time has to be given to groups to socialize and know each other’s skills” (p. 1811). Roberts and McInnerney (2007) also state that “in cases where students participate in group work without any prior formal training in group skills, a minimum of two weeks at the beginning of the course should be devoted entirely to the core advantages and benefits of group learning, and the skills required” (p. 261).

Thompson (2002) mentions that one of the biggest problems encountered with collaborative learning is the students’ perception of fairness. Latch Craig and Zimring (2000) note that students may be afraid to expose their fledgling ideas, since they compete for grades and status. Hocaoğlu (2016) presents the results of a collaborative work between undergraduate students of Interior Architecture and Industrial Design programmes that aimed to encourage students for collaborative learning from different professions. She noted threats of a collaborative learning environment in the design process as being a single-handed, conflicted, frustrating and assessing method, and the opportunities as professional business life experience and gaining awareness on group dynamics.

Roberts and McInnerney (2007) list the seven most common problems of group learning found in the literature as follows:

1. student antipathy towards group work
2. the selection of the groups
3. a lack of essential group-work skills
4. the free-rider
5. possible inequalities of student abilities
6. the withdrawal of group members
7. the assessment of individuals within the groups.

This study will be evaluated based on these seven most common problems of group learning presented by Roberts and McInnery; therefore, terms and definitions of the problems will be explained in the further sections.
3 Properties of Novice Designers

The designers’ experience on design, affects their attitude towards the design process. Dorst (2010, p. 136), based on the study of Dreyfus (2004), categorizes seven types of designers as novice, advanced beginner, competent, proficient, expert, master, and visionary. Undergraduate students, as novice designers, are on the bottom level who are trying to understand the meaning of design and the rules of the game. Newstetter and McCracken (2001, p. 67), based on their observations on student behaviour, describe features of novice design activity as ideation without substance, design arrogance, design shutdown, design jumps, and design routinisation. Based on the studies of Cross (2006) and Newstetter and McCracken (2001), properties of novice designers can be listed as follows:

- Ideation without substance: Students get the wrong idea about design that it is only coming with good ideas, and they underestimate analysis, evaluation or realisation steps (Newstetter & McCracken, 2001).
- Design arrogance: Students do not analyse user profile or environment, and they often design for themselves (Newstetter & McCracken, 2001).
- Design shutdown: Students tend to focus on an initial idea and stop considering alternatives (Newstetter & McCracken, 2001).
- Design jumps: Students are inclined to think too generally or too detailed; they do not move between these spaces (Newstetter & McCracken, 2001).
- Design routinisation: Students often see the design problem as a linear algebra problem. They do not make iterations, revisit past decisions or evaluate alternatives (Newstetter & McCracken, 2001).
- Problem focused strategy: Before starting to generate solutions, novice designers often get stuck in attempts to understand the design problem (Cross, 2006).
- Depth-first approach: Novices often show a depth-first approach to a design problem and try to generate numerous sub-solutions in depth (Cross, 2006).
- Design fixation: Novice designers can also become fixated on a solution. Experts usually show a breadth-first approach, top-down strategies, and reject being liable for early solutions (Cross, 2006).

In this study, the findings of the research also will be evaluated in terms of the properties of novice designers that are determined by Cross (2006) and Newstetter and McCracken (2001). The evaluation will be just performed based on the novice designers’ attitudes; the qualification of their designs will not be considered.

4 The Research Study

4.1 Scope of the Research

This study is based on the research of a collaborative learning system that was integrated into an industrial design studio course. The scope of the research comprises evaluating the intra-group dynamics of collaborative learning, while the qualifications of the projects that students carried out, were excluded.

The research was conducted under two cycles: the first project as a pilot study and the second one as a workshop. It assigns two different project briefs to the students. The first cycle was a pilot study for observing the attitudes of the students during the collaborative work. In order to observe the benefits and problematical sides of collaborative learning, in the pilot study, groups were determined by the instructors, and in the workshop the groups were formed by the students. In the pilot study, the design project topic was determined by the instructor, but in order to eliminate the prejudice of the students against the project topic, the topic of the workshop was determined by the students. The attitudes of students during the collaborative work, the formation of the groups in the second cycle, and the projects that were submitted, were evaluated to gain an understanding in the situation of collaborative learning in design studio courses.

4.2 Research Method

4.2.1 First Cycle: Organizing Groups and Determining the Topic of the Pilot Study

In the 2013-2014 spring semester, the collaborative learning environment was tested at Doğuş University, Department of Industrial Product Design, in the design studio course. The project was given for a semi-period (seven weeks) and was conducted with twenty-five students in five groups; seventeen students from the Project Year 2, six students from the Project Year 3 and two students from the Project Year 4 (Table 1).

The principles of organising the groups were classified below as:
• The groups were formed by the instructors.
• In order to create equal groups in the studio year of students, friendship (restraining close friends taking part in the same group), age, gender, design development skills and computer aided design skills were taken into consideration.
• The students were selected from the ones who had never done a group project before to eliminate the positive and negative prejudices against collaborative work.

Table 1. Distribution of students per groups in pilot study

<table>
<thead>
<tr>
<th>Group</th>
<th>Project 2</th>
<th>Project 3</th>
<th>Project 4</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>4 students</td>
<td>1 student</td>
<td>-</td>
<td>2 male, 3 female</td>
</tr>
<tr>
<td>Group 2</td>
<td>4 students</td>
<td>1 student</td>
<td>-</td>
<td>3 male, 2 female</td>
</tr>
<tr>
<td>Group 3</td>
<td>3 students</td>
<td>1 student</td>
<td>1 student</td>
<td>2 male, 3 female</td>
</tr>
<tr>
<td>Group 4</td>
<td>3 students</td>
<td>2 students</td>
<td>-</td>
<td>4 male, 1 female</td>
</tr>
<tr>
<td>Group 5</td>
<td>3 students</td>
<td>1 student</td>
<td>1 student</td>
<td>4 male, 1 female</td>
</tr>
</tbody>
</table>

**4.2.2 Second Cycle: Organising Groups and Determining the Topic of the Workshop**

In the second cycle it was planned to organise a short, one-week workshop, as only group formation variables would be observed. In the first cycle, the students had also disagreed on the topic of the design project; therefore, in order to eliminate the objections of the students related to the project topic of the first cycle, students were asked to select the workshop topic.

Five project topics that could encourage collaborative learning were selected among the topics that the students had previously wanted to study and were presented to the students. The students chose the board game among the five project topics presented to them. This topic is also an advantage for collaborative learning due to the nature of the board game. "Game", a word originating from German and with the same meaning in English, refers to learning by observing and practicing (Kaszap, Ferland & Stan, 2013). The game has been dealt with as an important issue in every period in society, as it is part of human life and allows for the formation of culture (Huizinga, 1955). In addition to supporting learning, game is also fun and fair for both children and adults and develops their open-mindedness (Sutton-Smith, 1997).

While the game encourages learning by observation and practice, it also shows how complexity could emerge in the game as a result of simple rules (Holland, 1998). In traditional game theory, games are divided into two basic categories: competitive or collaborative. Competitive games require players to create strategies that directly oppose other players in the game. As in many traditional board games such as chess and checkers, the goals of the players are diametrically opposed (Jones, 2000). In contrast, a cooperative game models a situation where two or more players have interests that are “neither completely opposed nor completely coincident” (Nash, 2002, p. 99). There are opportunities for winners to work together to achieve a win-win situation.

Although not accepted in game theory, cooperative games also appear as a third category (Table 2). In such games, all participants act together as a team, and if the team wins or loses at the end, everyone wins or loses. A collaborative board game has a set of static goals and rules to provide only obstacles and counter strategies. As a result, after multiple play sessions, players adapt better to the game and use their abilities. Over time, the game becomes easy because the team can easily beat it. Therefore, unlike competitive games such as chess, collaborative games must be adapted to the abilities of the players in order to sustain the replay ability (Zagal, Jochen & Hsi, 2006).

The selection of the project topic was notably coherent with collaborative learning in terms of playing the game with more than two people and sometimes players/students behaving more as a collaborator, sometimes behaving more dominant and causing conflicts. In the later stages of the project, collaborations among students, discussions, and the observation of situations such as leaving the group made the project resemble real life situations.

One of the problems that cause conflict among group members is grading, and in order to eliminate this problem observed in in-group grade assessments, it was decided that absence would be graded instead of the projects designed in the workshop. In this way, students were motivated to participate in the workshop.
The workshop was held in the 2015-2016 fall semester at Doğuş University, Department of Industrial Products Design. The workshop was conducted with sixteen students in four groups; fifteen students from the Project Year 3, one student from the Project Year 4 (irregular class) (Table 3).

<table>
<thead>
<tr>
<th>Games</th>
<th>Type</th>
<th>Category</th>
<th>Players</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chess</td>
<td>abstract strategy and mind</td>
<td>competitive</td>
<td>2</td>
</tr>
<tr>
<td>Risk</td>
<td>strategy game</td>
<td>cooperative</td>
<td>2-6</td>
</tr>
<tr>
<td>Go</td>
<td>abstract strategy and mind</td>
<td>competitive</td>
<td>2</td>
</tr>
<tr>
<td>Monopoly</td>
<td>fast-dealing property trading</td>
<td>cooperative</td>
<td>2-6</td>
</tr>
<tr>
<td>Backgammon</td>
<td>abstract strategy and mind</td>
<td>competitive</td>
<td>2</td>
</tr>
<tr>
<td>Scrabble</td>
<td>word game</td>
<td>competitive</td>
<td>2-4</td>
</tr>
<tr>
<td>Lord of the Rings</td>
<td>action role-playing game</td>
<td>collaborative</td>
<td>2-5</td>
</tr>
</tbody>
</table>

Table 3. Distribution of students per group in the second cycle

<table>
<thead>
<tr>
<th>Students</th>
<th>Project 3</th>
<th>Project 4</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>3 students</td>
<td>1 student</td>
<td>4 male</td>
</tr>
<tr>
<td>Group 2</td>
<td>4 students</td>
<td>-</td>
<td>4 female</td>
</tr>
<tr>
<td>Group 3</td>
<td>4 students</td>
<td>-</td>
<td>4 male</td>
</tr>
<tr>
<td>Group 4</td>
<td>4 students</td>
<td>-</td>
<td>2 male, 2 female</td>
</tr>
</tbody>
</table>

The workshop was held for four days, with sixteen hours of design time and two hours of jury time. In addition, the students prepared models and layouts for the jury in their leisure time. Students came to the workshop being aware of the topic of the project. According to Richards (2009), the size of the group is directly proportional to the complexity level of the study topic but working groups of 4-5 people are ideal in non-complex subjects; therefore, students were asked to form groups of four. Close friends had formed three groups by choosing each other, and compulsorily the remaining four people formed the fourth group. At the end of the project, four different project concepts were determined: mountain climbing, brainstorming, desert strike, and legend (Table 4).

Table 4. Properties of the board games

<table>
<thead>
<tr>
<th>Group</th>
<th>Project Concept</th>
<th>Type of Board Game</th>
<th>Category of Board Game</th>
<th>Players</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>Mountain Climbing/Board Game</td>
<td>Strategy game</td>
<td>Competitive</td>
<td>2-4</td>
</tr>
<tr>
<td>Group 2</td>
<td>Brainstorming/Board Game</td>
<td>Mind game</td>
<td>Competitive</td>
<td>2-6</td>
</tr>
<tr>
<td>Group 3</td>
<td>Desert Strike/Board Game</td>
<td>Strategy and action role-playing game</td>
<td>Competitive</td>
<td>2-4</td>
</tr>
<tr>
<td>Group 4</td>
<td>Legend/Board Game</td>
<td>Abstract, strategy and action role-playing game</td>
<td>Competitive</td>
<td>2-4</td>
</tr>
</tbody>
</table>

5 Results and Discussion

5.1 Outcomes of the Collaborative Learning

In the first cycle, the students were demoralised after the formation of groups, and the instructors needed to create in-group communication. A course hour was spent outside of the classroom with group inclusion activities; but in-group conflicts continued. Two of the five groups had adapted and carried out the collaborative study; the other two of the five groups could not adapt to the group work and were able to manage the process with the support of the instructors; and the last group could not adapt to group work in any way and was dissolved.
In the pilot study, collaborative learning dynamics had been determined for research, whereas appearance of an unexpected situation, such as the dissolution of a group, came into question, and the focus of the research was changed. The main factor in the dissolution of the group was the formation of groups by the instructors and the unwillingness of the students to work together. Therefore, in order to observe the group formation variable, the second cycle of the study was performed.

In the second cycle, with the observation of the workshop process of the students, the problems they faced were examined in the context of Roberts and McInnerney’s study (2007), and the novice designer properties featured by the students were interpreted based on the studies of Cross (2006) and Newstetter and McCracken (2001) (Table 5).

When Table 5, the table of common problems of group learning encountered during the workshop, was analysed, it was seen that problems 1 (student antipathy towards group work) and 2 (the selection of the groups) were not observed in any group. Students did not complain about group work or the way of selecting the groups as they formed their own groups (Table 5).

The third problem (a lack of essential group-work skills) was observed in all groups except for the fourth group. None of the students participating in the workshop had any experience in group work. Although Roberts and McInnerney (2007) suggested a minimum of two weeks at the beginning of the course for students without any prior formal training in group skills, as the fourteen-week training process was intensively planned, a two-week time period could not be allocated.

The first three groups were homogeneous groups of close friends; the first and third groups had one dominant character in each group, and the second group had two dominant characters in the group. The second group, which had two dominant characters in the group, fell into disagreement on project concepts and were divided into two groups on the second day. The group lost a day until the participants of the group made a joint decision and continued with the project. The third group was composed of four best friends. They could not develop design alternatives since they approved each idea of the dominant character of the group. No difficulties were observed in the group work of the fourth group.

The fourth problem (the free rider) was only observed in the first group. The free-rider effect, mentioned in the fourth problem refers to group motivation losses, when a group member or members do not participate in group work and decrease group performance (Kerr & Bruun, 1983). In the first group, only one student had strong design skills, while the other three students had low design skills, and their participation in the class was minor. When they formed a group as friends, the student with strong design skills became the dominant character of the group and the other students handed over the responsibility of the project to the dominant student. For this problem Roberts and McInnerney (2007, p. 261) suggest that the instructor can use pressure on the free riders. Although the instructors tried to interfere with the group to give responsibilities to the free-rider members, the dominant character of the group defended those friends and argued that they did not pose a problem.

As a consequence of the relationships and the abilities of the free riders, the fifth problem (possible inequalities of student abilities) was also observed in the first group. Kerr and Bruun (1983) state that there is always the possibility
that the most capable student(s) within a group may fall victim to what has become known as the *sucker effect*, which in many ways may be the reverse of the free-rider effect. In this study, this person in the group was the dominant character who had strong design capabilities and attendance to the class; and was therefore left to carry the bulk of the workload.

Therefore, the sixth problem (the withdrawal of group members) was also observed only in the first group. As a result of the free-rider and sucker effect relationships, the dominant character designed the whole project. The other students joined the workshop at a minimum level. The seventh problem (the assessment of individuals within the groups) was not observed in any group because at the beginning of the workshop it was stated that participation in the workshop, not the projects designed, would be graded.

Referring generally to Table 5, only in group 4, which was formed compulsorily, was no problem observed. The fourth group was composed of two male and two female classmates, who had different backgrounds. Kagan (2015) defines this kind of mixed groups as heterogeneous groups, in which participants are mixed by student ability level, sex and race; and states that heterogeneous groups can be advantageous, because of the different perspectives brought to the group. Besides being a heterogeneous group, the coming together of people with strong design skills was another strong side of the fourth group. The group had weak communication skills and could not conduct the brainstorming process at first on their own. The process of brainstorming began with the support of the instructors.

5.2 Evaluation of Novice Designers’ Attitudes
All attitudes of the students who participated in the workshop were also evaluated by considering the properties of novice designers, based on the studies of Cross (2006) and Newstetter and McCracken (2001). Properties of novice designers are; ideation without substance, design arrogance, design shutdown, design jumps, design routinisation, problem focused strategy, depth-first approach, and design fixation (Newstetter and McCracken, 2001; Cross, 2006).

As seen in Table 6, design jumps and design routinisation were observed in all groups as they were third year novice students. Alongside these properties, design arrogance has also been observed in all groups except for the fourth group. This property is associated with the designer who designs for him/herself, rather than analysing the user profile. The three groups that had design arrogance were homogeneous groups of close friends with common tastes and interests, and were same sex groups. Since the whole group had common tastes, the diversity of ideas could not be established, and students could not go beyond their interests. In addition to the properties mentioned so far, the third group had design shutdown and depth-first attitudes. This group of friends, who had common interests, stuck to their initial design ideas, ignored instructors’ critiques and began to elaborate on this initial design idea. They were so obsessed with their first ideas that they did not accept the critiques of the instructors even in the jury of the workshop.

<table>
<thead>
<tr>
<th>Group</th>
<th>Relationship</th>
<th>Dynamics of the Group</th>
<th>Common Problems Generally Observed at Collaborative Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>Classmate and friends</td>
<td>Intermediate Design Capabilities</td>
<td>1 Dominant Character</td>
</tr>
<tr>
<td>Group 2</td>
<td>Classmate and best friends</td>
<td>Intermediate Design Capabilities</td>
<td>2 Dominant Characters</td>
</tr>
<tr>
<td>Group 3</td>
<td>Classmate and best friends</td>
<td>Strong Communication Skills Best Friends Strong Design Capabilities</td>
<td>Best Friends</td>
</tr>
<tr>
<td>Group 4</td>
<td>Classmate</td>
<td>Heterogeneous Group Strong Design Capabilities</td>
<td>Weak Communication Skills</td>
</tr>
</tbody>
</table>

At the end of the workshop, four groups submitted four design projects that had different board game concepts. As was mentioned at the beginning of the workshop, students were evaluated according to their absence and all students—except one—got full marks.
6 Conclusion

Although collaborative learning is a frequently applied method in design education, there are still problems that need to be overcome. In the literature, it is stated that the students are inclined to be in a group with close friends, but this tendency is not very favourable in forming groups for collaborative learning environments. It is stated that it is a more efficient approach for the instructor to create heterogeneous groups by considering certain criteria (Johnson, Johnson & Smith, 2007; Roberts & McInerney, 2007; Ergulec, 2017).

In the pilot study (first cycle) summarized in the paper, heterogeneous groups were formed by instructors, considering certain criteria; unfortunately, conflicts arose from in-group communication which the instructors could not predict. In the first cycle, one of the five groups was dissolved and the group could not complete the collaborative study. Based on this outcome, the second cycle was carried out to examine the effects of the group formation. In the second cycle, the group choices were left to the students completely and a one-week workshop was organized in order to observe the effect of group selection. Thereupon, the second cycle was carried out to examine the instructors’ necessity of heterogeneous group formation. The students were allowed to choose the project topic for the workshop. Also, to avoid problems related to in-group grade assessment they were informed that they would be graded according to presence or absence in the workshop. Twelve students formed three groups of four as best friends and the remaining four students compulsorily formed the fourth group. Through the observation of the workshop process of students, the problems they faced were examined in the context of Roberts and McInerney’s study (2007) and the novice designer properties featured by the students were interpreted based on the studies of Cross (2006) and Newstetter and McCracken (2001). Unexpectedly, in the first three groups various problems were observed although they worked on their chosen project topic and with friends of their choice; no problems were observed in the fourth group that came together compulsorily but composed a heterogeneous group incidentally.

In this study, the attitudes of participants observed by researchers were summarised as below:

- Homogeneous groups tend to design for themselves or their own interests when they are the same sex, and have the same interests or backgrounds.
- Homogeneous groups could show design arrogance.
- Although it is important for group members to have strong communication with each other, forming the group with best friends narrowed the viewpoints of the group members and prevented the development of critical thinking.
- Different sex and different interests in a heterogeneous group provide a different perspective to the project topic.
- Heterogeneous groups face fewer problems in collaborative studies.
- In spite of everything, unexpected situations could be observed during the collaborative work due to the bilateral relations.

In this study, it was seen that when the groups were organised by the instructors, groups could dissolve because of in-group communication. Taking into consideration in-group communication as criteria at forming heterogeneous groups could be regarded as impossible for instructors. At this point, as Roberts and McInerney (2007) note, spending more time on group-inclusion activities may transform in-group communication from negative to positive. In further research, it is possible to study group-inclusion activities in order to familiarise students with group work in design education.

References


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Abstract: This paper aims to disclose undercurrents of in-class interactions and provide a deeper understanding of the social interactions and performances in the design studio. By adopting an ethnographic approach, this study attempts to explore the participants’ activities and dynamics behind them. The chosen subject environment for this study is a first-year basic design studio at a selected School of Architecture and Design. The setting is taken as a social environment and observed using ethnographic methods; then the observations are interpreted through Erving Goffman’s metaphor of drama (1959). This study is not primarily interested in the materials used in the class; similarly, maintaining a certain standpoint for the methodology of the education is out of concern. Rather, it uses such subjects as mediums to understand participants’ behaviours in the design studio. Being an on-going descriptive work, focusing on social interactions, this study delivers insights from the design studio and provides social explanations which can form a basis for developments in design education in the future.

Keywords: design education; design studio; ethnography of design; drama metaphor

1 Introduction

Design studio is an environment, which is constantly in transformation for and through its inhabitants: it becomes a classroom, a workshop station, a place for chatting, eating, working, napping, sharing, relaxing, and simply living from time to time (Anthony, 1991; Cuff, 1991; Oh, Ishizaki, Gross & Do, 2013). In that regard, it differentiates from other spaces of learning in universities for its duration of use and affordances. For first year students, this environment can become a context, which challenges their best performative skills at their first encounter with design education. The architectural education literature usually refers to the design studio as the centre of the programs, yet the studies on the nature of interaction between students and instructors are surprisingly little (Ochsner, 2000). As design studio shows distinct qualities of its own regarding especially its inhabitants, an exploration of its use in social context might be useful. Understanding how design studio works as a place for living in altered aspects for different inhabitants would benefit the design education for providing the educator a more expanded “web of moves” (Schön, 1983).
This paper aims to disclose undercurrents of in-class communications and provide a deeper understanding of the social interactions in the design studio. It is interested in how and in what terms participants act in it and which dynamics work in the background of these interactions. Being an on-going descriptive work, this study focuses on a chosen first year design studio, trying to explore and develop an understanding towards the intelligence (Findeli, 2001) of its complex social realm.

As the first author of this paper was attending to the concerning design studio as a teaching assistant the setting was practically suitable for such a study. This condition supported the insider state of the researcher which was crucial to realize the study in ethnographic manners. In addition, performing a role of teaching assistant, the researcher was a participant in the community, which helped to observe both participant groups, i.e. students and instructors. This particular school of architecture and design accepted students for the first time at the semester of the study. This means both students and instructors were in charge of constructing the initial social interaction in the studio. We find this particular case of construction remarkable for the sake of discovering the elements of design studio. Even though the basic design studio (physically) and teaching syllabi were planned before the semester by instructors and therefore they—including one of the researchers of this study—had certain expectations, its practical use and impact was only available to our knowledge after the involvement of students.

The foundation of the physical and social setting for interaction, agents’ behaviours, and related multiple cases of living were observed and interpreted for this research. Our attempt is to understand this particular environment, design studio, with all the action happening inside through Erving Goffman’s metaphor of drama (1959). In his book *The Presentation of Self in Everyday Life*, Goffman applies dramatic terms to daily behaviour of ordinary people. According to Goffman (1959), all activity of a person achieving to influence any other in any case can be considered as a performance. Thereby, all actions of participants in design studio were taken as performances that deliberately or not try to give impressions to every other participant i.e. audiences. Doing that, this paper aims to explore in-class interactions in depth and provide a “thick description” (Geertz, 1973) of participants’ activities. As this study is based heavily on Goffman’s descriptions, his approach is discussed in detail in the following section.

## 2 Theoretical Framework: Towards an Understanding of Goffman’s Dramaturgy Metaphor

As this study aims to provide a profound understanding of dynamics in a particular design studio environment through an ethnographic prospect, a comprehensive and applicable concept was needed to interpret in-class happenings. Those involve verbal communication and not less importantly other types of communications such as facial impressions, gestures or attitude. To that end, this paper consults *The Presentation of Self in Everyday Life*, a book by Erving Goffman (1959) in which he introduces the dramaturgical approach to understand the interaction between people. Borrowing the terms from Ichheiser, he states that an individual has to act in a way that he deliberately or not expresses himself and in return, observers inevitably have to be impressed. Noting that two-sided activity is certainly present in any case, in one respect, he recognizes interactions with no verbal symbols. Interactions happen in multiple layers. A message is transmitted through not only the layer of verbal symbols but also the layers of gesture, attitude, and facial expressions, etc. To demonstrate this multi-layered communication model more explicitly he gives the observer a role as significant as of observed. According to him, verbal assertions are easy to manipulate by an individual, whereas other expressions given off are harder to control and of little concern. Goffman puts a secondary channel of message forward: “In this a fundamental asymmetry is demonstrated in the communication process, the individual presumably being aware of only one stream of his communication, the witnesses of this stream and one other” (1959, p. 7). In fact, he takes that subordinate stream of communication as observer’s instrument for checking the validity of verbal statements of observed. Consequently, observer (witness) is expected to have an advantage over observed (actor).

He argues that, when before others, there are numerous reasons for an actor to take the witnesses’ impressions under control. Pursuing the desired impression, actors engage some common techniques and face common unexpected malfunctions. The main concern of the book is, in his terms, dramaturgical problems participants confront while presenting their selves. Goffman’s own words regarding why he attributes importance to aforementioned issues toward social analysis, also portrays our approach to the case of this research: “The issues dealt with by stagecraft and stage management are sometimes trivial but they are quite general; they seem to occur everywhere in social life, providing a clear-cut dimension for formal sociological analysis” (1959, p. 15).

It has been said that all activities of any given individual, that tend to influence others in any way, are called performances. Accordingly, we recognize the terms performer and audience for participating agents. At this point, it
would be useful to introduce some key terms and concepts of Goffman regarding performances, as they will be consulted in this paper.

We will use Goffman's term front for an individual's standard equipment for expression, which includes setting and two halves of personal front: appearance and manner. Setting is where stage props such as furniture, décor and backdrop are located for scenery. A designated performance starts with entering to the corresponding setting and ends with leaving it. The communal expectation is a consistency between setting, appearance and manner; that is called social front. One thing should be pointed out here as it signals an intriguing proportion of this study's design studio case; that is, "social front tends to be institutionalized in terms of the abstract stereotyped expectations" (1959, p. 27). In other words, when an individual applies for a social role, usually he or she finds that the particular front has already been established. Contrarily in our case, for the department (or theatre if you will) is just founded, although participants brought their personal experiences, it cannot be said that there are established fronts especially for students.

In order to deliver a convincing performance, a performer often should make invisible efforts visible. Goffman takes this issue under the name of dramatic realization. However, this effort may cause a problem within the order priority of an action. If we are to put forward the argument related with this research, we should mention the dilemma he states of expression versus action. In this respect, he says that a person who uses his or her time and talent to perform a task well, may not have the time and talent to make apparent the wellness of the performance. Jean-Paul Sartre has a similar approach to the subject matter. He portrays that who is called the good speaker as a person who plays during speaking, for he cannot actually be speaking. In another very fitting portrayal to our case, Sartre suggests: "The attentive pupil who wishes to be attentive, his eyes riveted on the teacher, his ears open wide, so exhausts himself in playing the attentive role that he ends up by no longer hearing anything" (2001, p. 220). Dramatic realization here is playing a role.

When evaluating a performance, it must be kept in mind that it often presents an idealized image of the situation. The term ideal is approached here in societal context. A performance to some extent has to strive common established values of society. Goffman noted that a performance before others tend to include and demonstrate the officially accredited values of the society more than the performer's own behaviour. In this respect, he sees the world as a wedding where moral values of the community are rejuvenated and reaffirmed. Related with that, in the sense of social agreement, Goffman puts emphasis on performers' tendency to provide an impression that their current performance in the routine and current relationship with the current audience offer something special about them. He says that perhaps the audience also contributes to the reason for this state by actually expecting such an attitude. While holding both agents accountable for this pseudo-gemeinschaft he illustrates the current: "... there is hardly a performance, in whatever area of life, which does not rely on the personal touch to exaggerate the uniqueness of the transactions between performer and audience" (1959, p. 50).

Goffman takes the audience with a quality to extract important things about the performance from minor cues. On one hand, this characteristic of audience assists the delivery of the particulars of a performance and serving the actor; on the other hand, it may cause misinterpretation of minor cues that are designed to convey a different meaning or not designed at all. That is why Goffman places emphasis on the maintenance of expressive control. Related to that, he distinguishes the discredited impression from the false impression. In that respect, a truthful performer and a deceitful performer share a practice. Whether it is an honest performer trying to convey the truth or a dishonest performer the lie, they both need to mind for the fear of the audience deducing unintended meaning and to avoid presenting a discrediting expression.

In addition to this notion of having control over what is expressed, Goffman puts perception in a certain perspective. "If we see perception as a form of contact and communion," he says, "then control over what is perceived is control over contact that is made, and the limitation and regulation of what is shown is a limitation and regulation of contact" (1959, p. 67). This argument actually indicates its validity often, for social distance is commonly used as a tool to accent different levels of social hierarchy of many kinds. Using this instrument develops an uneasy space for the audience in which they are in a state of mystification. By creating this space performer defines a curtain—with a front and back— which he or she can draw at any time and which the audience wants it to be there. Pre-established social roles need mystifications for the sake of the performer and the audience to maintain relational setup.

Yet, when an individual enters into a new position in society, and applies for a new part to perform seldom he or she is told in depth how to act. Usually, what is on hand are only some cues about the part, which are provided, and the individual's own idea of how fundamental bits such as compassion, reverence or reasonable fury should be played.
This research’s case constitutes an appropriate example for such situations, as students are just introduced to their parts to play for several years to come.

3 The Fieldwork: Inside the Design Studio

In order to explain the fieldwork comprehensively and how each data contributed to the findings, the setting, participants, and data collection procedures are described in detail in the following sections.

3.1 Setting of the Studio: The Stage

Design studio was meeting up two times a week on Mondays and Thursdays between 9 a.m. and 12.30 p.m. The fieldwork took five weeks in the middle of a 14-weeks semester. The studio subject to this study is located on the first floor of the faculty building and has an open plan rectangle shape. A wall is separating the room from the building’s entrance hall at one long side, and at the opposite, there are large windows overlooking the outdoor garden. Along one short side (will be called front side), a whiteboard surface illuminated with spotlights allows a practical use as a magnetic wall to exhibit students’ work. There are tables for each student’s individual use that are in clusters of four to six. There are locked cabinets for students’ personal storage. As for the style of the room, chairs and cabinets are in vivid colors (one can say DeStijl/ish) whereas, the rest of the room is mostly in tones of grey.

Figure 1. A quick sketch of the design studio drawn during the participant observation.

Front side is where most of the exchanges take place. Occasionally, student works are displayed on the whiteboard for teachers and students to discuss on. Some other times, two clusters of tables at the front side are brought close together to form a large surface to put 3D models or mock-ups. In either case, all of the participants gather around at the front side of the room and therefore, create an interaction-prosperous setting.

3.2 Participating Students: The Performers

The studio included 47 first year students from both Industrial Design and Interior Architecture and Design Departments. The group consisted of 37 females and 10 males with an age range between 18 and 20. In addition to them, there were three instructors and two teaching assistants, one of which being the first author of this paper. All of the students and teachers were native speakers of Turkish language. In order to keep the participants anonymous all names were replaced with false ones in this paper.

3.3 Data Collection

Complying with our approach towards the design studio, we defined two complementary settings for data collection: stage and backstage (Goffman, 1959). Stage stands for the design studio within the class hours where all the agents are there as performers and audience at the same time. Performances exhibited there are in public display. It is where official projections (Goffman, 1959) are demonstrated. Therefore, it consists our main focus of interest for this paper. However, since our aim is to provide an understanding of the intelligence (Findeli, 2001) of the complex social system of the design studio, it is significant to recognize its unofficial side. Backstage is the conceptual domain which contains

all of the rest of the performances of studio agents which have an impact on the design studio to some extent. Private conversations of instructors, students’ text messages, and student-instructor interactions outside the studio can be counted as performances within the backstage. They were valuable for providing supportive data to what is observed on the stage.

In terms of collecting data, firstly, the first author of this paper was attending the class as a teaching assistant with the instructors for that semester and he was able to conduct participant observation (Boellstorff, Nardi, Pierce & Taylor, 2012) and take field notes (Emerson, Fretz & Shaw, 1995) during the study. In order to get a deeper understanding of the social interactions and performances on the stage, his study focused on two settings: an ordinary class and a jury setting. Having managed to note his on-site observations both as a participant (instructor) and non-participant (observer) in these two settings, he was able to explore significant social interactions between the agents of the design studio.

Secondly, a casual meeting with the students was arranged where an informal conversation with the students took place to gain deeper insight from the backstage. A one-hour group meeting is conducted in a room outside the design studio with 10 students, who voluntarily participated in the meeting. Participants sat around a big table and were offered snacks in a relaxed manner. They were free to speak in any order and leave at any moment. The conversations were voice-recorded with the permission of the participants. A semi-structured list of themes and questions were formulated beforehand that could potentially lead the conversation. Some of these questions were: “How do you describe your class?”; “How do you decide on where to sit in the studio?”; “Which critiquing settings do you find more fruitful?”; “How active is your student messaging group?”, and so on. To get a deeper understanding of the observations inside the design studio, the meeting was very helpful and eye-opening.

The first author of the paper was a participant of the chatting group created in a smartphone messenger app put together by the instructors for maintaining communication with the students. The group consisted of five participants: three instructors and two students as representatives of the class. Students were selected randomly from volunteers at the beginning of the semester, and they were assigned to forward the messages of the instructors to the rest of the class and of the students to the instructors. Apart from that, the students had another chatting group of their own. In relation to that an unobtrusive approach is adopted to obtain relevant data through ethnographic content analysis (Altheide, 1987) of text messages. In addition to that, private conversations with instructors were also taken as secondary sources of data to develop the knowledge of the backstage.

Using three research methods, participant observation, conversation, and unobtrusive methods, simultaneously, a triangulation of data is built and a more inclusive understanding of the design studio is provided. It also helped to justify the data that was obtained from one method with the findings of others.

4 Findings: Performances

We relied on the diversity of the performances in order to comprehend the social structure in the studio. Accordingly, based on the fieldwork, five particular performances are described: 1) the favourites; 2) the latecomers or the careless; 3) the backside loners; 4) the extras; and 5) the mainstream. Having said that, there are no definite boundaries between these performances. Rather, they are transitional descriptions in which performers can move around.

4.1 The Favourites

The common performance of the favourites relies on a consistency of being at the studio on time; meeting the expectations of the instructors by presenting well done assignments; sitting in the front row; paying good attention to what is told by the instructors and responding cleverly. Needless to say, the quality of the work is the most significant part of this performance, we observed that this alone is not sufficient to become a favourite in the studio. The favourites are expected to display not only the actions but also some merits that are attributed to the role e.g. acting independent, pioneering, showing courage, or being progressive. Furthermore, they need to have good social interactions with the instructors and the rest of the class.

As in drama, there is a positive correlation between the persuasiveness of the performance and its impression of being performed effortlessly. Meeting the expectations of instructors with his works, Osman became one of the favourites starting from the beginning of the semester. This actor-role matchup became so strong in time that instructors occasionally used the term “Osman’s table” in private conversations referring to the students, who were also favourites, sitting –sometimes not even sitting– around the same table with Osman. Rendering his worth, Osman
made the best of his part by taking initiatives in studio in general and specific to his role throughout the semester. Although there were times when he could not meet the instructors’—first order—expectations, we can say that those performances contained the right kind of exchanges in securing his position in the role, for demonstrating some virtues of the favourites such as being progressive. In connection with that, we treat him as a successful actor in terms of the maintenance of expressive control.

Although Osman was a favourite from the start, Bahar showed that performing the favourite can be learned through time, as she became one of the favourites later in the semester. Besides her developing course related works, her qualified social interactions in the studio provided her a place within the favourites. Unlike most of the rest of the favourites, Bahar spent more time with the actors of other roles. This both drew the attention for her being the single actor who plays her role in that group and provided a balance in the studio in terms of social groups. However, it is probably her involvement in other groups that may have caused the late attribution of the favourite role to her.

4.2 The Latecomers (or the Careless)

The latecomers or the careless are defined by their significant habit of being late to classes. Still, it is not the only quality that brings these actors together. Latecomers usually do not have an involvement in the course higher than mediocre; they prefer to ask about minimum necessities over qualitative questioning, and try to build warm relationships with instructors through subjects that are unrelated with course curriculum. However, when it comes to subjects related to course curriculum, latecomers’ dialogues with instructors are built on a basis of neither agreeing nor going against the instructors. Their participation in class dialogues is limited to asking questions concerning technical matters on a given assignment, such as what type of paper to use or how a digital submission should be tagged.

The latecomers are also the best actors of playing the impression of carelessness, who, with reference to Goffman’s approach, are less skilful than the others in maintaining the expressive control. For, at the moments of communication malfunctions, a latecomer usually has difficulty in continuing the performance that he/she has been delivering until then. The following new performance, then, causes inconsistency. We can observe this, in Aslıhan’s case, who performs a typical latecomer: as an attempt to cope with a sudden communication glitch with the instructors, Aslıhan borrowed and used a technical term irrelevantly, which was previously articulated by an instructor in another topic for a particular purpose. Nevertheless, if we are to take the series of consecutive inconsistent performances as one big performance, we can consider that a latecomer’s performance of carelessness is a tool to overcome the incompetency of being consistent. Still, the performance-ness of their effort is so apparent that it poses a challenge to their persuasion.

4.3 The Backside Loners

The actors who play this role display an extremely disinterested impression bereft of visible social activity at the back row (we can also describe it as a location that is far from the main stage of any moment) of the studio. Like Kaan, a remarkable backside loner, they seldom have lines and when they have, it is usually trivial and weakly spoken. Not displaying any hint of interest unless otherwise is asked personally and giving a very still impression, Kaan had a distinctive character quality. However, we are not speaking of passive or invisible actors who do not have any impact on the studio. On the contrary, their effort of not being involved in whatever happening in the studio is so apparent and strong that one cannot ignore them.

According to Goffman’s approach, they should be credited as significantly successful actors in dramatic realization. In an incident it was noteworthy that, whether to catch minor signs to demystify his character or to see how well he will do academically, almost every actor in the room was paying their utmost attention when Kaan was presenting in front of the jury as an outstanding backside loner.

The backside loners deliberately do not pay attention to the class; therefore, their attitude is quite different when compared to the careless. Accordingly, we think that the traces of their motivation on sustaining such a performance for a long time can be discovered in this rather intriguing apparentness of their absence. After all, although this performance looks like it is not a well-received one by the instructors, it is also not taken as a criterion of evaluation for academic success. At multiple times, the first author of this paper has witnessed instructors’ dialogues in which they discussed that a particular backside loner is lazy and uninterested, yet he is actually smart and full of potential. Furthermore, their distantness to the studio content sometimes caused uncomfortable moments of awkward silences. In rare occasions when Kaan was the main act of the studio, such as a presenter before the jury, he asked questions or made comments which needed responses that were too obvious for the rest of the actors. Responses that are
discussed and agreed on through long sessions in the studio. Perhaps at those times Kaan was providing a setting for which none of the performers were ready.

4.4 The Extras

The actors of this role are relatively less visible in the studio. There are various reasons to think that their lack of apparent existence derives not from a planned impression as in the backside loners but from inadequacy of their dramatic performances. They usually do not take any noticeable initiative on social context. Moreover, they do not demonstrate an active participation in any act that directs or changes the trajectory of the studio (flow of the drama). Again, throughout the study there were numerous occasions in which their absence was not noticed in the studio or instructors could not recall their names, even though more than half of the semester was passed. In conclusion, we can say that the extras are the ones who have problems of recognition for all of the reasons above.

4.5 The Mainstream

The mainstream play the dominant role in terms of quantity, although it may seem like this group does not have an impact on the studio at first sight. It would not be wrong to say that the entitlement of this role can be associated with both dramaturgic and academic performance of its actors. As we acknowledge these students as effective actors on the stage, it should also be said that they demonstrate a quality to strengthen the dramaturgical setting for its active operation. In this respect, unlike the extras, we can think of them as the main feeder of the action. They are in fact the reference point for this study to analyse all the other actors and their performances. Damla, with the help of her individual performances became a representative of the mainstream. Her existence was always perceptible as a reference point. She performed effective and ineffective, successful and unsuccessful attempts many times to contribute to the studio almost as a reflection of the studio average. In relation with that, her moral demand upon the other actors (Goffman, 1959) with which she defines the quality of value and treatment she expects, was modest and away from margins. Damla was also one of the two student representatives in the social media group that instructors put together to preserve communication with the students outside the studio hours. On one occasion, about the materials to be purchased that week, in a text message which she accidentally sent to this social media group, she wrote: “Do they [stationery] give brushes along with the paints? Dude, we are screwed”. She was sharing an opinion which is personal yet also reflects the studio’s common view. In Goffman’s terms, at that moment, official projection of her-self and the reality differentiated embarrassingly. However, these dramaturgical failures help us to count actors like her in the category of the mainstream.

5 Conclusion

Aiming to understand the everyday life in the design studio, this paper tried to provide a thick description (Geertz, 1973) of activities in the setting. Erving Goffman’s metaphor of drama (1959) has been the key theoretical background for making sense of what has been observed in the field. Based on his framework and terminology some roles, performances, relationships and interactions were tried to be described. In order to get a deeper understanding of the social exchanges and activities in the studio environment, this study distinguished two different focuses: an ordinary class and a jury setting. Both settings were attempted to be analysed and interpreted with the help of anecdotes and students’ statements from the arranged meeting.

Adopting an ethnographic approach on the research method, the effort was to explore the working dynamics of social interactions in the design studio. Participant observation (Boellstorff et al., 2012) and taking field notes (Emerson et al., 1995) constituted the first pillar of the methods for the fieldwork. Additionally, a casual meeting with the students was arranged and an unobtrusive approach was adopted through ethnographic content analysis (Altheide, 1987) simultaneously to gain deeper insights. As a result, five particular performances were described.

In terms of self-criticism, even though it has afforded meaningful input for an on-going study, five weeks was not a long enough period of participant observation to obtain a saturated data. Additionally, this study was limited with the chosen design studio and particular participants. In further studies, long-term fieldworks would be carried out, in order to provide more extensive observations to work on. Additionally, similar studies on second and later classes would be worthwhile to understand the design studio of subsequent years in design education.

Studio materials were not under primary consideration in this study. Again, this paper did not aim to reserve a certain standpoint for the methodology of the education. Rather it is an attempt to understand the design studio as a social setting, for it is taken as part of the daily lives of students and instructors. However, findings can be utilized for
developments in design education, in terms of building models and methods based on social differentiations in, instructors’ social perceptions of, or students’ altering social impacts on the design studio.

References


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Exploring the Ongoing Diversity Issues Embedded in Product Design

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Abstract: The Fourth Industrial Revolution offers great opportunities and challenges to the UK design economy. The emphasis on communication and connectivity, together with new disciplines and new markets derived from technological, political and social change, makes it all the more crucial that the future design industry is infused with a wide range of skills, experience and perspectives. Lack of diversity is hindering that process, and this is especially true in product and industrial design – an industry which is 95% male with no measurable black contingent, according to current figures. Focusing on gender imbalance and opportunities for black, Asian and minority ethnic (BAME) designers, this paper explores some of the issues surrounding diversity and inclusion in product design. Using data drawn from a survey of BA/BSc students from Bournemouth University’s Product Design programme, together with academic records from the past five years, the authors investigate some worrying and enlightening trends amongst young designers in higher education. Drawing on the views of previous research and current professional practitioners, the potential causes behind the diversity deficit are explored, along with the methods that some companies are using to try to help build a more inclusive cohort of UK product designers for the future design economy.

Keywords: diversity; gender; ethnicity; product design; higher education

1 Introduction

The world stands on the threshold of a revolution. The Fourth Industrial Revolution – as defined by Schwab (2016) is a direct result of the global explosion of digital technology ushered in by the previous, Third Industrial Revolution. However, while the previous three industrial revolutions were all driven by technological change – in the form of steam, mass production and computers – this revolution has communication and connectivity at its heart. It has arisen in the face of complex global life-changing issues such as climate change and the rapid speed at which new developments are making their way round the world. It is to be expected that in the coming decades this revolution will fundamentally transform the entire structure of the world economy, our communities, our use of resources, and our human identities.
The importance of designers – and design education – as a crucial element in the Fourth Industrial Revolution is emphasised in a recent report published by the UK Design Council (Benton, Miller & Reid, 2018). However, the same report highlights a major stumbling block to the future success of the UK design economy – diversity: “The design industry has a responsibility to start recruiting individuals who break the mould of the current designer stereotype... Urgent action is required to improve diversity.”

This issue is not confined to the UK. AIGA, the professional association for design in the US, has widely condemned the lack of diversity within the industry. Their criticisms focus not only on diversity of gender and ethnicity, but on “diversity of experience, perspective and creativity”, the result of a whole host of factors from age to social background, sexual orientation to location (Carroll, 2014). Indeed, many commentators prefer to use the word inclusion over diversity as it defines a broader aim in common with the concept of social inclusion: a society “where all people feel valued [and] their differences are respected” (Robo, 2014, p. 191).

1.1 Why Diversity Matters

The moral arguments for inclusion are rooted in the ethics of equality and human rights, and as such are widely accepted and acknowledged. However, there are also practical and economic reasons why diversity is vital to the future design economy. Diversity brings with it new ideas and new insights. Hana Tanimura has experience of the benefits of leading a diverse design team at Google Creative Labs:

“It’s true that very different people working together on a project can sometimes require putting in a little extra time to achieve the kind of shorthand understanding that comes quickly with people from similar backgrounds, but from my experience, it’s precisely that light “friction” that enables new kinds of thinking and new ideas to flourish (Snoad, 2018).

US research supports the fact that, not only is there a positive link between gender diversity at management level and organisational health, but also that companies with a greater proportion of female board members reported a 26% higher return on invested capital (Barsh & Yee, 2011).

In addition, further diversity in the design industry could open up opportunities within markets which are currently being under-served. In the UK alone, black, Asian and minority ethnic (BAME) consumers wield a spending power of approximately £300 billion (Corke, 2012). In the US, the 2010 Census revealed that 19% of the population declared a physical and/or intellectual disability, and the estimates on the changing social landscape predict that by 2050 53% of the population will be “people of color” (Vernon-Chesley, 2016). With the onset of the Fourth Industrial Revolution a new global market has emerged in women’s health products, a direct result of improved connectivity and the increasing erosion of feminine health taboos. UK companies such as RocketSpace and Elvie are already benefitting from this new market, which is predicted to be worth up to £39bn by 2025 (Lawrie, 2018).

1.2 Investigating Diversity at Bournemouth University

This paper was inspired as a result of a survey conducted by the authors in 2017. This survey was primarily intended to inform research about personality distinctions in developing designers, and to discover influences and interests. However, inspection of the data also unexpectedly revealed a number of insights into gender traits. This information inspired the authors to look further into the issue of diversity in the design industry in general, and product design more specifically. It is important to stress that the survey data being used to discuss Product Design students at Bournemouth University (BU) in a diversity context for this paper was not produced for this purpose originally; which was to determine a detailed profile of student design personalities. The realisation that gender and ethnicity were so significant in the context seemed significant enough to warrant the discourse of this paper.

The authors received survey responses from 69 students attending the BA/BSc/MDes (Hons) Product Design course at BU, as well as a number of product design professionals. The student cohort contained representation from all levels of the course, and the gender split was similar to the course as a whole with 25% of the respondents being female.

As well as information about gender and level of study, the survey included the following questions:

- Who inspires you?
- Why did you choose to study for a degree in product design?
- Is studying product design at university what you expected it to be?
- Do you prefer to be given a specific brief or come up with your own project?
Which areas do you feel you could influence for the better in your career as designers?

In addition, using a Likert scale rating system, students were asked to indicate on a scale of 1 (not interested) to 3 (very interested) how interested they were in a list of the following relevant areas they had been exposed to during their studies and which are relevant to the product design process (Table 1).

<table>
<thead>
<tr>
<th>Style/Aesthetics</th>
<th>Fashion</th>
<th>Current Trends</th>
</tr>
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<tbody>
<tr>
<td>Technology</td>
<td>Brands</td>
<td>Not-for-Profit</td>
</tr>
<tr>
<td>Robotics</td>
<td>Mass Production</td>
<td>User-Centred Design</td>
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<td>Sustainability/Environmental responsibility</td>
<td>Rapid Prototyping</td>
<td>State of the Art Products</td>
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<tr>
<td>Inclusive Design</td>
<td>3D Modelling</td>
<td>Model Making/Prototype</td>
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<tr>
<td>Art</td>
<td>Print</td>
<td>Typography</td>
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<tr>
<td>Nature</td>
<td>Low Tech</td>
<td>Re-manufacture</td>
</tr>
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</table>

The primary element of the survey was about picking a design personality that the students decided to be most fitting for them. Students had the choice between six personality types that had been identified and coined by the authors over a period of five years’ teaching and marking product design projects. Table 2 lists these personality types, together with a brief description given to the students in the survey:

<table>
<thead>
<tr>
<th>IDEATOR</th>
<th>DOER</th>
<th>DREAMER</th>
<th>NEGOTIATOR</th>
<th>VISIONARY</th>
<th>WHATEVER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enjoys the front-end design process, finding problems, research, concept development, testing. Sometimes struggles to finish things.</td>
<td>Likes direction and problem definition before starting out on a project. Struggles to get started with ideas and projects.</td>
<td>You have loads of ideas, all the time, but you don’t really like the research part and never really get past initial concept stage.</td>
<td>Likes to question design parameters and has a tendency to try and renegotiate at all stages of the project. Has a tendency to take personal initiative beyond set design parameters which might not always be in the interest of the client/project outcome.</td>
<td>Always one step ahead, looking for opportunities, pushing boundaries, challenging views, ready to take a risk.</td>
<td>Just gets on with it. Will do whatever is enough to get through.</td>
</tr>
</tbody>
</table>

The responses to this question showed a distinct split between the genders (Figure 1) and it was this response in particular that motivated the authors to sift through the data for additional gender-linked responses. On the basis of the survey findings with regards to gender the authors decided that an investigation into the current state of affairs in...
product design would be relevant to the progress of the investigation. This paper is not aimed to draw any conclusions from the data as such but is meant to put the initial survey findings in a broader design and diversity context. By also drawing on BU student academic records from the past five years, as well as a range of academic and non-academic sources, elements of the survey data have been utilised to try to shed some light on some of the issues regarding diversity in product design, with a specific focus on gender imbalance and ethnic diversity amongst young designers in the UK.

2 The Gender Imbalance

Perhaps the most evident illustration of the diversity deficit – given that it affects over 50% of the population – is gender. The Design Economy 2018 report reveals that only 22% of the UK design workforce is female, a startling figure when compared to the national workforce at 47% female. Moreover, several sub-sectors of the design industry fall considerably lower than this figure, with product and industrial design at the bottom of the heap with a female contingent of just 5%. A sizeable gender pay gap also exists, according to figures from the Office for National Statistics. Again, the sub-sector of product design exhibits the greatest discrepancy, with female designers earning around 7,000 GBP less per annum than their male colleagues (Dawood, 2018).

Figures from Kerning The Gap (2018), the UK collective which campaigns for equality in design, shed some light on one of the causes. They reveal that while 70% of graphic design students are women, 89% of creative directors are male. The obvious conclusion would appear to be that either there is an element of (potentially unconscious) bias in the promotion of men, or that women are less inclined to apply for the more senior roles. However, the deeper reasons are varied, complex and potentially controversial. Sheryl Sandberg, Facebook’s chief operating officer, believes that women are largely responsible, by “leaning back” during meetings, pushing less hard for promotion and being satisfied with less responsible roles at work (The Economist, 2013). Extensive research by McKinsey in the US (Barsh & Yee, 2011) points the finger instead at “lack of role models, exclusion from the informal networks, not having a sponsor in upper management to create opportunities” and the fact that women are more likely to prize jobs that are enjoyable and meaningful rather than climbing the corporate ladder.

The comparatively low number of female professionals is in sharp contrast to university figures. Almost two-thirds of students studying on creative arts and design courses are female. While only 20% of professionals in architecture and the built environment are women, at university the figure is almost double at 38% (Design Economy, 2018). In product design, while the industry female contingent is just 5%, at BU the proportion of graduating female students has stood at between 21% and 26% over the past four years.

Similarly, UK data suggests that on the whole female students outperform their male peers at UK universities. Women are more likely to achieve a first or upper second degree classification, outperforming males by between 2 and 7 percentage points (Design Economy 2018). BU graduation figures show an even greater discrepancy: Over the past
five years the percentage of female students attaining a first or upper second degree classification in Product Design has outstripped males by an average of 9 percentage points (Figure 2).

2.1 The Perception of Skills
The under-representation of women in certain spheres of design can partly be explained by the historic and ongoing stereotypical gendering of design roles and tools. One hundred years ago, Gropius initially pronounced the Bauhaus to be a place for equal opportunities, which led to the number of female applicants outnumbering male entrants. Fearful of damage to the school’s reputation, a limit on female entrants was imposed and women were directed towards more “feminine” subjects such as textiles and ceramics (Sellers 2018). More recently, Attfield (1989) describes the dichotomy between “soft” design (as exemplified by fashion and jewellery) and “hard” design (such as product design), and Clegg and Mayfield (1999) expand on this with their investigation into how “male” technologies discourage female product design students. Even newer product design technologies – such as 3D printing and virtual reality – arguably have a predominantly “male” aesthetic and consumer base.

This gendering of skills and tools is echoed in a 2018 Design Council report (Miller, 2018) which asked professional product and industrial designers to rate the importance of specific skills for their job. Physics and engineering and technology skills were rated most highly – well above abilities such as creativity or user empathy. BU’s survey asked participants to rate their interest in various aspects of design, and the results were clear: while female interest in areas such as inclusive design and sustainability was noticeably higher than male respondents, interest in technology and robotics was significantly lower.

This would appear to suggest that women’s design interests are misaligned with the skill requirements for the job. However, it may also be true that these skills are particularly dominant in today’s product designers as a result of the overwhelming skew towards men. The Fourth Industrial Revolution, with its focus on personalisation and environmental issues, arguably favours designers with more diverse design practices. Areas such as inclusive design, design for sustainability over technology and design activism as well as attitudinal design are being more readily adapted by female designers (Rawsthorn, 2018). Ross Tulloch, Design Lead at Fjord, stresses the shift in focus away from “hard” skills:

> Things like software are learnable by anyone. What’s harder is often things like communication, like empathy, like observation, like being able to go into various environments and see how people are thinking and reacting to things (Design Economy 2018).

The female respondents in BU’s survey alluded to these “softer” skills in giving their reasons for wanting to become product designers: “I like making things” and “I always wanted to be creative in my professional life” were the most popular answers. Clegg & Mayfield (1999) pick up on the recurrence of the word “always” amongst their own students, as suggestive of “something belonging to nature rather than simply an attainment which can be acquired”.

2.2 The Role Model Issue
BU’s female students were almost twice as likely as male students to have been influenced in their choice of product design as a degree course by a teacher. The impact of personal acquaintances was echoed in the list of “design inspirations” quoted by women in the survey: colleagues and lecturers, alongside nature and the environment, were the most common specific responses. This contrasts starkly with the responses of the male students, who were much more likely to name Elon Musk, James Dyson and Jonathan Ive amongst their design inspirations. It may be significant that the Tesla and SpaceX entrepreneur – a billionaire business tycoon who made his fortune as co-founder of PayPal – is by far the most stated “design inspiration”. The appearance of Musk in the survey, alongside such figures as Steve Jobs and Alan Sugar, points to the changing nature of how young people are exposed to the influence of design.

Product design inspiration – for young men at least – appears to be dominated by global tech companies such as Apple, Google and Samsung that have utilised and adapted design thinking to amass massive global wealth (Mau, 2015).

Another gender issue evident from the survey is the startling absence of women – particularly contemporary women – singled out as design inspirations. Of the 62 individuals named by the students, only six are female. Of these, only two are designers: Ray Eames and Rowena Kostellow, both of whom passed away thirty years ago. The marginalization of female design role models has long been highlighted by a number of authors and commentators, such as Thomson (1994) and Buckley (1989), but the evidence in the authors’ survey appears to confirm that the situation has not improved, at least at BU. This may, in part, be due to the male predominance in the BU Product Design lecturing
cohort, which contained only 5 female lecturers in the 23-strong team at the time of the survey. However, as the gender imbalance in female design inspirations in the survey appears as marked amongst first-year students as final-year students, it is likely that earlier influences have played a part.

An event hosted by the Design Museum in London in December 2018 entitled “Women Design” attracted an almost exclusively female audience despite being marketed like any other event. All the attending women had long left school and very few were of university age. In conversation with the organisers and visitors of the event it became clear that it was never the intention to create an all-female event and the fact that all speakers were female was purely coincidental. It seems however that research into the history and practice of women in design is a subject matter explored by women rather than men. Many of the female creatives attending the event were unsure whether their male partners and business partners would be welcome. It was also raised that some of the younger ladies in the audience were surprised about the ongoing gender issues in industry as many had experienced more balanced learning environments at university level. For the authors this raises three core questions:

1. Do events with a focus on female designers/creatives need to be marketed differently to ensure they are perceived to be relevant to design practice irrespective of gender?
2. Do women attending such events need to be more proactive with regards to inviting their male colleagues and partners?
3. What can be done at school and university level to help ensure better gender balance in industry?

3 Exploring Ethnic Diversity in Product Design

According to the Design Council (Benton et al., 2018), 88.7% of product and industrial designers are white, 8% have an Asian background and 1.9% is classed as “other”. Black African/ Caribbean/ British have no measurable representation at all according to the data collected by the Office for National Statistics that forms the basis for the report. This compares to data from the 2011 Census indicating that 87.1% of the UK population is white (ONS, 2012).

Data from the Higher Education Funding Council for England (HEFCE) highlights the significant upturn in black, Asian and minority ethnic (BAME) students starting full-time first degrees in the UK in recent years. The period 2010–15 saw an increase of 34% – compared to a 5.5% increase for white students over the same period – and the 2015-16 figures indicate that 29% of all full-time first-year undergraduates are BAME students (HEFCE, 2016).

In order to investigate the specific state of affairs regarding Product Design students at BU, the authors collated data extracted from final year BA/BSc Product Design degree results between 2013-14 and 2017-18. During that period, the percentage of students from ethnic minorities studying Product Design at Bournemouth University in their final year was 7.7%. This figure is significantly lower than the corresponding 13% figure of BAME designers employed in the UK design industry (Benton, Miller & Reid, 2018).

One reason for BU’s lack of ethnic diversity may be down to the specific racial mix of the surrounding region. Although Bournemouth itself has an ethnic make-up comparable to the national average (86.7% white), the remainder of Dorset has a BAME population of fewer than 5% (Ward-Rice, 2018).

However, the lack of diversity may be due to economic and cultural barriers. The Design Council reports that “the design economy demands high skills levels. Workers with design skills are more likely to require a degree, post-grad qualification or professional qualification to enter the industry” (Miller, 2018). BAME students are more likely to come from less advantaged backgrounds, and as such may feel pressured – potentially by family members – to pursue a career with greater earnings potential (Ahmed, 2018). Greg Bunbury, of Bunbury Creative, explains: “From my [West Indian] ethnic and cultural background, parents know the challenges their children will face in the workplace, so they encourage them to go into practices that are more likely to yield results” (Snoad, 2018). This is particularly true for an industry which remains stubbornly London-centric, with the accompanying high costs of living.

Bunbury also singles out the lack of role models as a factor, and perhaps more importantly the lack of visibility. While some industries – notably healthcare – project an environment in which there is no shortage of successful, high earning BAME professionals, the design industry presents a more closed visage. Ansel Neckles, co-founder of Let’s Be Brief agrees: “If you have no idea who to speak to, you can forever remain looking through the window wondering ‘how do I get in?’” (Snoad, 2018)
However, attracting non-white youths to follow a design-related career path is only part of the challenge. ONS figures reveal that although university admission rates for ethnic minorities is increasing, the academic results for BAME students are significantly poorer, with non-white students markedly less likely to achieve a first or upper second classification than white students (HEFCE, 2016). When comparing the final degree results of BAME students against those of white students at BU it is evident that no student from ethnic minority backgrounds has been able to attain a first-class degree classification. Moreover, there is a considerable discrepancy – between 5.9 and 24.3 percentage points – between the average degree award achieved by white and non-white students. In 2013 and 2015 the average degree mark for BAME students was below the 40% threshold for a pass (Figure 3).

These results, both at BU and at a national level, present a worrying story and the causes are complex and not immediately apparent. Singh (2009) presents compelling evidence from many UK universities to propose a wide range of causes including “personal, cultural, institutional and structural factors overlaid with direct and indirect racism”. The suggested remedies are widespread and far-reaching, from the development of a more “inclusive” curriculum with greater appeal and relevance to diverse students, to specific support mechanisms and mentoring, and greater BAME representation within staffing and as role models. Despite the admirable work of organisations such as AdvanceHE (formerly the Higher Education Academy) and the Equality Challenge Unit to support academic achievement for non-white students in UK universities, much more clearly remains to be done.

### 4 Addressing the Recruitment Problem

There is currently a shortage of designers in the UK, and this problem is particularly acute in the product/industrial design sector. The level of vacancies amongst design firms is higher than across the UK economy as a whole, and these vacancies tend to be classed as “hard to fill” due to the stringent requirements for skills, experience or qualifications. In addition, it is estimated that around 59,000 people currently working in design have skills gaps, at a cost to the UK economy of £5.9bn per year (Miller, 2018).

The current situation is clearly not working. A long-term culture of recruitment at the hands of predominantly white, male, middle-class design managers has perpetuated a stereotypical design cohort that is not producing sufficient benefit to the UK design economy. Rawsthorn (2016) supports this view:

> The consequences are dire. If design is to fulfil its potential to improve our quality of life, it needs to attract the most talented practitioners and reflect the nuances, complexities and sensitivities of every area of society. How can it do so if it continues to be dominated by a particular demographic, and a privileged one at that?

A more creative approach is required in providing routes into the design industry to those who currently face barriers, particularly within product design. One major barrier is the stringent – and often unnecessary – demands of many job specifications. As Haydn Corrodus, founder of ethnic diversity champions We Are Stripes puts it: “If we are being honest, a lot of the roles you can learn on the job, but job specs oversell what you need to have done” (Snoad, 2018). A McKinsey report in the US revealed that “women are often evaluated for promotions primarily on performance,
while men are often promoted on potential” (Barsh & Yee, 2011). It is likely that the same practice is occurring in recruitment as well as promotion.

In addition, during recruitment – and at university level – greater consideration for the transferability of skills would help to address the diversity gap. This is particularly true for skills that are perceived to have a gender bias. Skills such as sewing or jewellery making are very relevant to the male-dominated world of product design, but may be perceived as being less desirable than more “masculine” endeavours such as 3D printing or workshop fabrication. This transferability of skills may not always be immediately obvious in some areas, and needs a degree of broad consideration. As Karen Mahony, of Mahony Associates, says:

It may sound strange, but embroidery is good training for doing pictures on-screen. They are both about designing to a grid (O’Kelly, 1997, cited in Clegg & Mayfield, 1999, p. 8).

However, part of the problem may be due to the mindset of applicants rather than recruiters. The oft-quoted finding by Hewlett Packard that women tend to only apply for jobs they feel 100% qualified for, whereas men do so with only 60% of the requirements (The Economist, 2013) must be a factor. Yet further research by Mohr (2014) found that this was not usually due to a lack of confidence in the applicant’s own ability, but instead a greater fear of failure predicated on the belief that the requirements stated in the job specification were immovable. Men were found to be much less likely to fear rejection, and placed less faith in the stated requirements. It may be that promoting greater understanding of the recruitment process, and simple rewording of job adverts and specifications would help to address this issue and attract a more diverse range of candidates.

5 Working Towards a More Diverse Future?

Despite the disappointing figures on diversity, there are a lot of organisations and companies within the UK design industry making positive moves to force a change. Organisations such as We Are Stripes, The Other Box and Let’s Be Brief are pushing the agenda and promoting wider access to under-represented groups in design. Companies such as Candy Crush creators King and digital agency ustwo have introduced initiatives such as diversity recruitment goals, mentoring schemes and non-gendered maternity leave to encourage inclusion. Design studios such as Studio Moross have made use of social media channels and BAME recruitment agencies like Creative Access to attract more diverse talent. Founder and Director Kate Moross states:

I previously came from a traditional point of view that the best person for the job is the best person for the job. But then I was opened to wider systemic issues. I kept on getting the same type of person applying for our jobs and wondering why we weren’t drawing in a more diverse pool. So we’ve made moves to readdress how we appeal to people (Benton et al., 2018).

However, despite the progress in some spheres, there are still major areas of concern. Perhaps one of the most telling signs comes from the exhibition New Designers, an annual showcase for “more than 3,000 of the brightest and most radical new creative minds” across all areas of design, from over 200 design courses across the UK (New Designers, 2018). In July 2018 New Designers, and its associated sponsors, awarded 57 individual prizes to talented new designers. Promisingly, 75% of the prize winners – including one of the two New Designers of the Year – were women, reflecting the current success of women in higher education. Conversely, only five of the 57 prizes were awarded to non-white designers, highlighting the ongoing issue of the poor outcomes for many BAME students at university.

Gail Anderson, a black female graphic designer, is only the third woman to receive the Cooper Hewitt National Design Award for Lifetime Achievement since the awards were launched in 2000. She states that when she comes across another black designer, she is happy that they are out there “doing good work just like everyone else” but stresses that “the woman thing is a tougher nut to crack”. She remains incredulous of the fact that her young female students still have to tackle gender barriers and discrimination in 2018 – one hundred years after women gained the right to vote in the UK (Sayej, 2018).

Diversity in design needs to be tackled head-on before the design industry can fully engage with the Fourth Industrial Revolution. An industry confident about producing answers to the complex questions the world of tomorrow is facing cannot successfully produce viable solutions that reflect all facets of society with the current lack of diversity, particularly in product design within higher education.
References


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Industrial Design Students’ Reflections on Cross-Institutional and Distance Collaboration

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Abstract: As an inevitable outcome of the increasing globalization of design and manufacturing of new products, distributed design teams bring new opportunities and challenges for creative engagements. In recent studies, there is a growing interest in the ways design teams collaborate and communicate. This paper builds on this strand of work by exploring a virtual design studio course conducted across three higher education institutions, Middle East Technical University (METU) from Turkey, Loughborough University from the UK, and University of Applied Arts Vienna from Austria, in 2017-18 fall semester. In this course, students work in teams in their home university, paired with another team from one of the other institutions. Each team writes a design brief and commissions it to the coupled team, who is then expected to deliver the design solutions. In the process, each team simultaneously works as clients and designers, interacting through online conference tools and e-mails, gives and receives feedback, and documents all the process on an online design process diary. Drawing on three sets of data derived from (1) systematic participant observation in every session, (2) reflective essays students submit at the end of the course, and (3) interviews conducted with students once the course has finished, this paper investigates how and in what ways pursuing a process-focused design studio provides industrial students with a different learning experience compared to their previous experiences in traditionally end-product-focused design studio courses.

Keywords: distributed design teams; design education; digital skills; collaboration

1 Introduction

As the role of design changes in response to both organizational and societal problems in the 21st century, competences required from designers diversify. For instance, it has been noted that since designers act more and

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more often as value negotiators for businesses (Inns, 2007), design graduates require business-related and entrepreneurial skills (Press & Cooper, 2003; Kiernan & Ledwith, 2014). As such, versatility has become possibly the most key trait for design graduates, with an emphasis on the transferability of the designerly skills and tools across different projects and job definitions (Kiernan & Ledwith, 2014). For this, design students and practitioners are expected to reflect on their own practice and learning (Raen, 2005) and so develop competences for planning and executing design processes for diverse problems (Martinsuo, 2009; Kaygan et al., 2017).

Another major challenge for design education is the rising importance of collaboration for design work (Dykes et al., 2009). We witness the increase in the number of the design courses that incorporate collaborative work, bringing together students not only from design disciplines, but also from a wide range of programs. This includes disciplines such as law and sociology, which do not traditionally contribute their expertise to the solution of design problems like engineering and business typically do (Boyarski, 1998; Yang et al., 2005). Design collaboration stands out with its social character, in which communication as a creative activity needs to be fostered by the participants themselves (Feast, 2012; Kaygan & Demir, 2017). In such collaborations with other professionals, as well as non-professionals, designers are expected to take on roles as coordinators and mediators (Inns, 2007). This further highlights the importance of competences related to interpersonal relations, especially negotiation among team members.

As an inevitable outcome of the prominence of collaborative work, combined with the increasing globalization of the design and manufacturing of new products, distributed design work has become a part of the designer’s routine. Taking place across departmental, organizational or geographical boundaries, such work has called for the effective use of ICT and Web 2.0 technologies, from social media to efficiency apps. Management of distributed design teams, however, is more complex than that of traditional teams in which members work in the same physical environment (Monalisa et al., 2008). Developing tools and methods for communication, which is the primary condition of developing shared understanding among team members, is highlighted as a main concern for distributed design teams that collaborate through digital tools such as video conferencing (Larsson et al., 2002).

Reviewing the existing studies that focus on the transformation of the role of the designer in the 21st century, we identify three main challenges for today’s design education: (1) the need for more versatility and reflexivity, (2) the increased prominence of interpersonal skills, and (3) the use of electronic communication tools for collaboration. In this paper, we describe a design studio course that is organized in response to these challenges, as a globally distributed, cross-institutional and partially cross-disciplinary collaborative experience. The course has a focus on the process over the end-product, and on reflexive learning and interpersonal skills over technical design skills. As such, in this paper our aim is to understand how students interpret the learning outcomes of the course, especially in their comparisons of their learnings to their practice at the traditional design studio.

2 Virtual Design Studio

Our industrial design studio activities at Middle East Technical University have been shaped by the need to provide our design students with real life encounters with diverse stakeholders, including collaborations with industry and community partners, and with students from various disciplines across the campus (Börekçi & Korkut, 2017; Kaygan & Demir, 2017; Kaygan et al., 2017). As part of this strategy, we have been running an undergraduate elective course called “Virtual Design Studio” as the METU leg of the Global Studio, which is a design course that has been conducted for more than a decade across various design schools in the world with the leadership of Loughborough University. The premise of the Global Studio is facilitating the development of skills of design students in cross-organizational and cross-cultural communication and collaboration. It also aims to enhance the working skills of design students in distributed design teams, since these skills are required to work in contemporary workplaces and globally networked organizations (Bohemia et al., 2009).

The Virtual Design Studio course, examined in this paper, was carried out in 2017-18 Fall semester and lasted for ten weeks. Each student team at METU collaborated with a team of students located in either one of the two other participant universities of the Global Studio: Loughborough University from the UK and University of Applied Arts Vienna from Austria. The project theme of the semester was “re-imagining a folklore” with a focus on the elderly. Within the frame of the project, students were expected to translate folklore into a designed item for elderly people. In this way, students gained experience of not only designing with other students from different cultures, but also designing for other cultures.

In the course, student teams are expected to deliver design solutions that meet the requirements specified in a design brief written by their paired team. In the process, each team simultaneously work as clients and designers, interacting
through online conference tools and e-mails, give and receive feedbacks and document all the process on an online design process diary. In 2017-18 Fall semester, the Virtual Design Studio had twelve students – seven women and five men – who were diverse in terms of their level: ten students were in the second, third and fourth years of their undergraduate education, and two students were from our M.Sc. in Industrial Design program. In the beginning of the semester, three groups of four students were formed. Each group was composed of students from various levels of study considering the skills and experiences they focus on at different years of education, and in order to ensure balance among the teams. While two of the three groups at METU were paired with groups of graduate students at the M.A. in Social Design program in Vienna, the other group became partners with a team of undergraduate industrial design students at Loughborough University.

3 Research Design

The research presented in this paper has been carried out by the three tutors at METU Department of Industrial Design. The empirical data comes from research conducted with the students who participated in the Virtual Design Studio course in 2017-18 Fall semester. We utilized three different and complementary sources of data with the aim of gaining a broad understanding of the students’ experiences, and to achieve credibility and validity in our analysis (Denzin & Lincoln, 2011).

The first source of data is generated through participant observation that was conducted in all sessions during the semester. Every week, each team presented in turns how they spent the previous week at the beginning of the course. Students discussed their weekly meetings with their coupled teams, where they were on the schedule and the difficulties they faced. After all the teams completed their turns, they worked in the class as a team for the tasks of the upcoming week. Observation notes were taken from the weekly reviews and classroom discussions, and from when students were working with their home teams in the class. Communication between team members and with the coupled teams, difficulties or problems teams faced and the strategies they adopted to solve them were the main aspects specifically paid attention to. The second set of data comes from the reflective essays that were individually written at the end of the semester by the students, with respect to their experiences in Virtual Design Studio. Thirdly, once the classes were over, interviews were conducted with eight students (out of twelve) who volunteered to participate in the research. At least two students from each group were interviewed. In order to make an in-depth exploration of students’ experiences in Virtual Design Studio, we utilized the interview guide consisting of three sets of questions, which are about the course conduct, teamwork, and design process.

The reflective essays and interviews were analyzed through a thematic analysis approach through line-by-line coding (King, 2012). Observation notes mainly provided contextual data for our analysis, and we referred occasionally to them to check how the students’ approaches to certain issues that have occurred during the course have changed over time.

4 Analysis

In line with the premise of the course, both observation notes and interviews show that students’ primary motivation for taking the course was the opportunity it offers for meeting and collaborating with design students studying in different learning cultures. In the first session, which focused on the course introduction, different students explained their motivations as follows: “I am most interested in being in communication with others abroad, [seeing] how we and they look at the [design] process [differently]”; “We see what it’s like in Turkey. I’m here to see how [design approaches] differ in other countries”; “My motivation is to work with students from other cultures.”

In the interviews, where students further elaborated on their motivations, some participants explained that by collaborating with students from other countries, they aim to compare themselves to those students in order to see to what extent they go through a similar education and share a similar approach to design. One of the participants, for example, says,

I took [the course] because I wanted to see how it’s like to communicate with a foreign culture, to make a project [together], to see what they do [that’s different from] what I do. [I took it] because I am curious how different cultures look at design and what they see. For example, we... Where do we stand in relation to other universities? Now for example I have an idea of where we stand in relation to [the school our team collaborated with], and [my friends in other teams] have an idea of [the school they collaborated with].
Some students even expected this course to serve as an opportunity to develop an international network among students through which they would develop long-term relations with their paired teams.

Our data reveals that at the end of the semester, when asked to reflect on their experiences in the course, students’ emphasis shifted. In their responses, their emphasis was no longer on the opportunity of cross-organizational and cross-cultural collaboration. More often, they associated their learnings with the process—rather than end-product-focused context of the course. Both the reflective essays and interviews with the members of two teams demonstrated disappointments in their communication with the paired teams. Still, as we will discuss under two separate sections below, placing the process at the core of the course seems to result in development of a number of soft skills among students, without marking these disappointments necessarily as negative experiences for themselves.

4.1 Digital Communication, Negotiation and Critiques

According to students, developing communication skills is an important outcome of the course. Among the skills they mentioned, two were prominent: skills for (1) negotiation and (2) criticizing other designers’ work.

The former is described as a skill that is related to problem solving and adopting a professional attitude. Particularly the members of the two teams who were matched with teams from the social design program mentioned the intensity of negotiation that was required throughout the process. They had problems in developing a common language, especially in the absence of face-to-face interaction, as their regular communication happened across e-mails and blogs, and with weekly virtual meetings over Skype. The major problem was, according to the students, that their paired teams did not share the same level of technical skills and knowledge due to their different backgrounds. For example, although they provided their paired teams with sketches during idea generation phase, and technical drawings, materials and manufacturing recommendations during the prototyping phase, they did not receive a parallel documentation. Although students expressed their frustration and from time to time even panicked during these phases, in the reflective essays and interviews they indicated that the negotiations required in these phases offered them a great opportunity to learn how to communicate with non-industrial designers with whom they will probably work together in professional life. One student explains below how they, as a team, learned to develop an empathetic attitude towards their paired team:

The problem at the beginning was us thinking them as [similar to] ourselves, thinking like ‘they should at least know [how to do] this’, but then when [our tutors] told us later that [we shouldn’t assume], we said, ‘yes.’ When they sent us technical drawings, we really had a laugh, like ‘is this technical drawing?’ [Our tutors] told us, ‘they sent you technical drawings, what more do you want?’ […] Then we thought, ‘yes, it doesn’t make sense to expect from everyone to send the same thing as we ourselves do.’ Everybody has their own thing.

Another student in the same team states that such problems can be even better representing the troubles they will encounter once they start working as industrial designers. He says,

[At first], I’d seen [the course] as a really professional environment, you know, because it’s international. I mean, everything was well-organized, so when we agreed on a certain time to meet, I was expecting everyone to show a level of [professionalism]. But again, you know, it’s people. Mostly because of the people in the other team, [but also] from our own team, I saw that, um, not everyone taking it seriously to the same degree. Yet when I look back, it was good, I mean it was more realistic. Maybe if everyone was [punctual] and so on, it’d be a perfect process. Then it’d be off-putting because it’s so perfect, because it’s never like that in real life (laughs).

Thus, to the extent that students accepted this project process as a rehearsal of professional life that requires collaboration with people from other fields of expertise, they had the tendency to focus on the negotiation skills they developed. One student in the team that was matched with the team in the industrial design program compared herself to the students in the other two teams, indicating that although she finds her team “lucky” in that they had a smoother experience, she believes that other students have gained more experience in communication.

Secondly, criticizing other designers’ work was raised as another important issue regarding communication. Since during design education students are usually in the role of evaluatees, on the receiving side of critiques, they stated that for the first time in this course they had a chance to observe how their own critiques can be interpreted and responded to by other students. One student explains this as follows:
It’s good that you experience it, I mean, what the other party understands when you are giving feedback. I think this is something that we, designers, need to experience more often.

Students also underlined the significance of learning from team members during critiques. Contemplating the vocabulary, tone and attitude used by their teammates in both written and oral communication across digital media, most of the students seem to have reflected on their own communication skills. Students in the final year of their studies placed further emphasis on these skills, as they believe they will be vital in their graduation project in which they collaborate with industry and their future jobs. The below quote shows how one final year student tries to change her tone and wording in not only critiques but also in general professional communication after observing one of her teammates:

I think I was communicating a little, um, sternly in e-mails. For example, I had one of my teammates, and of course we are talking about it while writing the e-mail, ‘shall I write like this’, ‘shall we write like this’, and, um, when we received feedback from the other team, they said they really liked the language we used. Rather than ‘yes, yes, but…’, more like, ‘could we add this, too’, or ‘could it be something like this?’. I think, this sort of an approach motivates people better. It made me understand this; it developed me a lot in this respect.

To sum up, by both dealing with the problems that emerge during cross-institutional collaboration and searching for the most appropriate language for sharing their feedback on other designers’ work, students believe that they gained communication skills that will have a positive impact on their professional relations in working life.

### 4.2 Blogs, Documentation and Project Management

It was common among students to distinguish the design studio courses, which they describe as “end-product-focused”, from this elective course, which they identify as “process-focused”. While the aims and learning outcomes of these courses are different, they are not considered to be unconnected by the students. On the contrary, particularly third- and fourth-year students suggested that taking a course that is focused on soft skills and the process, they realized that these skills are transferable to main design studio courses to support their projects. One student, for example, says,

Actually, it wasn’t a very different process for me. You know, we do research, user research, etc. These are now the things we know from [the design studio course]. But here I saw how to apply it while realizing a product. [...] For example I noticed that normally I should apply all of such processes in our own studio [course], too. That’s what I’m trying to do now taking [the studio course]. [...] More organized… I mean how to manage my time while doing a project, how much time I need to spare for what.

In the course students keep an online design process diary in the form of a project blog through which each team gives and receives feedback, and documents all the process. Among project management skills, documentation of the whole process through the online diary was highlighted by more than half of the students. Some students retrospectively evaluated the design processes they followed in the previous years’ studio courses, indicating that they can now see how their previous projects would have benefited from keeping a design process diary. The following quote illustrates this concern:

Until this course, in design studios [of the past years], for example, it had never occurred to me to keep a list of what we do. [...] And if [the tutors asked me to], I’d think that it’s a waste of time. But after this course, it really helped me. [...] It was very good to keep the blog, to [be able to] say, ‘oh, we started from there, ended up here’. [...] I mean, to see here that design is a process with a beginning and an end, and [...] it’s not only the outcome that matters. I believe [the course] made me realize that the whole process is important.

A fourth-year student believes that keeping a project diary in this course prepared her not only for the graduation project studio, but beyond that, also convinced her about the significance of documenting whole projects from beginning to the end to ensure a well-controlled design process. She states,

I had never taken such an interactive course where so many things are left to us. Um, also, I had never written a blog. We are told that we’ll do it also at the graduation studio. I think it’s really important in that context, too, [...] because we need to document everything. I saw [at Virtual Design Studio] that if you can set up a document well at the beginning, it ends up really well.
Students suggested that documenting the whole design process is important, first, for keeping track of the reasons behind decisions, i.e. why the designer took that particular decision and why; and second, to resolve any conflict that may occur among co-workers. They indicated that particularly working with social design students, who are from a different field of design, she realized how undocumented communication is open to misunderstanding due to the lack of a common vocabulary or ways of working among various fields of design expertise. Thus, the project management skills, particularly documenting the design process, were perceived to play an important role in cross-disciplinary and cross-institutional collaboration.

5 Conclusion

Drawing on our findings, we suggest that for distributed design teams electronic communication constitutes one of the learning outcomes. As part of the changes in the role of the 21st century designer, we see the rise of distributed design collaboration and distance communication among team members. This brings a challenge for design education as it adds new types of collaborative skills to be learned by students. On the other hand, electronic communication has the potential of serving as a means for learning within design education. As our research has shown, collaborating via electronic communication tools provides students with real life experiences of collaboration, which are impractical or outright impossible in traditional settings. It also leads to self-learning of soft skills necessary for managing interpersonal relations in teams, distributed or otherwise. In this sense, electronic communication offers opportunities for design education at large.

We started this paper with the aim of exploring how and in what ways pursuing a process-focused design studio provides industrial students with a different learning experience compared to their previous experiences in traditionally end-product-focused design studio courses. This question was triggered by our observation that in design literature while there are various sources on teaching and learning of technical skills of designers, there is a tendency to disregard the question of how to integrate soft skills into design education. Drawing on our findings, we assert that rather than expecting students to develop their soft skills on their own during their design education, we should design process-oriented courses with explicit learning outcomes, classroom discussions and assessments that are concerned specifically with the targeted soft skills. On the other hand, while we have been interested in soft skills during the course, we can presume that a process-oriented educational approach could be equally beneficial in the teaching of technical skills, such as idea generation, material selection, user testing etc. In Virtual Design Studio, we observed the value of classroom discussions in which we discussed with students about their problems in communication, teamwork, delivery and timetabling. Our findings indicate that these discussions helped them to reflect on their attitudes and approaches, as well as the methods they adopted in their responses to these problems. Moreover, teams suggested various strategies to each other for handling the problems they encountered, so we can suggest that, when openly shared in the classroom, students can also learn from others’ experiences.

Confirming the argument highlighted in the existing literature that electronic communication is more complicated and requires additional strategies in comparison with face-to-face communication in collaborative design work, our study reveals how these challenging collaboration processes can also function as unique learning opportunities in design education. We conclude that communication and collaboration problems in a design project should not be avoided, but rather be designed into the process as part of the learning outcomes of the course.

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How Inquiries into Craft Generate New Avenues for Multicultural Collaborations in Design

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Abstract: This paper reflects on the STICH research project, an international research cooperation between Switzerland and India that investigated the topic of requirements of future design education by jointly exploring issues in the areas of craft, design and social innovation. The cultural differences between these two countries allowed for an inquiry into the transformation of craft and design in new contexts of social innovation – and to discover similarities in the re-interpretation and significance of craft and design in the context of entirely different social challenges. The paper builds on existing theories of design education, crafts and design to propose future approaches to design education that involve multi-cultural research collaborations. The findings suggest how design education can reach new target groups by way of exploring new educational formats and contents that focus on the reinterpretation of traditional design skill in globalised contexts. This research fills a significant gap in the literature both in design and in crafts and provides opportunities to conduct further comparative studies.

Keywords: design education; multicultural collaboration; research; social innovation; crafts

1 Introduction

Societal development leads to the growing role of education for regional and national development. Today, a successful country is associated with a competitive national education system, leading to competitive human
resources and a competitive economy (Avralev & Efimova, 2013). Thus, one of the main objectives of higher education is to contribute to economic development and to social equality. Research and educational cooperation with countries from outside the European Union constitute an important aspect of internationalisation strategies of design schools in Europe. New target groups for design education and new educational formats and contents for design are considered to be central to design education in order to respond to an evolving design understanding (Buchanan, 2001). International cooperation with partners from outside Europe can be a way to achieve these goals as it provides contrasting contexts to mirror and discuss practice and theory. Simultaneously, successful and sustainable partnership is still more difficult to achieve, as there is no bilateral framework similar to the Bologna Declaration in Europe – coordinating, for example, recognition of degrees and periods of studies. Partnership with research partners from South Asia involves complex issues such as agreeing on suitable formats and communication tools, development of areas of mutual interest, joint research questions and trust.

This paper reports on the STICH research project, an international research cooperation between Switzerland and India that investigated the topic of requirements of future design education by jointly exploring topic issues in the area of craft, design and social innovation. The great cultural differences between the two countries helped in reflecting the transformation of craft and design in new contexts of social innovation – e.g. seeing similarities in the reinterpretation and significance of craft and design in the context of entirely different social challenges.

Based on the review of a nine-month research cooperation between two design schools in India and Switzerland, the paper proposes ways of linking-up with new target groups for design education and new educational formats and contents that reflect the reinterpretation of traditional design skills in globalised contexts. Thus, the paper’s significant contribution is through application of theory in the specific context of a research cooperation highlighting particular target groups, formats and contents for future design education in Switzerland and India. This research fills a significant gap in literature in both design and in craft, and provides opportunities to conduct further comparative studies.

2 Literature Review

First, we need to clarify some of the terms used in this paper: The term ‘craft’ subsumes those activities that deal with materials and turn them into products employing the local, traditional wisdom of craft processes (Das & Hasija, 2017). Craft is about making and working with material. It is about knowledge and the practice of making specific products. As such, crafts are associated with “sensibilities of material understanding, of making and haptic perception as well as the production of emotional values [...]” (Niedderer & Townsend, 2014, p. 625). Craft, therefore, incorporates ‘intelligent making’ (compare: NSEAD: definition http://www.nsead.org/craft/index.aspx). Apart from crafts (the actual artefacts), we refer to this dimension of informed and sensitive choosing and making when speaking of craft in this paper. Thus, craft is characterised by being not elite, typically a gendered activity and polarised in terms of religious categorisation of different types of crafts.

Craft in Switzerland, like in most developed countries, is discussed in the context of industry and business, yet in countries like India, where there has been a continuous unbroken craft tradition of thousands of years, crafts have an integral role in design studies. In India, colonisation had a crushing impact on crafts: a de-industrialization took place which broke the backbone of the Indian economy and the crafts sector, which had been the mainstay of India for millennia, suffered in unimaginable ways. The years after Independence in India were difficult in many regards, but especially in economic terms. However, craft traditions in both of the above-mentioned countries share the experience of an IT boom, which introduced an important transition: the economy opened up, resulting in more room for cultural issues and a new focus on craft as informed making, which can serve as a means to communicate new messages, reinterpret values for new contexts (Junginger, 2016) and as means for empowerment (von Busch & Pazarbasi, 2018). Thus, craft is crossing into design – e.g. challenging existing understandings and creating new meanings (Junginger, 2016) or “imagining and creating future opportunities” (Nielsen et al., 2017, p. 620). Table 1 provides an overview of focus issues for traditional application of design and craft and for the application in new contexts. Therefore, we can speak of correspondences between craft and design practice, when it comes to social innovation; when discussing craft knowledge in the context of social innovation, we can also draw conclusions on requirements for future design practice and future design education.

Craft as design strategy is directed towards identifying ways out of complex muted conversation by challenging complex situations. A similar movement can be observed in the context of design: the understanding of design has shifted from an understanding that emphasises technique or method to one that highlights design as a strategic art (Junginger, 2016, p. 48), which is concerned with not only techniques (skilled, unskilled), but also with social issues.
Design used at this strategic level, promotes the skilful application of techniques and engages people through methods to inquire into problems of approaching societal challenges, sets the path for social transformation and social change that concern the human experience. Buchanan coined the term third and fourth order of design problems, which are concerned with the design of new processes, services or environments and systems, rather than visual symbols, graphics- or and product design (Buchanan, 2001). Buchanan emphasizes that dealing with problems of third and fourth order of design, requires the consideration of additional levels of investigation such as the experience of using products – e.g. considering usefulness, usability, and desirability, rather than limiting the design inquiries to form, function, materials and manner of production (ibid: 13).

One of the key issues addressed in research on design education is that there are clear links between design research and design teaching, and that maybe they could be closer – e.g. design research does support design teaching (e.g. Tovey, 2015). This is a good reason for undertaking joint investigation in craft design and social innovation in order to inform the progress of future design development.

Existing research on the requirements for future design education include a number of different claims, such as development of new areas of design practice such as interaction design, mastery of advanced design methods and of design research (Buchanan, 2004). In relation to the development of future design curricula, Buchanan’s (2001) concept of four orders of design lends itself to hypothesising that contexts of use need to be considered when investigating future design curricula. Buchanan (2001) highlights changing features in design practice and design education that concern contexts in relation to a) experience: “How do we plan an action, how do we create the concrete form of experience […]” (ibid:11-12) – and b) systems in which “things” are integrated and used (ibid.). Also, design research makes substantial efforts to highlight the teaching of design from elementary school as an essential contributor in support of a better tomorrow (Vande et al., 2015; Lloyd & Boehmia; 2016, Storni et al., 2018). One reason given is that “Every day we need to apply knowledge from a variety of sources to resolve problems, manage relationships, and establish a quality life” (Vande et al., 2015, p. ii). In order to extend existing synapses and initiate links between design research and design education that can support teaching in design (Tovey, 2015), we will also consider the question of new formats in design curricula. Therefore, new target groups for design education, new educational formats and contexts for design curricula channelled the research project activities that this paper reports on.

### 3 Materials and Methods

The STICH research collaboration was a seeding project that lasted from 1 March – 31 December 2018. It was funded with a Bridging Grant of the Leading House South Asia and Iran and offered two Swiss researchers from the Lucerne University of Applied Sciences and Arts (LUASA) who have already successfully completed a project with the National Institute of Design (NID) the possibility to continue joint research in order to prepare a grant application for a full joint research project. Also, the project team involved a staff member with expertise in higher education development, on the Swiss side. On the Indian side, the two researchers from the NID have demonstrated research interests in the crafts sector, and they identified the research site in Ahmedabad city which is a craft cluster of disenfranchised women located around a heritage monument of the city. Over the funded nine-month period, the research partners achieved a number of accomplishments, spanning from qualitative data collection, two joint research symposiums, and the foundation for a collaboration on doctoral education. The planning and execution of a joint research symposium in Lucerne in September 2018 and the planning and execution of a joint project workshop during the
insight’18 Design Research Symposium at the NID in Ahmedabad in November 2018 were vehicles to share relevant research from both institutes and led to a state-of-the-art overview on research into craft and social innovation in Switzerland and India. There was a successful application for an SNSF-mobility grant that covered travelling and accommodation for the two Indian researchers, as this was not part of the Bridging Grant budget. The results were implemented in a follow-up project proposal (January 2019) to MOVETIA, the Swiss Exchange and Mobility promotion agency aiming at setting up a joint international collaboration on the topic of craft, design education and social innovation. One of the key elements of the proposal is the setting-up of a joint international research and exchange platform on craft, design education and social innovation, where results can be made available and the interrelation between craft and design in future society and economy can be further discussed.

The STICH project took place within the existing Craft Design Research Lab – a research and education framework between the NID and LUASA. Both LUASA and the NID offer praxis oriented and application-oriented competences in design education, enabling an entry into design practice. This includes a focus on social design in many of the courses through socially engaged practice projects. The design program at LUASA is situated between traditional design skills and an extended design practice operating in fields of service, process, and systems design. NID is a top ranked Indian Design School that offers design education at the level of B.Des., M.Des. and PhD. Its internationally recognized focus points include social and ecological correlations, and international cooperation. The NID-Design Vision Center investigates an extended design practice and the role of design in the future society and economy in India.

The project team used one symposium and a workshop for joint investigation on the topic of craft design and social innovation to jointly explore target groups, formats and contents for future design education in Switzerland and India. Our research question was an explorative one in so far as we wished to study a so far yet poorly understood phenomenon. We were interested into gaining insights from analysing a range of issues and include the view of different stakeholders. This implies a qualitative research design. Data collection accompanied the process as an additional information source that nourished the discussion with additional data from practice. It consisted of a field visit of the entire team comprising both Indian and Swiss researchers to the Sarkhej Roza Women’s Collective in Ahmedabad and interaction with some of the stakeholders, as well as a series of nine problem centred interviews (Witzel, 1985) with craft-related social initiatives in Switzerland1. Interviews were transcribed verbatim. While we used predefined categories (design strategies) in the three-step coding and mapping process (Miles & Hubermann, 1994) the two researchers also remained open for categories to emerge from the material. In order to increase interpretative validity, the results were presented and discussed at the Insight 2018 Design Research Symposium at NID, Ahmedabad, India.

4 Results

The joint exploration of craft design and social innovation led to a number of relevant indications for future design education. The symposium and results from the interview analysis highlight the importance of strengthening design competencies as basic skill for Swiss primary school to respond to the basic skill focus of Swiss educational goals for Swiss primary and secondary school. Basic skills describe the heart of educational goals. They cover basic capabilities and skills that need to be reached at particular school levels. Aesthetics and creativity constitute an integral part of the basic skill concept (compare: http://www.edk.ch/dyn/12930.php (in German and French only)). Additionally, the results from the project emphasized the significance of focusing on creating cultural competencies in the education of designers: they more and more need to be able to operate in global contexts. Design students need to not only experience, but also reflect work across different cultures – inside and outside university, across different communities, and across different countries.

The multicultural research cooperation confirmed the shared interest and potential of craft, design and social innovation in relation to developing future design curricula. The project particularly showed similarities in the re-interpretation, significance and function of craft and design in the context of the entirely different social challenges in India and Switzerland – e.g. bridging between dissimilar groups, creating new narratives around a topic issue, and finding ways out of muted conversation. The project also revealed the difference in nuanced understanding of and approach towards crafts in both cultures, of the crafts sector in both countries, and the correlation between design and craft in design education of both institutes. Additionally, the research projects showed that new narratives include the potential to emphasize new roles for design and creating, e.g. promoting design as innovation practice with an open, flexible approach, and emphasizing new roles for designers. Innovative educational formats such as

1 MachWerk, Social Fabric, HelloWelcom, Architecture for Refugees, Guerilla Urbanism, Nähatelier ZH, Café Maitri, Tüftelwerkstatt, FabLab Luzern
How Inquiries into Craft Generate New Avenues for Multicultural Collaborations in Design

interdisciplinary and collaborative summer schools that focus on social transformation and economic innovation can serve as vehicles to generate these new narratives. Furthermore, the exploration led to the realisation that joint international PhD-calls and programs in the field of extended design theory can particularly underline the commitment of design to complex social and economic issues, because it promotes and supports scientific publication of design researchers. Consequently, both NID and HSLU are working out collaboration on their PhD calls with clear invitations at NID to research proposals of people engaged with the craft sector and social development and innovation for their next cycle of PhD admissions so that a shared content, structure and format of doctoral education in design may take place.

However, working across multicultural contexts also included discussing differing national demands on higher education in design, e.g. differing demands on designers, from industry such as an emphasis on infrastructural, marketing and international web technology projects in India and an emphasis on commissioned freelance studio work in Switzerland.

At an intercultural level, the project brought new findings in relation to understanding of, and accessibility to funding. Researchers’ responsibilities, for example, towards the general public in India and in Switzerland seem to differ - e.g. research grants from the Swiss Government, such as the Bridging Grant, are entirely provided through taxpayer’s money. Furthermore, we noted that there is a real problem in terms of the income differences in Switzerland and India. There also seems to be an issue with most funding instruments, as they provide (some) money to Swiss researchers but none to Indian researchers. We experienced this with SUDAC and with MOVETIA (Swiss funding agencies), for example. The Indian partners are often relegated to providing specific materials and letters of support without being fully able to understand and without fully being able to participate on an equal footing in the grant proposals.

5 Discussion

As part of the Craft Design Research Lab and implementation of internationalisation of design schools the STICH research project provided the opportunity to investigate the reinterpretation of design in new contexts in relation to craft and social innovation initiatives. The main purpose of the paper was to report on results of the joint investigation of future oriented design education target groups, formats and context. The study illustrated how relating craft to design and social innovation is about considering craft in relation to communication and interaction (e.g. bridging, creating new narratives, and re-creating conversation). This observation allows us to link craft to Buchanan’s (2001) third and fourth orders of design – groups of people interacting with other groups of people and things. Furthermore, the joint investigation showed a lack of visibility and commitment of design education to design in relation to complex issues. Instead, design is mainly understood as styling and in relation to products – e.g. tables, chairs etc. This is true for both educators and also for most of the students and general public in the contexts of the Indian and Swiss school. Instead, design is increasingly applied in new contexts and with new target groups, e.g. interdisciplinary innovation process contexts. With the new target groups, design is understood as having an open and flexible innovation approach – e.g. including interdisciplinary and international project partners with continuously evolving project briefs that require design method and research competences (Buchanan, 2004).

The researchers proposed a number of important aspects, which can serve as guidelines for future investigations and development of future design education and creation of new narratives around design in new contexts. They include the importance of:

- responding to national educational strategies to promote design in relation to future oriented skills such as aesthetic knowledge and creativity to create common reference points between design and new target groups such as primary school;
- utilising interdisciplinary formats such as summer schools that focus on social transformation and economic innovation to create new narratives around design to mediate the role of design process as flexible, open innovation approach;
- finding ways to demonstrate leadership and commitment to complex issues.

The study confirms earlier realisation on the importance of strengthening the relevance of design research in design education (e.g. Buchanan, 2001). This study shows that joint, international PhD-calls can provide an opportunity to underline the commitment of design to complex social and economic issues, because it promotes and supports scientific publication of design researchers.
6 Conclusion

The paper reported on a joint investigation on the topic of craft design and social innovation to jointly explore future design education requirements.

Working on the issue of design, craft and social innovation, and seeing similar functions of craft in social innovation, we find that the topic offers new avenues for multicultural collaborations across radically different cultural context like those presented by Switzerland and India. Craft in our study is assigned a role in relation to pioneering and developing new ideas across different groups, rather than being linked to one particular tradition and to retaining one particular cultural identity. This type of repositioning of craft and related skills and traditional craft knowledge to todays’ challenges is also reviewing and revaluing respective skills, knowledge and practices. The topic however is not explored well and deserves more research. Finally, we conclude that the ideas, techniques and methods of crafts can be detected in and are related to design of the first and second order problems (see: Buchanan, 2001). We argue that human-centred design can learn from crafts and their relations and efficacies on social change. In a world of disruption and change, the search is on for continuity. The exploration of crafts from a design angle allows for new insights into what continuity may mean in the context of social design. The links between design skills and techniques of the first and second order to third and fourth order design problems – i.e., the broadening of design approaches to systemic change and new contexts can benefit from a new understanding of crafts and its contributions to social innovation.

Future-oriented skills such as intercultural communication and interdisciplinarity have been acknowledged through respective educational formats but are still the poor relative, when it comes to theoretical back up. One way of creating new narratives that emphasize complexity in design and preparing students to contribute to a complex world include the development of international PhD-programs, which necessarily emphasize the legitimacy of design in research and can demonstrate thematic leadership. This requires long-term commitment through the education partners, which may not always be granted or funded.

We therefore conclude that more research is needed. However, we also conclude that the funding for such projects remains challenging as many funding bodies only support one side and demand deep knowledge about funding bodies and promotion agencies. Still the research collaboration is leading towards new curricula ideas that we are trying to fund with the MOVETIA open project call.

References

How Inquiries into Craft Generate New Avenues for Multicultural Collaborations in Design


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Crossing the Finish Line Together: Collaborative Team Learning in Design Studios

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Abstract: Shaped by technological advancements and external forces, the narratives of contemporary architecture practices shift from the celebration of the master architect to the collaborative team player in explorative enterprises. Curiously, our studio culture remains lukewarm to such disruptions. The studio pedagogical framework embedded in our design studios of how design tutors teach plays a quintessential role in shaping future architecture educational discourses. It is argued that the traditional one-on-one desk crits have limited potential for breeding new modes of cross-industry design practices. To date, the relevancies of such ubiquitous hierarchical master and apprentice teaching pedagogical structure remains unchallenged. This paper argues for a collaborative design studio characterised by collective actions and mutual support as an alternative. This research examines the repercussions of an experimental model of facilitating architecture design studios with a reinforced focus on collaboration (Collaborative Team Learning - CTL) comparing against the traditional one-on-one (OOO) studio pedagogy. CTL’s pedagogical strategy situates the design tutor as an enabler, engaging students in a cross-pollinative and collaborative approach. At the end of the academic year, students were invited to complete a paper-based questionnaire to gauge their learning experience. Preliminary analysis revealed that CTL students accomplished improved academic performance, instilment of self-directed peer-to-peer learning and lower attrition compare with OOO students. This research advocates that these CTL experiences play a pivotal role in inculcating collaborative mindsets for emerging modes of architectural practices that centre on effective communications, emotional intelligence and negotiations.

Keywords: design studio pedagogy; learning experience; collaboration; heterarchy; cross-pollination

1 Introduction

Over the past decades, we have witnessed notable progressions in architecture and design alongside improvements in construction technologies, computational tools and advanced fabrication techniques. These advancements rewrite the narratives of having the architect as the Master Designer to the collaborative team player in contemporary practices. Curiously, architecture education's studio pedagogy remains lukewarm to such disruptions and the stratified one-on-one studio pedagogical framework of Tutors as Masters and Students as Apprentices remains unchallenged.

Throughout this paper, the term studio pedagogical framework refers to the method of facilitating student's design work in progress with formative intents. Researchers have argued that we can understand how students learn and the
implications for their academic achievements by focusing on their learning environment (Prayoonwong & Nimnuan, 2010). The discourse of our studio learning environment must not be limited to the confines of our physical teaching space, but rather, the pedagogical frameworks and learning culture embedded in our design studios.

Practice and academia can never be divorced. Institutions often look to practice’s changing dynamics and advancements to steer their academic directions. In the 21st century context of accelerated change, academia can no longer rely entirely upon the state and cultures of contemporary practices to chart its prospects. In recent years, various architectural studio typologies, e.g., research studios, participatory design and interdisciplinary studios (within built environment disciplines) are conceived to respond to the changing landscapes of practice (and vice versa). Despite this, the pedagogical environment in academia resides comfortably in a dismal state of stagnation (Salama, 2016). While design professionals pride themselves as agents of change advancing their respective fields, it is perplexing as to why we have remained conservative in our design for an appropriate studio pedagogy reiterating the one-on-one studio teaching practices inherited from the 20th century. This paper highlights the challenges of such one-on-one individualised desk crits in instilling collaborative mindsets as breeding conditions for alternative modes of cross-industry practices to emerge. To date, pedagogical experiments that deviate from the individualistic one-on-one desk crit pedagogical framework of studio facilitation is sporadically examined (Goldschmidt, Casakin, Avidan & Ronen, 2014). Thus, this research evaluates students’ learning experience and its repercussions of both authoritative one-on-one (OOO) desk crits and the experimental Collaborative Team Learning (CTL) pedagogical framework during formative design reviews. This paper hypothesises that students immersing in CTL would achieve improved academic performance, learning experiences, efficiencies in their self-directed peer-to-peer learning and student retention.

In this experimental CTL, tutors lead design reviews in a small-sized student team facilitating in a non-hierarchical and collaborative approach within the freshmen’s architecture studio throughout one academic year. Can design educators lecture effectively in teaching collaborative mindsets for emerging modes of practices? Unlikely. Conversely, tutors can inculcate such mindsets in their daily engagements with students. The tutor is both an actor and an enabler. It is argued that students will foster valuable soft skills like critical thinking and complex problem solving as a result of modelling tutors’ approaches of facilitating design review conversations in their architectural journeys (Stevens, 1998; Fisher, 2012). Students practising self-directed learning is a virtue for lifelong learners. Self-directed learning occurs when students conduct and evaluate their learning journeys themselves. Being self-directed does not mean that their learning is highly individualised in isolation. Students can work in self-directed ways while engaged in group-learning settings (Brookfield, 2009). Inculcating a culture of self-initiated peer-to-peer learning can strategically respond to the international trend of funding cuts that decreases to the one-to-one student-tutor contact time (Tucker, 2016; Wallis & Williams, 2012).

2 A Future Built on Collaborations

Physical commodity and natural resources can no longer sustainably drive our economies (Powell & Snellman, 2004). In developed capitalist economics, production of knowledge, technological output and dissemination of information are deemed the main drivers. With the imminence of the artificial intelligence-driven Fourth Industrial Revolution, students of today will be journeying into a super-complex workforce. Educational theorist Ronald Barnett projects a world that exhibits global characteristics of challenges, turbulence, contestability and unpredictability (Barnett, 2000). Unlike the previous Industrial Revolution, the latest iteration shifts away from the emphasis of technical capabilities, mechanised and procedural skills to the acquisition of soft skills in supporting effective communications and collaborations. Soft skills depict capabilities of negotiation, competencies in their emotional intelligence, empathic and critical/creative thinking is considered paramount for a future collaborative workforce (Schwab, 2015).

The landscapes of future architectural practices must react to these disruptions. Prevailing narratives of starchitects celebrated as singular creative individuals, rather than being in collective enterprises in architectural pursuits (Till, 2018a) are losing relevancies in our current time. The architect’s role is constantly evolving from a siloed, individualistic practice of the master designer to the collaborative team player. Practices have to stay nimble and highly adaptive in challenging situations in the future (Duffy & Hutton, 2004; Jamieson, 2011). Bryant, Rodgers and Wigfall (2018) identified four main predominant trends of emerging modes of practices and the common denominator amongst them, is that architects are redefining and diversifying their traditional roles to working outside the realm of building as products. Turner Prize-winning group of designers and artist of Assemble and Architecture 00 are recent exemplars of such alternative architectural practices. Research agency, Forensic Architecture, expands the influence of architectural thinking and techniques working alongside artists, filmmakers, software developers, investigative journalists, archaeologists, lawyers, and scientists (Forensic Architecture, n.d.). This research group have since produced ground-breaking video graphic evidences presented in political and legal forums, truth commissions, and
human rights reports. Success in such interdisciplinary collaborative environments relies heavily on an open/growth mindset, building upon the foundations of soft skills and effective communications.

3 Mechanisms in the Design Studio

Curriculum reviews are frequent affairs in faculties. Architecture schools have responded enthusiastically to the imminent of the Fourth Industrial Revolution by equipping the latest state-of-the-art facilities, robotics and virtual reality technologies into their pedagogy to address the tool-sets of imminent design trends and inclinations - the hardware of architectural practice. As expounded, having strong interpersonal, communication and collaborative traits are valuable in incubating new modes of cross-industry practices. Educators can design their studio learning experience as a pedagogical strategy aiming to inculcate soft skills (software) broadening their mental capacities in preparing students’ journey into an uncertain future (Ostwald et al., 2008; Burke et al., 2016). After all, education is about character building, empowerment, enablement and the transformation of the individual for them to intervene in this world (Till, 2018a).

Design studios are widely acknowledged as the pulse in architecture education worldwide. Weekly formative reviews in design studios typically involve students working on their design projects in the studio individually, in teams or groups. Typical scheduled contact hours are two to three times per week of four hours each for students to discuss their designs in progress. Alternative forms of pedagogical approaches during formative reviews include individual pin-up or group reviews. Nevertheless, these formative design review conversations still adhere to the hierarchical one-on-one teaching between the studio master with the student with a studio master at their desk (Goldschmidt, 2002; Webster, 2004; Mewburn, 2009; Goldschmidt et al., 2010; Tonkinwise, 2011; Liow, 2016). This pedagogical approach is commonly known as the desk crit. Desk crits’ one-on-one mode of teaching is widely preferred in architecture schools (Goldschmidt, 2002; Liow, 2016; Tonkinwise, 2011).

The studio pedagogical approach is such that design solutions to a singular problem are deemed to be endless. The design tutor can latch on to these instabilities of the design process to foster collaborative mindsets and mental resilience with their students in a team environment. Can tutors explicitly introduce attributes required for successful collaborations? Unlikely. The inculcation of soft skills and the impartation of successful collaboration techniques can be a challenge to teach in seminars or lectures. Can students learn how to collaborate by mimicking their tutors? Probably. It is argued that design tutors could facilitate students’ learning with such qualities and thus, potentially to be latched on by students by modelling these values and behaviours in their lives (Stevens, 1998; Fisher, 2012). While researchers advocate the importance of collaboration in our curriculum and teaching engagements (Tucker & Rollo, 2003; McPeek, 2009; McPeek & Morthland, 2010; Tucker, 2016; Wilson & Zamberlan, 2017), institutions had garnered little repercussions. Many high-performing research schools are seldom equally concerned with the teaching-research nexus (Ostwald et al., 2008).

3.1 One-on-One Design Studio Pedagogical Model

As design professionals pride themselves as agents of change advancing their respective fields, it is curious why architects are lukewarm towards architecture education by depositing their faith through repeating the same studio pedagogical formula from the 20th century. Although the site of architecture education progresses from medieval work-sites, Beaux-Arts’ studios, Bauhaus’s workshops to the widely adopted Unit System, the revered one-on-one master and apprentice model of teaching remains unchallenged to date. The envisioned spontaneous dialogues, negotiations and discussions of an ideal design studio environment unconsciously slide back into the re-adoption of the Beaux-Arts apprenticeship model resulting in a dictated and regimented learning environment. This monodirectional design review conversation is a worrying aspect of our studio pedagogy.

Architecture schools need to question the relevance of such instructional and procedural teaching methods inherited from incarnations of the previous industrial revolutions. This unchallenged pedagogical approach promoted Webster (2004) to strongly criticise architectural educators for failing to embrace a more student-centric learning, remaining stuck in the master and apprentice model of engagement. Goldschmidt (2002) investigated this phenomenon and discovered that, in this one-on-one mode of teaching, the tutors’ critique constituted 62% of the review session and intensified to 74% in sessions with two tutors! Kurt (2009) elucidated that generally in every review type (both summative and formative), the design review conversation is usually tutor-centred. Whenever design review conversations remain tutor-centric, students’ learning outcomes are disappointing. Students tend to depend on tutors for the generation of ideas and the resolution of their designs (Green & Bonollo, 2003). Sometimes, students may be interested in fulfilling the design tutor’s design advice blindly and might end up as an exercise in mimicking the tutor’s architectural styles and design methodologies. Tutor centred design review conversations potentially limit students’
creativity and prevent them from exploring their designs freely (Kurt, 2009). This master and apprentice relationship continues to exert an immense influence in today’s studio culture, often results in missed opportunities of advancing the fields in design and architecture. Figure 1 and Section 3.1.1 aim to illustrate key characterises of a typical one-on-one desk crit.

**Figure 1. Key characterises of a typical one-on-one desk crit review. (Liow, 2016)**

### 3.1.1 Keys Characterises of a Typical One-on-One Desk Crit review

- A *Sign Up* queuing list ensures the review sequence.
- Minimal opportunities for cross-pollination and interaction. Predominately a one-way dialogue.
- Competitive students might hog the tutor for up to 40 minutes.
- Less motivated students may disappear during mid-day
- Lack of active participation from fellow peers. 2-3 students may gather around the table and not participate as active contributors but as passive learners waiting for their turn to consult.
- Breeding of competitive individuals. (Liow, 2016)

### 3.2 Team/Group Work Studio as a Collaborative Pedagogical Model

Educators recognise that learning in teams/groups theoretically leads to students’ development of interpersonal and critical thinking skills (Gokhale, 1995; Dochy, Segers & Sluijsmans, 1999). Diving into the literature pertaining to collaborative practices in the academic design studios reveals subtle differences in their definitions between *group work* and *teamwork*. Tucker, an authoritative figure in studio pedagogy research, clarified that the main difference between teamwork and group work in the design studio is that, for teamwork, students jointly work on a singular assigned project where members actively contribute to team cohesion and task achievement. While group work, students worked separately on different aspects of a project/task and then combine their work, often with limited attempts at integration (Tucker, 2016). Both methods of collaboration are characterised by students working towards one unified submission sharing the same academic outcome (Richard & Catherine, 2006; McPeek, 2009; Kamalipour et al., 2014; Pawson, 2016; Rodriguez et al., 2018). Even working together under the guise of collaborative assignments, educators cannot guarantee that students had communicated well to reap the benefits of developing their non-cognitive skills working in a group (Dillenbourg, 1999). Collaboration assignments usually occur in the beginnings of the design project as a formative assignment, i.e. site analysis and precedent studies which capitalise on students working together. This format of working in groups ceases when their individual design project begins.
4 The Current Study - Formative Design Reviews as a Collaborative Act

While a collaborative learning environment is universally lauded as a useful model for learning, collaborative assignments in the design studio conventionally refer to student groups/teams being stakeholders of a single deliverable, sharing the same grade. Deviating forms of collaborative pedagogical strategies during formative design reviews are sporadically examined. This paper reports on an action-research in which an experimental Collaborative Team Learning – CTL (treatment group) is infused into the day-to-day formative reviews contrasting against the ubiquitous one-on-one studio – OOO (control group) for one academic year.

The research questions examined for this study include:

1. Would students learning in a CTL environment garner positive effects on their learning experience and thus, influence students’ academic performance and retention?

   A simple hypothesis is that with positive learning experiences in CTL, associations would surface between their respective pedagogical frameworks with academic achievements. CTL students are anticipated to have lower attrition compared to OOO students.

2. Would CTL help to increases the frequencies and effectiveness of students’ self-directed peer-to-peer learning outside official studio hours?

   This paper speculates that OOO students inducted in an individualistic learning environment would register lower frequencies of peer-to-peer discussions. Conversely, students modelling of CTL’s strategy of cross-pollination and therefore, inculcate routines of self-initiated group discussions. The effectiveness of their peer-to-peer learning is primarily correlated through the analysis of their academic performance.

   4.1 Experiment Methods – Team Size, Tutor Allocation & Structure of Assignments

   This study is centred on first-year architecture students of 17 to 18-year-olds, who had embarked on a difficult transition from the logical STEM curriculums of high schools into the uncertainty and idealistic nature of an architecture school. The cohort of 110 students is randomly distributed across three studios as illustrated in Figure 2. The design brief is identical for all across the academic year. Twenty-six students from Studios A and B were facilitated in a CTL approach, and the rest of the cohort are taught in the traditional OOO desk crit format. A maximum of 1:14 teaching ratio is maintained throughout the cohort with contact times of 8 hours per week, divided into two sessions of 4 hours each. Students in the CTL group initiates their grouping and are paired with a fixed tutor. This strict pairing is in contrast with the OOO group as students can consult from any tutors in their studio via a sign-up list.

   ![Figure 2. Overview of the cohort distribution and context of CTL.](image)

The freshmen’s design projects were conceived to cover a wide range of fundamental architectural sensibilities from site studies, architectural/environmental strategies, tectonic expressions to structural and constructions elements. The complexities of these assignments ramp up from the resolution of a tectonical sculpture as Foundation Exercise 1, a WW2 memorial as Foundation Exercise 2 to the Final Project of a single detached dwelling unit.
4.2 Experimental CTL Pedagogical Framework

Traditional education programmes are (unintentionally) orientated towards a competitive and individualistic climate of learning (Emmitt, 2009). Figure 3 illustrates how CTL’s pedagogy departs from both one-to-one desk crits as well as the established mechanics of team/group work. As a counterpoint, a typical scenario of CTL is that tutors guide students as a neutral facilitator that optimistically leads to less dictative review conversations. Design decisions of individual students are occasionally collectively made as a team and, students being aware of one other’s progress helps in the pacing of their design. This shared learning environment thrives on students’ camaraderie and finds encouragement within the uncertainties of design.

The intensity of the tutor’s intervention and drawing of questions from students decreases towards the end of the academic year as reflected in Figure 4. CTL’s diminishing level of prompting questions contrasts with OOO’s consistent level of engagement with tutors domineering discussions. It is projected that CTL students, towards the conclusion of the academic year, would have modelled the tutor’s approach in promoting and asking relevant questions. Active learning is a key component as tutors consciously orchestrate these formative conversations, engaging students as means to instil collaborative mindsets. The design tutor is both an actor and the orchestra conductor. CTL’s learning environment aims to breed moments of Cross-Cohort/Studio Pollination with collaborative tasks, illustrated in Figure 5.
4.3 Data Collection

Following submission of the final assignment of the academic year, students were invited to complete a paper-based questionnaire. They were informed that their participation was voluntary and would not affect their grades. This exercise was administered before their final results were released to ensure that their replies remain objective. There were four questions, the first as a Likert scale question asking about their learning experience, with a 5-point Likert scale from (1) very negative, (3) neutral to (5) very positive. The students were asked to reflect if they had received sufficient guidance (duration of tutor-student time, qualitatively) and to ascertain if their learning journey has been explorative, encouraging and engaging.

The next two questions were structured as open-ended responses so that students could provide a written reflection of their learning experience and suggest potential improvements. The questionnaire ends with a Yes/No question that seeks to uncover the frequencies of students’ self-directed peer-to-peer learning. Students would answer yes if they have met up with 2-3 other peers to discuss the progress of their design project at least three times per week outside allocated studio contact hours without the tutor’s facilitation.

5 Results

This primary research aim is to uncover various after-effects of learning in both OOO and CTL after one academic year. This section is broken into four sub-sections – 5.1) Academic Performance, comparing the end of the year scores of both groups of students, 5.2) Learning Experience, the breakdown of the data collected through the 5-Likert scale question. 5.3) Frequencies of students’ self-directed peer-to-peer learning outside official contact hours. Lastly, 5.4) Cohort Attrition, to uncover if their experience in their respective design studio’s pedagogical framework has any correlation to student retention. The response rate for the questionnaire was 85% with 94 students after seven cases of non-participation and nine attrition cases.
5.1 Academic Performance

An analysis was conducted to uncover any correlation between academic performance and the studio pedagogical framework between OOO and CTL group. A key finding, as hypothesised, is that CTL students outperformed OOO students with their academic grades. Figure 6 reveals that within the top 10 performers, six students were taught in CTL as opposed to 4 OOO students. Students from CTL are more likely to perform within the top 50th percentile with 80% of the 26 students contrasting against 38.2% of the 68 OOO students. 61.7% of students from OOO performed within the lower 50th percentile against 19.2% of the CTL students. No students from CTL fell into the lower 25th percentile. The lowest performing student from CTL achieved an academic score of 70% which not far off from the average cohort score of 73%. The mean scores from the CTL group are 72% with the OOO group at 69%.

5.2 Learning Experience

Figure 7 provides an overview results for the 5-Likert scale questionnaire seeking reflections on their learning journey. Majority of the CTL students, at 42%, gave a rating of 5 while the majority of OOO students, at 38%, gave a rating of 4. 69% of the students from the CTL felt that their experience was positive (Rating of 4 & 5) compared to the 56% of the OOO students. Comparing within the very positive (Rating of 5) band, there are more students in the CTL group at 42% as compared 18% of the OOO students. Surprisingly, almost one-third of the participants (27% from CTL & 31% from OOO) remained neutral about their learning experience.
Crossing the Finish Line Together: Collaborative Team Learning in Design Studios

Figure 7. Breakdown of the 5-Likert scale question on student’s learning experience

Figure 8 further analyses student’s positive learning experience (Rating of 4 & 5) to seek out any correlations between their academic grades and learning experience. With a comparable sample size of about 12 students from both groups (Rating of 5), 100% of CTL students scored above the 50th percentile of the cohort as contrasted with the 42% of the OOO students. Students from OOO are more likely to fall within the lower 50th percentile of the cohort with 58% and from the same group, 33% in the bottom 25th percentile. 73% of the CTL students scored within the top 25th percentile as compared to the 17% of the OOO students in the same scoring band. A similar trend can be observed for students who had a positive experience (Rating of 4).

Figure 8. Breakdown of academic performance for students who had positive experiences

5.3 Frequencies of Students’ Self-Directed Peer-to-Peer Learning

The social dimension of building supportive friendships in a studio is a critical aspect of the students’ learning process. (Degregori, 2007) An engaging learning environment in small groups can nurture relationships. This section seeks to uncover the frequencies of students’ self-directed peer-to-peer learning without the guidance of their tutors. The results revealed that the majority of the cohort (84%) discussed their projects with their friends outside the formalised contact hours of at least three times per week. The findings differ from the hypothesis that OOO students would register lower frequencies of peer-to-peer discussions. Surprisingly, there are not any significant disparities between the CTL group (85% - 22/26 students) and the OOO group (84% - 57/68 students) as illustrated in Figure 9.
5.4 Student Attrition

The cohort’s attrition rate (9 students) revealed no improvements from the previous academic years’ average of 10%. Referencing from Figure 10, seven attrition cases originate from the OOO group. Five OOO students cited having lost interest in the programme with two students who developed mental health issues relating to stress. In contrast to the CTL group, only two students left the programme with one student suffering from physical health issues and other citing depleting interest.

6 Discussions

This section aims to understand the repercussions of learning in both OOO and CTL groups. The most compelling finding is the close correlation between students’ academic performance, learning experience and attrition to their studio pedagogical framework.

6.1 Academic Performance and Learning Experience

Most noteworthy, CLT students’ academic performance is observed to have led to positive repercussions. This phenomenon may be explained by the student’s collaborative learning experience in CTL. Majority of CTL students have indicated a very positive learning experience (rating of 5) of having the tutors sufficiently facilitated their design process. Even with an average contact time of 35 minutes per student weekly, CTL students felt that their tutors had engaged them adequately and aided their design process in a team learning environment.

Students’ approval of their learning experience does not equate to excelling in their academic performance as illustrated in Figure 8. Benefiting from CTL’s strategy to capitalise on the dynamics of learning in teams, CTL students reported enjoyable experiences building rapport with each another. Friendly competition keeps the students motivated during trying times. Exchanges of constructive criticisms in an intimate setting without the fear of offending their peers are strongly valued. With sufficient guidance from their tutors, the students sometimes take over the review sessions. One particular student enjoyed this aspect of collaboration reflected: “While spending time cracking my brains for an alternative solution after critiquing our classmate’s projects, I had unconsciously thought of and found solutions for my own” (ref participant 08). At the end of the academic year, the students reflected that they have learnt to communicate, negotiate and enjoyed the collaborative learning atmosphere of CTL. CTL students revealed that they grew to be confident and intrigued by the design process in their projects in a collaborative learning environment.

One rationale for OOO students’ unfavourable ratings of their learning experience is the competitive queueing system. OOO Students collectively remarked: “I hated the queuing list. It is so competitive! I wanted to join the list many times but was discouraged after seeing the [length of the] list!” (ref participant 43) and “It is very tough for me to get a tutor
to discuss with me! The queues have started since early morning, and the review session can take up to one hour for each student!’’ (ref participant 65) Students acknowledged that the queue system inevitably causes tensional moments in their learning environment. OOO students predictably echoed that the studio atmosphere was individualistic and competitive.

6.2 Self-Directed Peer to Peer Learning
The frequent occurrence of such self-directed peer-to-peer learning for OOO students strangely does not correlate with their academic performance. On the contrary, the improved academic performance of CTL students seems to suggest that their peer-to-peer engagements were more effective even without the tutor’s prompting and interventions. The better performance from CTL is likely attributed to their collaborative learning experiences, observing the tutor encouraging cross-pollination and students re-enacting and modelling these review conversations on their own. These findings strangely compliment and contradict the experiment by Ghassan & Bohemia (2015), experimented with a student-led pedagogical model in which tutors purposefully maintain their distance as to encourage autonomy. Students construct conversations and outcomes primarily via discussions with their peers. They reported that in the absence of the tutor, students enjoy critiquing each another’s works informally. The findings from this paper partly align with Ghassan & Bohemia’s deduction that students from the OOO group are likely to struggle with the decision-making process without a tutor-led environment. CTL Students appears to be able to overcome this challenge without the tutor’s intervention by achieving better grades and learning experience.

6.3 Student Attrition and Academic Resilience
Christudason (2003) had reported that peer-to-peer learning situations could help to foster greater psychological well-being, social competence and communication skills. As a by-product of the shared learning environment, students cultivate close and supportive friendships purportedly build students’ academic resilience (Graber, Turner & Madill, 2016). In this context, Academic resilience refers to students achieving good educational outcomes despite adversities. Cassen, Feinstein & Graham, 2009). Attrition is observed to be lower at 22.2% (2/9 students) for CTL. This phenomenon strongly suggests that by having that collaborative environment inculcated during CTL’s design studio builds emotional support and resilience in trying times. The majority of the attrition cases originated from the OOO group can be attributed to their hierarchical one-on-one, master to apprentice learning experiences. During their exit interviews with the level coordinator, recurring issues of the one-on-one pedagogical framework (discussed in 3.1.1), were identified as the root causes. Attrited OOO students regularly cite the lack of contact time with their tutors due to the long waiting list, being confused during design stages and constantly working alone in their studios as their reasons for quitting.

6.4 Limitations
The basics of comparison of students’ learning experience might be equivocal due to unbalanced sample size. As this research is carried on with freshmen students, their opinions might be inaccurate as they are inexperienced in other studios’ pedagogical frameworks to form the basis of comparison. A positive studio learning environment, which rests on the keystones of formative review conversations, is particularly contingent on design tutors’ pedagogical and conversational skills (Goldschmidt, Hochman & Dafni, 2010). Further research might explore having that same tutor teaching in CTL and OOO as the constant variable, for future comparative studies. The long-term repercussions of the CTL may worthwhile to be researched and documented in a longitudinal study to understand and seek out correlations between learning in a CTL framework and academic resilience.

7 Considerations and Conclusions
Architecture’s studio pedagogical framework today continues its struggle to shake off the ghosts of the competitive and stressful learning environment inherited from the medieval work-sites, Beaux-Arts’ Studios, Bauhaus’s Workshops to E A A Rowse’s (Architectural Association) Unit Systems. The current pedagogical model of the Master and the Apprentice dictating the learner’s design approaches and outcomes resulting in an individualistic and competitive environment is particularly worrying. OOO’s limited potential in preparing students journeying into emerging modes of future practices centred on effective communications, emotional intelligence and negotiations must be challenged. Furthermore, creative work in the 21st century calls for ways of learning which encourage participation and dialogue rather than judgment and discipline (Brown & Godlewski, 2014).

This study questioned the relevancies and identified limitations of the one-on-one formative pedagogical framework of our design studios in breeding future collaborative practices. While collaborative studios in academia are nothing new, this study prototyped an alternative form of collaboration that hinges on tutors facilitating in heterarchical
Zhengping LIOW

studio pedagogical framework. The explorative nature of this research revealed early findings which illustrates CTL’s positive correlations with students’ learning experience and improved academic performance. Although this cohort of students frequently engaged in self-directed group studies, the effectiveness of student’s self-directed peer learning can be positively associated with the academic performance of CTL students. Further studies are required to validate this phenomenon. CTL’s lowered attrition rates compared to OOO proves to be advantageous in this era of reduced funding. These findings will add to a growing body of literature that argues for the design studio pedagogy to be relevant in the 21st century’s context of constant change.

Despite breaking new grounds in the field of architecture and design in recent years, educators rely on the trusted pedagogical model inherited from the previous incarnation of industrial revolutions. Curiously, inquisitive architects and designers heading design studios are mostly apathetic in designing an appropriate and relevant pedagogical framework that fosters graduates in launching alternative modes of practices. As Jeremy Till had frequently highlighted – architecture education is [indeed] deeply conservative (Till, 2018b).

References

Crossing the Finish Line Together: Collaborative Team Learning in Design Studios


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Abstract: In most university settings the rooms are scheduled centrally in such a way that even moving tables and chair configurations can prove problematic. Because different faculty use the space for different purposes, common courtesy and institutional exigency both dictate that classrooms should be reset to neutral at the end of each session. However, from the perspective of design pedagogy this otherwise beneficial practice becomes problematic. For design students there is a strong benefit in the material culture of the design space being intrinsically modelled in the classroom. We therefore offer an alternative argument to the conventional deployment of classroom space, based on three case studies from institutions in the USA and Canada where the opportunity has existed for various forms of material permanence in the classroom setting. The benefits to the students of leveraging materiality and material persistence in the classroom include: pedagogical benefits; efficiency; opportunities for mental reset; and more accurate discipline representation. Finally, and perhaps most importantly, embodied classroom environments support students more holistically by remembering that makers have both brains and bodies that need physical, psychological and emotional nourishment.

Keywords: design education; material design; material culture; embodiment

1 Introduction

The concept of information permanence has long been recognized as a benefit by design studios. From dedicated parts of the studio, to designated war rooms, to pop-up displays within the lab, these spaces allow design teams working at different paces and times to easily keep track of progress on a particular project. However, beyond information permanence, these spaces also often contain a variety of artefacts (objects, sketches, maquettes, tools, protocols, statements of policy or principles) that help orient the team. At IDEO, for example, creative spaces mean long communal work and meeting tables, hidden clocks, and a homey kitchen (IDEO, 2017).
Unfortunately, North American universities do not function like design studios. In many instances, even design programs—stubborn hold-outs against neutrality—have succumbed to university-wide scheduling and classroom allocation systems. This means that the same classrooms as are allocated for use by design students on Tuesday mornings, are used by general education students in the afternoons. Signs abound reminding occupants to return classroom space back to neutral for use by the next group (see Figure 1).

In some design programs, the solution to the problem of scarcity in dedicated space, is to allocate each (often, senior) student a desk within a large, shared space that becomes their work area during the academic year. Subsequently, it becomes common practice to move instruction to those shared student spaces rather than to use allocated classrooms. The downside of using student offices in such a way is that students end up with no privacy —workspaces that should be dedicated to them become public teaching spaces. Additionally, because these are often shared studios, the classroom schedule can interfere with students, out of class, trying to do work. The individualized nature of the student cubicles or desks is also at odds with the idea of a shared project space where multiple people have access to resources and are contributing to its outcomes. It makes little sense for large, collaborative projects to be divided up into a dispersed set of individual contributions, with students scattered across a space while working on those parts.

In thinking about the territory defined by issues of space, use, and materiality, we propose a four-quadrant model that builds on existing makerspace literature and culture (see Figure 2). To further our argument, we present case studies from the following three post-secondary programs: Information Design taught at Mount Royal University in Calgary, Alberta, Canada; Communication Arts at University of Waterloo in Ontario, Canada; and School of Art and Design at the University of Illinois at Urbana Champaign in the United States. In our model, manifest and neutral spaces are positioned on opposite ends of the x axis; and the material and the digital are positioned on opposite ends of the y axis. Manifest spaces are those that gather and maintain evidence of use, while neutral spaces are returned (essentially, cleaned) back to a state where previous use is no longer visible. Material defines thinking through making using physical materials and tools. Digital references technology-based environments (such as computers, tablets, virtual reality, environments, augmented reality, mobile interfaces, immersion studios, etc.). Though each space has
its own unique set of benefits and some downsides, in this paper we argue primarily for the value that comes with the manifest-material space type.

Figure 2. The intersection of space and making defines four types of classroom experience: (1) manifest-material; (2) manifest-digital; (3) neutral-material; and (4) neutral-digital.

2 Maker Spaces—Spaces for Making

The recent popularization of maker spaces has resulted in a revitalization and some diversification (at least from a disciplinary perspective) of the conversations surrounding the creative and pedagogical benefits of such spaces. Dedicated spaces where making occurs are not a new phenomenon, and neither is the notion of learning through doing that is a key aspect of the maker-movement ethos. According to Watson et al. (2016), “the epistemological roots of the maker movement can be traced back to the constructivist theories of Jean Piaget and John Dewey”, with recent contributions by Seymour Papert. Piaget (1973) called for reform in scientific education with the motto: to Understand is to Invent, and advocated students using active methods to rediscover knowledge. While the maker movement does share the conceptual structures of (and often partners with) STEAM initiatives, it has garnered some criticism that—through a STEM association—it is intentionally excluding other kinds of making, once again relegating (and, subsequently, subjugating) them to the realm of craft (Martin, 2017). In particular, women and people of colour have traditionally been held back from pursuing interests, education, and professions within science, technology, and mathematics; and, more importantly, when these populations have engaged in such making, their contributions have been minimized or outright removed from the pages of history (for one example, see Hidden Figures: The American Dream and the Untold Story of the Black Women Mathematicians Who Helped Win the Space Race by Margot Lee Shetterly). Therefore, engagement with and leadership in STEM-based maker spaces by a diverse community is an absolutely critical and ongoing issue—the “lack of women in makerspace leadership and a pronounced tendency to see boys as more tech-proficient” continues (Kim, Edouard, Alderfer & Smith, 2018).

However, the maker movement has roots and could have futures beyond the paradigms and materials of science and technology. For design, spaces for making and remaking, as well as the conceptual tools and processes that support these activities, pre-date the Bauhaus. As with project-based learning (PBL), designers’ education is constructed through inquiry, with students gaining increased control over the selection of their topic, materials, process, and final products as they gain knowledge and training. Another common ground between design and PBL is the process of working towards a solution through an iterative cycle of making, receiving feedback and conducting evaluation, and remaking based on the results. Finally, both making and design projects are based on experiential learning, with making and design connected through a common set of activities that can have “playful or useful ends” and are “oriented toward making a product of some sort that can be used, interacted with, or demonstrated.” (Martin, 2014; cited in Watson et al., 2016). As far as these authors are concerned, there is no need for a hierarchy of materials or a STEM orientation when it comes to learning or thinking through making. Indeed, some of our best work has made use
of materials often ignored or undervalued by STEM, such as thread, sand, wood, fabric, balloons, tampons, and tape (see Figure 3 for one student example from Winter term 2018).

Figure 3. Does it Seem Like People Are Becoming More Easily Offended These Days? Final project in material data design by Dani Massee, Information Design, MRU, 2018. Photo by Radzikowska, 2018.

In terms of environments designed for learning, we can look to Resnick (2007) for an argument to treat learning environments like lifelong kindergartens. We can also consider the early childhood centres of Reggio Emilia, Italy, and the work of the Constructionist Learning Laboratory (CLL) at the Maine Youth Center that is based on them. In the Reggio approach, the classroom becomes the third teacher (in equal partnership with the parent and the instructor). It is a space filled with compelling artefacts, a variety of materials, and makes visible works in progress and evidence of the various stages and types of learning (Edwards, Gandini & Forman, 2012). In modifying the Reggio triad in order to suit the incarcerated nature of its learners, the CLL placed an even greater focus on the learning space, turning it into a “school based on constructionism, tinkering, making and personal computing” where, for five hours each day, “learners could soar above their otherwise impoverished and punitive conditions” (Stagger, 2013, p. 487).

There has been much fruitful discussion about the benefits of makerspaces, and several notable texts now exist providing direction on how they can be set up in all manner of classrooms and institutions. We are interested less in the creation of makerspaces or in their use in-the-moment, and more in investigating the nature of the manifest space—space where persistence of maker objects is of primary importance:

- the pedagogical benefits of working while surrounded by evidence of work;
- classroom conditions for material persistence;
- opportunities for mental reset; and
- discipline representation.

1 See, for example, Makerspaces: Materializing, Digitizing, and Transforming Learning, Koole et al., 2017; or Makeology, Peppler et al. (editors), 2016.
3 Material-Based Reminders

It is well known that repetition aids memory formation (Hintzman, 1970). One way to accomplish this repetition efficiently and easily is to use objects that either metaphorically or literally represent core concepts. For example, one of our co-authors teaches theatre in a studio at the University of Waterloo, where stage design maquettes created by her colleague William Chesney for productions at the university and elsewhere (Chesney, personal communication), are kept on shelves along one wall (see Figure 4). The maquettes can be used as direct pedagogical tools, for teaching stage design, maquette-making, performance history, and performance analysis. They can be used as tools to help conceptualize a production-in-preparation, and also as technical plans to communicate to technicians and stage crew how to build a set once designs have been completed. They assist in rehearsal by showing directors, stage managers and performers not just the ground plan, but also the vertical levels of a set. And since maquettes capture a moment in the design process that typically continues iteratively right up until opening night, they also provide (especially when cross-referenced with other production records), an opportunity for the meta-study of theatre creation practices.

An important feature of the maquettes is that they serve as a form of institutional memory. Whenever they are drawn to the students’ attention, they evoke a recollection of the number of kind of productions that have been designed and produced by previous generations of students and faculty. Current work-in-progress is always contextualized by, compared to, and competes with the work of the past. This awareness has the potential to be invigorating. No matter what else is happening at the time outside of this theatre-making space, everyone working in this space is in a place where work is and has been conceptualized, accomplished, and presented. Further, the collection argues that the work is important enough to be remembered. Whatever design the students are currently creating with their instructors, its maquette will also find its place on the shelf among the others as part of the living record of the school (see Figure 4). At its worst, this kind of institutional archive can serve only as a form of nostalgia in which people look to the golden age of a past that can never be recaptured because of the many constraints and failings of the present. However, when artefacts like these are not fetishized as monuments to the past, but actively used in the ways we describe, they act as access points to an expanding repertoire of practices shared over time through collaborative work. In other words, they can enable a making-based design memory similar to the repertorial memory recognized in performance studies (Taylor, 2003) as distinct from archival memory.

In addition to the five repetitions that aid memory, it is often useful to have a way to signpost core lessons learned in previous years or classes. For example, students at Mount Royal University (MRU) are introduced to the Gestalt principles in their 1st year. In their 3rd year, they need to be putting these principles into practice without a long and complicated re-learning process. To be able to point to an infographic where similar items are indicated through grouping allows this reminder to take place with a gesture and a few framing words (see Figure 5).
4 Pick Up from Where You Left Off

It is helpful to keep in mind that class time is rare and precious. For many students an hour of class time costs more than an hour of a first run movie. Although it is possible to do project work outside of class, it is often advantageous to have the instructor available for immediate feedback and colleagues nearby for quick conversations, critique, and collaboration. With this in mind, time spent recovering the work state from the previous class is almost always time wasted.

In addition to the material considerations, there’s also a cognitive benefit to students being able to pick up where they left off quickly and efficiently—it can sometimes happen that seeing the work in progress after an interval can result in new inspiration that can either allow the project to make a leap forward or pivot it in some productive way. For classrooms that are not booked solid, there can be opportunity for students to use the space as a work area outside of assigned class time.

What we are proposing is not that everyone drop tools and march from the room when the whistle blows, but rather that a few minutes be taken at the end of each class to prepare the workspace for the next class. Loose, light-weight items, for example, might be taped down temporarily, or a note might be left about the stages of the process already completed. In some instances, the work can also be set aside off the main workbench on shelves or lockers appropriate for the purpose.

5 Multi-Use

One of the more interesting examples of the benefit of material persistence comes from colleagues working in theatre and stage design. Although it is seldom possible, for reasons of scheduling, it can sometimes happen that a small theatre space is available for as much as an entire semester by a single production (Figure 6). In a case like this, the various members of the creative team—from directors, to actors, to set and lighting designers, to technical crew—can all work towards refining the production by collaborating both in unison and in situ. This process was recently tested in Studio 180, a teaching studio at the University of Waterloo, during the creation process for Welcome to the Tree Museum (Plowman, Houston, et al. 2019), produced and performed in the Theatre and Performance program between January and March 2019. The lead design instructor, Professor Paul Cegys, observed three categories of pedagogical benefits: first, when students were at liberty to make a mess, and could work continually through the mess, they engaged in a deeper exploratory prototyping process; second, students took more pride in their work, which was implicitly valued more highly than usual because it was not marginalized at the end of each work session (Cegys, 2019). Third, and most relevant for this part of our argument, Cegys observed that the simultaneous multiple uses of the room promoted a collapsing of roles or dissolving of the departmental lines that normally differentiate the work of, for example, set designers, lighting designers, and video designers. Sharing the Studio 180 space resulted in a much closer collaboration and integration of set, light, and video in Welcome to the Tree Museum (Cegys, 2019; and see figures 6-13, which show the transformation of the teaching space over three months through all phases of design, production, and performance).
Although generally positive, these sudden realizations can also be difficult and even traumatic depending on when they occur in the process. These might be because they represent actual errors that need to be addressed, but it can also be because they represent hitherto unrecognized opportunities for excellence that, in some instances, can be even more disruptive for a project that is already underway and operating under tight constraints. At this point we feel compelled to point out that there is more than one response possible when anchored in the actual practice of design consultancy. Some people may say that such scope creep is the sin of the holy ghost of industry, while others might argue that more often than not it is a chance to communicate with the client/team about an opportunity for greatness that could be achieved with even relatively minor increases in scope and budget. In some cases, the tyranny of deadlines can be stricter at the university than in industry given the hard deadlines of the university calendar.

It is not only these rare moments of inspiration that are made possible by a space shared by multiple stakeholders; in fact, this approach can also benefit the day to day tasks of communication both between and within groups. These moments of recognition would not be possible without shared space and materials of the works in progress. For designers of other kinds, it is seldom possible that the workspace at some point eventually becomes the final deployment space of the design; however, the many valuable lessons to be learned from the theatre design community can be leveraged for benefit in the classroom right up until that moment. As an example of the advantages
of a shared workspace, one of the authors had the opportunity to share a studio with two colleagues. One was from graphic design (Eric Benson) and the other from architecture (Mark Taylor). Eric has his students make paper out of unusual crop residues and Mark is developing some similar approaches to the creation of alternative building materials. The proximity of these other projects led to a new initiative in using alternative materials for paving bricks. In the end, more than a dozen different materials (Figure 7) formed the basis for a series of reflections on walking surfaces and their properties. Most recently, the biologically inert resin-based binder for the first set of pavers is being replaced with an even more sustainable binder that uses mycelium from mushrooms (Figure 8).

![Figure 7. 17 alternative materials for paving bricks. Photo by Ruecker, 2018.](image1)

![Figure 8. Paving brick made using a more sustainable binder—from mushroom mycelium. Photo by Claudia Grisales, 2018.](image2)

### 6 Transition

As a design opportunity, liminal spaces provide a chance to prepare people for the mental activity associated with the primary experience. In the case of theatre lobbies, the primary experience will be a play or performance; in the case of design pedagogy, the primary experience will be the learning that takes place in the classroom.

In some of our previous work on liminal spaces, we considered entrance ways into public events as providing opportunity for people to reflect on either what they were about to see, what they were in the middle of seeing (i.e. the intermission), or what they had just seen. What we were primarily interested in was the role of opinion and
whether or not it could be possible to shift people from holding a single opinion to entertaining simultaneous, multiple, possible interpretations (Roberts-Smith, Ruecker, et al., 2016; Ruecker, Radzikowska & Roberts-Smith, 2017; Ruecker & Roberts-Smith, 2017; Ruecker, Roberts-Smith, et al., 2016). Although this goal is also shared in many classroom experiences, it is only one of the many ways in which it is beneficial to prime students or help them prepare for the classroom.

Figure 9. A makeshift gallery space in a small hallway between a main campus artery and a design classroom at MRU. Left image: hall with the door closed; right image: same hall with the door open. Photo by Radzikowska, 2019.

Figure 10. Genius loci boards, meaning the spirit or distinctive feeling of a place. Based, in part, on Larissa Fassler’s work, an artist who maps unconventional characteristics of places. Work on display by students in COMM 2673, Fall 2018, MRU. Kelsey McColgan, Instructor. Photo by Radzikowska, 2018.

Other examples include reminders of previous concepts covered, core ideas that are being explored in ongoing ways, projects at various stages of completion and where they are in the process, and even the larger learning objectives of the class. For example, while working on the tail-end of a semester-long material data project, one of the co-authors
Milena RADZIKOWSKA, Stan RUECKER, Jennifer ROBERTS-SMITH

(Radzikowska) wrote on a white board placed in the entrance corridor to the classroom the goals, activities, and deliverables for the last three weeks of the semester. Those items remained there as a reference point and visual reminder till the end of term. This was really only made possible by a quirk of architecture where the location of the classroom was in a cul-du-sac so that the entrance hallway served as a transitional space between the rest of the school and the classroom, rather than a public space (see Figure 9). Other items placed in this corridor included a display of past projects from the current class and mockups of the current project in progress.

The benefit of having the work in progress remain on display is that it can serve as a basis for critique at any time, including, outside of assigned classroom time (see Figure 10). One approach we’ve taken, for example, is to provide students with sticky notes and instructions around what constitutes constructive feedback.

7 Immersion

Once the students enter the classroom, they are immediately immersed in a working environment where the current phase of the project is available for reflection and alteration. There is an important distinction between work as useful reference and garbage. The former requires a returning to—a repeated extraction of value through engagement with the object. The latter should be cleaned up, re-purposed, or recycled regularly. For example, we have created re-purpose bins for scraps of material that have some remaining value. However, caution should be exercised when it comes to recognizing that what might look like a piece of garbage could actually be a very important element in someone else’s thought process (see Figure 11).

![Figure 11. Precious model or piece of misshapen garbage? This chunk of foam visually represents the linear algebra of optimization. Photo by Ruecker, 2018.](image)

One of the advantages of an ongoing room for works in progress is a visible challenge to the false idea that design springs fully formed like Athena from the forehead of Zeus: that, instead, good design is the result of repeated cycles of improvement. This is far more difficult to demonstrate when work takes place in the virtual environment than when ideas are embedded in material form, because virtual environments (being digital) typically seek to replace old drafts with new ones, rather than accumulating a panorama or a palimpsest of drafts.

Given the right conditions, it is even better to include, within the classroom, work in progress from different years. That way, the expectations of students who are newer to the program, about what constitutes their future work/effort, are managed through no additional effort. The same principle can be applied, if it is possible, if senior students are immersed in the work in progress of faculty. While teaching at the University of Nebraska in the Hixson-Lied College of Fine and Performing Arts, one of our co-authors observed just that—a world-renowned ceramicist and faculty of the College experimenting with specialized glazes along-side undergraduate ceramics students learning their first formulas. One distinction, however, must be made between faculty and classroom projects: there is a time constraint in a semestered class structure, while it is unusual for faculty work to be limited by four-month time
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frames. It is a common occurrence for us to pick up a project off the office shelf that has been percolating on the back burner for a year or more. However, even in the scenario where a faculty member’s project progress extends across years, making that progress (and lack thereof) visible to students provides them with valuable insight into intellectual life.

8 Embodiment

It has been extensively argued elsewhere that making is a kind of thinking (as a start, see Maeda’s The Art of Critical Making, 2013); that, in fact, a better designation of Homo sapiens, wise people, would be Homo faber—people who make. We now recognize that making and using tools is not a unique human attribute, but it seems relatively incontestable that we have done more with it for longer than other species, and with greater impact on ourselves and the world around us. To make something is to instantiate an idea. Or is it? Perhaps to make something is to simultaneously produce the idea of what is being made. Theorists like Herbert Simon, an economist with an interest in engineering, stressed the industrial model of design, which places emphasis on planning (devising) rather than actual fabrication: “to design is to devise courses of action aimed at changing existing situations into preferred ones” (Simon, 1988, p. 129). However, pre-dating Simon, designers such as William Morris and the professors and students of the Bauhaus strongly believed that making was not subordinate to planning (see Meggs, 2016). So, if we consider the designer not just as a planner but also a maker, then it becomes important to accommodate the fact that makers are not just brains inhabiting bodies, but that embodiment is central to the activity. Bodies need nourishment, rest, a variety of working surfaces (not just tables and chairs), adjustable temperature, light, air, a sense of passing time, opportunities to separate from the group, and opportunities for reinforcing social relationships (see Figure 12).

Figure 12. HH168, the University of Waterloo Theatre and Performance Program’s dressing room and technical booth.

9 Conclusion

We have argued in this paper that there are advantages in design pedagogy to being able to treat the classroom more like a design studio than like a routinely neutralized learning space. This is particularly important because of the materiality that is an essential component of design pedagogy. Students in design learn by making. They think through making. They explore concepts through various forms of tangible discourse. Of course, there are other disciplines on campus that share these needs, but the vast majority of campus architecture and space management has not been designed with material persistence as a priority.

To conclude, we offer our current version of best practices for constructing a manifest-material space. We say current because we consider space creation, like all our design efforts, to be an iterative, experimental process.

1. Wherever possible, make use of liminal spaces as entryways to the creative space. These transitional spaces can be used to provide team members with memory, inspiration, celebration, and confidence.
2. Materials need to be in a configuration of their use, not their storage.
3. A space shared with material persistence for one team can also be a resource for other teams working in adjacent areas of the same project.
4. Keep in mind that material persistence can encourage moments of fertilization and can equally serve for routine communication.
5. The work of making is embodied work. Do not forget about ready access to cold brewed coffee, a fridge, microwave with popcorn, and places to catch a quick nap between work sessions.
6. Try to keep in mind that the tone produced by material persistence should be invigorating not sentimental.
One consequence of the workarounds that allow persistent pedagogical maker spaces to be implemented even when they are not institutionally allocated, is that many such spaces are the ones that have fallen through the cracks of university management systems. They are oddly shaped, repurposed storage areas, sometimes little more than closets with no ventilation, inadequate lighting, low ceilings, and inappropriate flooring, furniture, and equipment. Perhaps needless to say, the difference pole from each of these failings would comprise a list of the optimal configurations.

There is also a fundamental problem in that universities typically do not have the resources to dedicate a full-time room for every class. The unenviable situation we find ourselves in is as much an outcome of austerity as it is anything else. One of the features of a reconceptualized university with proper funding (see our forthcoming book) would be space planning optimized for pedagogical effectiveness rather than fiduciary constraints.

Figure 13. Non-consensual fish phallus. Microaggression by ANON; project board owned by a group of 1st year Information Design students. MRU. Photo by Radzikowska, 2019.

Finally, the micro worlds we create within our design classroom are bound to reflect both the positive and the toxic aspects of our human interactions. For example, Figure 13 is an example of vandalism perpetrated against a student group project that had been stored in a common space at Mount Royal University in the Winter 2019 semester. In arguing for material persistence, it would be irresponsible of us not to acknowledge the human potential for toxicity, nor the fact that it is more likely to be directed at vulnerable or marginalized populations—often based on socioeconomic status, disability, gender, gender expression or identity, sexual orientation, race, ethnicity, nationality, or religion (the vandalism in Figure 13 was perpetrated against a group of female students of colour). Encouraging students to co-create (have ownership over) their learning spaces (and not to clean up after they’re done), can result in toxic interactions between students, microaggressions, or damage to student work (see Figure 13). Part of good pedagogical practice in the kinds of environments we propose must therefore include strategies for managing the space in the same way that it is sometimes necessary to manage toxic moments in the classroom (see Martinez, 2015).

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University Classroom Prototypes for Innovative Learning

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Abstract: The relationship between the university and the society is a continuous exchange that never stops to influence itself, bringing benefits to both realities. Nevertheless, it is necessary to focus on the changes that can be applied in the learning field and not only on the evolution of the university system itself. The desire to refine the educational approach is an extremely current topic in the field of education. This is why, to face a series of social changes, it is fundamental to reconsider the method used to disseminate knowledge and to understand its real needs. Moreover, another element that has to be recalibrated is the lack of effective tools that are provided to students to deal with sudden changes in the business world. As a result of these transformations, the Politecnico di Milano has decided to undertake a deep revision of its didactic spaces in order to better understand the needs of all the university users and to foreshadow new scenarios that can support the evolving teaching and pedagogic methods in all the disciplines involved. The paper presents the results of a research that aims to dissert on spatial needs, potentialities, new habits and uses, and to organise all the requirements in guidelines for new learning spaces that will be firstly applied to four classroom prototypes, and then finalised and revised for a large-scale dissemination.

Keywords: new learning models; innovative spaces and services; interdisciplinary; flexibility; customization
1 Introduction

Like every social organism, universities have also been witnesses to a massive evolution of their structure, shaping themselves with the progression of the centuries. For De Ridder-Symoens (1992), universities have formed the new academic layer and changed the entire structure of society, enriching it and making it more complex. The global changes and the advent of elements that are breaking with the past have stimulated the creation of a vast field of study and research that is heading to new physical and conceptual frontiers. Although the main topic of research focuses on the physical design of innovative learning spaces, it is necessary to dwell on recent considerations of the role that universities play in the formation of future social class. The need to have innovative laboratories to stimulate students to gather a much wider field of information and to prepare them for the future must firstly face the relationships and gaps between universities and the business world.

Nowadays what universities are less able to transmit to students is the ability to face challenges in most of working environments, as well as the flexibility in managing multiple issues at the same time and the ability to create transversal and soft skills that can be used in multiple contexts (Morrell, 2012). This is due to the university structure itself which, on many levels, is still remarkably anchored to the past. It is therefore necessary that the educational programs of universities are able to transmit to students a wealth of skills composed by not only a competent technical and notional preparation but also a dynamic combination of cognitive and metacognitive, interpersonal, intellectual and practical skills (Haselberger, Oberhuemer, Perez, Cinque & Capasso, 2012). Fundamental changes are needed towards more personalized, social, open and dynamic learning models that can be stimulated by the design of innovative spaces (Chatti, Agustiawan, Jarke & Specht, 2010).

Designing innovative learning spaces does not only bring benefits in the sphere of academic learning but can also be extremely important for broader purposes, connected in the field of scientific research and the definition of partnerships with professional realities. In recent years there has been a flourishing birth of initiatives that are related to the creation of incubators that aim to enhance the results of academic research carried out in universities. The establishment of start-ups and spin-offs can be seen as an opportunity to promote activities and services (such as mentorships and research labs) offered by students, graduates, Ph.D. students, and academic staff to encourage the launch of new successful business initiatives and support their development (Egusa & Stunt, 2017). By creating this system, universities' potential can be extended effectively over the canonical educational role, relating more with professional realities and new dynamics thanks to reliable and innovative technology. Designing innovative spaces within the campus is therefore extremely important to allow its use by external actors, thus contributing to the creation of an integrated and mutually utilized organization between campus and city environments (Lees & Melhuish, 2015). Universities, therefore, assume even greater importance, encouraging the creation of new and productive horizons where the set of new users can move in search of new and profitable possibilities of action.

2 New Learning Models

As discussed in the previous section, universities must think about the gap between themselves and the business world, offering students more opportunities for growth in various fields. To solve this problem, the traditional didactics must incorporate new approaches to favor their insertion in a teaching path composed of new transversal and disciplinary competencies, turning the time spent in a school environment even more useful and profitable (Zanolin, 2017).

Focusing on education itself, and on the future field of the application of innovative learning methods, requires entering a system that is based on three essential elements: pedagogy, space, and technology (Radcliffe, Wilson, Powell, & Tibbetts, 2009). If the first two elements have always been put in dialogue to design an effective educational path, the last factor has been imposed with intensity only in recent times. The significant weight that technology has taken in everyday life has brought to a necessary revision of the entire learning system, making it much more dynamic and including a substantial number of useful tools and virtual layers. This new type of education, which can be collective or individual, is defined by the concept of seamless learning that is the ability to extend learning across time and locations, accessing physical and digital worlds and engaging multiple types of device to integrate different approaches to teaching and learning (Sharples et al., 2014). Also, a set of behaviours and human relationships, stimulated by the use of technology, can start a rethinking on the effectiveness of today's learning systems, thus delineating a reflection on the form and the use of spaces. In the same way, an environment, independent of its intended use, can shape people's behaviours (and therefore teaching and learning models) that tend to manifest in it (Radcliffe et al., 2009).
As far as pedagogy is concerned, it is interesting to verify how the evolution of the relationship between the primary users of the university system — both teachers and students — has changed over the centuries in a continuous relational exchange. The blended learning models used in new training offers are the result of changes in the relationships between users and a consequent shift from a passive type of teaching to an active one. The lack of effectiveness of adaptation to the new social approach shown by the passive model has encouraged a large number of teachers, scholars, and researchers to define an active learning method based on a more involved approach. The latter can be defined as “a method of learning in which students are actively or experientially involved in the learning process and where there are different levels of active learning, depending on student involvement” (Bonwell & Eison, 1991). The lesson, from a mere unique exchange of information through a single subject (the teacher) and its interlocutors (the students), takes shape on a broader opportunity of direct learning based on a set of experiences. These experiences are not only theoretical but, above all, are technical and logical and lead students to greater implementation of personal skills (Zanolin, 2017). The active acquisition takes place through discussion and collaboration, critical thinking and problem solving, and uses a wide range of tools that are not considered in a passive model. It is the action and maturation of experience that unites all types of active learning models, such as participative and cooperative learning. This hybridization of new learning systems is emerging as an incisive and more performative innovation (Christensen, Horn & Staker, 2013) but only through the stimulation of the entire sensory sector available is it possible to achieve positive and satisfactory results.

Although in Italy research on this topic is still at a particularly embryonic stage, it is a current and growing topic in various universities: meetings and seminars are organized to understand and disseminate the innovations that are most common in Anglo-Saxon contexts. In 2017, Politecnico di Milano held open training sessions for the academic staff within the Innovative Didactics Project. The seminars, diluted in five different meetings, were conducted by the delegates of education and counselling Lamberto Duò and Susanna Sancassani, the head of METID, a structure conceived with the aim of supporting the professors of the Politecnico di Milano in teaching innovation through the use of new technologies in information technology, multimedia and telecommunications. The meetings dealt with various tools and fields of application of new learning methods, from the explanation of the peculiarities of blended learning to the use of tools such as MOOCs; from the importance of implementing soft skills development to the design of courses in co-production with the world outside. The workshops were particularly involving thanks to smart tools permitting better management of time and continuous collaboration between the participants. Moreover, they have triggered a profound rethinking of current teaching investigating and clarifying the most critical points of an already anachronistic learning system, born and developed in a context that is too old to be compared to the current one.

3 Objectives

The new learning models are one of the essential components to implement an effective rethinking of the didactics. However, the different types of teaching are always in contact with a physical environment that guarantees their development and correct functioning. Although it is commonly thought that the space is only a shell that requires a series of characteristics that are purely structural to be effective, it is necessary to activate a whole rethink that includes more elements. The social context, which is much more dynamic and technologically rich, requires greater sensitivity and cognitive ability to grasp needs by turning them into physical spaces. It is no longer possible to only rely on defined design standards, but is necessary to consider new variables, in some cases poorly investigated, for a total re-planning of the dynamic and effective spaces which will motivate students in a more creative way.

What is extremely important is the awareness of the current role of users operating in an increasingly hybrid educational path. As previously investigated, active and blended learning models have decentralised the figure of the teacher in favour of a greater responsibility for students. Consequently, students are becoming the essential and generating fulcrum of space. To design an environment therefore implies a clear reflection on the behaviours and degrees of relationships that occur between the different users who live in the space. Most of the classrooms that can be seen in contemporary universities present an extremely rigid structure with almost no scope for rearrangement and improvement: spaces designed for an obsolete conception, where the spatial configuration presents a view of the teacher as the figure of primary importance. The current concept of a classroom can be reviewed as a generic learning space able to support a considerable number of behaviours and activities; we need to explore spatial alternatives to the classroom to provide a range of learning styles that link the pedagogical paradigm, its approach and its spatial archetype (Cleveland & Fisher, 2014).

One of the fundamental objectives of changing educational strategies and models is therefore the support that innovative learning environments can offer to students. Spaces can question and encourage them to become active,
independent and permanent learners inside and outside learning spaces (Moore, Fowler & Watson, 2007). Never before has there been such a gap between the use of traditional approaches to education and an increasingly rapid advancement of technology, an element that is now rooted in almost every aspect of everyday life. Classrooms must face this continuous interaction between people and spaces, adapting themselves to current needs. It is also necessary to support the design of spaces with a series of essential qualities for the correct realisation of new learning models, also relying on innovative approaches that are able to make spaces as functional as possible.

However, in the field of widespread learning, the classroom is no longer the only place to activate new learning possibilities. It is necessary to look at the university environment as a living and vibrant organism, composed of constantly moving information that flows through users, spaces and tools. This implies the awareness of all the other spaces that are potentially suitable for widespread and flexible learning: libraries, cafés, green areas and connective spaces have great design potential. Thanks to the internet, the opportunity to access information and data remotely allows to activate learning paths in any part of the campus or to define a new project field based on an interesting development. Besides configuring itself as an environment with a high degree of permeability, the space must be managed and set up for high-performance use through the insertion and use of instruments with a high degree of comfort, safety and functionality (Oblinger, 2005).

4 Class p-Prototypes for Innovative Teaching

As seen in the previous section, it seems very important for a university to start a rethink of success in terms of new social and spatial needs. This challenge of addressing the design and concept of innovative teaching and learning spaces emerges from present and future plans of the Politecnico di Milano. The university has decided to undertake a deep revision of its spaces in order to understand the needs of all the university users, and in all the disciplines involved, to foreshadow new scenarios that can support the evolving teaching and pedagogic methods.

The Politecnico di Milano has defined a general programme with these main goals for the next three years, to address the new contemporary needs on the topic by developing four prototypes of innovative university classrooms. Four spatial applications suitable for experimentation, as the test and tool for a reiterative process aiming to involve all the users in a participatory implementation of the new requirements. The experiment involves all the disciplines of the university (Engineering, Architecture, and Design) to test the innovative process in different scenarios.

Therefore, a research team of the Politecnico di Milano has been appointed to define a series of requirements and needs for the general organization of innovative teaching and learning spaces. The team has been asked to dissert on spatial needs, potentialities, new habits and uses, and organize all the requirements as guidelines to be first applied to the four classroom prototypes and then finalized and revised for a large-scale dissemination. In accepting the task, the team agreed with the goal of developing a path towards excellence along the following actions:

- acquisition of the progress of research in the sector above mentioned, deepened through the evaluation of case studies of contemporary campus projects;
- definition of requirements for designing innovative teaching activities, consisting of innovative spaces and services for learning and considering the most innovative approaches to teaching and research, with reference to the most advanced learning tools;
- development of specific guidelines to use and spread within the educational environments;
- implementation of strategic partnerships with the educational field and industry around the world for a significant social intervention;
- new interdisciplinary research lines to face emerging social challenges especially in rethinking the higher education facilities; and
- to embed scientific developments and research results into university education.

Although this paper sets out the whole research program, it will mainly focus on the first phase of the project, especially the part involving the design of a classroom of the School of Design of the Politecnico di Milano.

5 Methodology

Learning is no longer bound by classrooms, learning happens everywhere (Jackson, 2015). Rethinking educational spaces means being in tune with new needs, trends and other factors that underpin ways of experiencing the university environment. The objective of this research is to investigate these new needs from the point of view of spatial and service requirements considering new habits and new pedagogical approaches that all stakeholders face in these spaces. To meet this objective, the research team of the Politecnico di Milano has been called on by the Rector
to draw up guidelines for the preparation of classrooms dedicated to innovative teaching. Since it has been decided to adopt a user-centred method, categories of research participants have been defined to involve them in the research process (Figure 1). It is possible to divide them into four categories:

- internal actors experienced in teaching activities;
- internal actors experienced in innovative teaching;
- internal actors responsible for the maintenance of teaching spaces; and
- external actors experienced in technologies applicable to the analysed context.

As stated, the project focuses on the creation of four different learning spaces in three different discipline contexts. The first step was to analyse the different types of teaching carried out in schools to identify macro-areas of intervention on space (i.e. the disciplines of design and architecture require a distribution and a type of instrumentation different from the discipline of engineering). In order to collect as much information as possible, the research group has analysed, with the help of teaching experts, various learning behaviours implemented in various disciplines.

The next step was to meet the centres that are dealing with the didactic interaction formulated through the use of technologies, already present in the Politecnico di Milano spaces:

- the METID centre which has set up a room specially designed to test the use of technology in innovative teaching;
- the interdepartmental laboratory EDME (Environmental Design and Multisensory Experience) that offers a physical space in which to develop and undergo experiences of digital, multimedia and multi-sensory worlds.

In these two experimentations we have been able to deal with new learning technologies such as large-scale digital smartboards and analog smartboards able to share written information in the cloud, immersive digital theatres where the user is able to make a teaching experience inside a specially created virtual set that transforms the walls of a room into touch and interactive surfaces.

![Figure 1. Map of the actors involved in the research process](image-url)

After collecting the information to better assess the context, the logistics offices responsible for maintenance were involved in order to decide on the types of intervention applicable to the spaces in relation to proportions, possibility of light and sound control, position with respect to access flows and connection spaces. At the same time, technological equipment was examined to promote active learning behaviours and allow teaching activities dedicated
to the smart exchange of information and online discussions between students and distance lecturers. The last step of the process was to relate the research carried out, within a dedicated meeting, to then be able to recalibrate the interventions and reformulate research and design proposals in future actions.

6 Guidelines

Aiming to develop specific guidelines, some rules and criteria were defined to set the required elements. These were as follows.

- Flexibility: Key element and space generator for the furniture, the environmental predisposition and the management of space.
- Temporal fruition: The time factor is essential; the space must easily allow the transformation of the environment with furniture and systems that are fast and intuitive to reconfigure the space.
- Customization: Students must feel involved in the spatial context through the implementation of an interactive approach to the environment. The presence of writable surfaces, in addition to the benefit linked to learning, allows, for example, students to express their personal contact with the environment and with other students.
- Motivation: Learning spaces must be nurtured by an effective motivational level suggested through the choice of aesthetic and environmental qualities that stimulate an efficient response from the students.
- Conduct: The learning space is a public environment and is continually subject to the use of multiple users. The conformation of the structural apparatus should stimulate a correct conduct of the students for the maintenance of the provided equipment.

6.1 Parameters of the Guidelines

Since the criteria defined are linked both to the container and the content, different levels of intervention have been identified in order to satisfy the different needs. According to the main purpose of the class, a scheme of different levels of intervention and parameters that guarantee the best execution of the teaching activity was designed. The scheme (Figure 2) is built on three main elements considering the starting environment and possible hardware and software implementation:

- Base level: Comfort guaranteed from the point of view of acoustics, visual, accessibility, Wi-Fi connection, environment, energy and furniture, available in all the classrooms.
- + level: Availability of floating floor, advanced energy systems (e.g. movable plugs), sound-absorbing panels, modular furniture, writable panels, advanced audio and video systems, projection systems, smartboards, cameras, cloud.
- ++ level: Availability of specific equipment to satisfy the specific requests coming from the didactic activities carried out (e.g. equipment for online immersive learning; online video talk among students and international teachers).

![Figure 2. Diagram of the different levels of intervention](image-url)
In addition to the levels identified, more connected to the physical space itself, it is important to investigate transversal parameters related to the use of the space. These parameters are useful to encourage new uses of the spaces involving new interactions between the stakeholders and new relational needs, fostering at the same time the improvement of the so-called soft skills.

These parameters have been included as:

- the creation of three main functional areas: didactic area, informal area, storage area with a ratio of 70/15/15;
- the flexibility in transforming space in the tree typologies; and
- the capability to divide space and create different compartments of use.

The didactic area, defined as the portion of space set up to support didactic action (even if of an innovative nature), is used during the time in which the structured classroom lesson (lecture) takes place. The informal area refers to an area with different devices that facilitate collaboration and working activities to support teaching that can be carried out at different times, in an unstructured and autonomous way compared to the teacher’s action in the classroom. The storage area is the support area, container of all the elements not used in the personalization of the function performed.

6.2 Relation Between Spaces and Technologies

The choice of the technologies to implement was guided by the analysis of the types of activities and the actors using the space. On one side it was important to consider the kinds of interaction that take place between teacher and student, on the other it was necessary to evaluate the impact that technologies can have on the relations system both off-line and online (Figure 3).

The contest was analysed identifying two main didactic activities. Firstly, an activity carried out by the teacher that can be described using four different poles:

- traditional (frontal) didactic activity during which the teacher spreads knowledge among the students;
- collaborative didactic activity in which the teacher involves the students in the construction of knowledge;
- off-line technology; and
- online technology.

Secondly, an activity carried out by the students that can be described using four different poles:

- represented activity in which the students show the outcomes to teachers and peers, or only to peers;
- collaborative activity during which the students work among peers in the construction of knowledge and in the realization of the outcomes;
- off-line technology; and
- online technology.

Figure 3. Diagram of the technologies dealing with the space and the people’s actions
The technology used in educational spaces must therefore make a transition from a vertical technology, for teachers’ needs in a confined setting, to a horizontal one, for meeting students’ personal needs across multiple physical contexts (Stroup & Petrosino, 2003) (Figure 4). The students can use technology to construct their own personal way to create knowledge and learning outcomes in a proactive way, in order to reach the expected learning outcomes.

7 Discussion, Results and Next Steps

The evolution of the role of teachers and students, the innovative methods of learning and the increasingly prevalent use of new digital tools, are important signals that must first be supported by an appropriate environment, ready to stimulate the users’ interest. An environment that is primarily physical but also includes a digital level that allows the creation of platforms for the exchange of knowledge and information. The research, developed through the three essential dimensions, pedagogy, space and technology (Oblinger, 2005; Radcliffe, 2009), led to a project that aims to take some time to evaluate a new teaching approach in which spaces, services and technologies stimulate a transversal and integrated learning by encouraging new types of learning pathways such as teamworking experiences, distance learning, informal learning and learning by doing. In particular, the classroom designed for the Design School illustrated in the paper is a prototype that will be tested during an entire academic year to deeply and better understand the potentialities of the various solutions that may be used. These solutions, depending on the type of teaching and learning activities that will be implemented in the educational journey, will facilitate an increasingly fluid and innovative way of doing didactics. By monitoring the behaviours and the uses of the different actors involved, it will be possible to deduce which solutions could be better applied and implemented to all future classrooms, making clear which typology of teaching and learning path would be reserved to specific cases. The first prototype of the new classroom is currently under development and it will be inaugurated in September 2019 in the Bovisa’s Campus of the Politecnico di Milano. The learning space, equipped with most of the hardware and software implementations described in the paper, will be able to concretely test the levels of interaction between actors, spaces and technologies by evaluating how these last two variables could be used and mixed together to activate and balance different types of relationships between users. Moreover, a continuous planning of the learning space, and the realization of other prototypes in different university contexts, will support both consolidated design solutions and elements of experimentation, still following the typical user-centred approach of the design project.

References


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Section 3: Tools and Methods
Abstract: Design is integrated into every discipline practiced today and is employed in a plethora of interdisciplinary techniques which connect design to every aspect of modern life. This paper provides case studies where nature is used as a framework to teach design at the time when the complexity of the world challenges the ways design was traditionally taught. Looking at the university as a system, the author identifies the opportunities where design education could interact with a larger community and provide tools to meet some challenges of the complex world. This includes: teaching design in the classroom, teaching design outside the classroom by integrating it with other disciplines, and teaching design across the curriculum. Using nature as a model for learning, integrated design can be used as a method of investigation or an inquiry that seeks to create new ideas in any field. After testing different scenarios, the author examines what design educators can learn by looking at the ways students first understand theories, practice design skills and later reflect on their experiences. Outlined below are several experimental courses and projects attempting to use nature as a framework to teach and integrate design at every level of undergraduate coursework.

Keywords: biomimicry; interdisciplinary collaboration; sustainable design; human-centred design; innovation

1 Introduction

In Ontological Designing Anne-Marie Willis states that “design that is something far more pervasive and profound than is generally recognized by designers, cultural theorists, philosophers or lay persons” (Willis, 2015, p. 80). It is also known that the current dire situation with the world’s ecology happened by design and because of design (McDonough & Braungart, 2002, pp. 18-23). In order to combat that situation, we need to “re-learn how to be living beings” (Escobar, 2017). There is no question that our profession demands that design students be prepared to “identify the nature of values and modes of inquiry in various disciplines that contribute to the successful solution of complex design problems” (American Institute for Graphic Arts, 2017, para 17). If we were to hope that future designers will be ready to solve big problems, then we need to find new opportunities to educate students holistically across a wide range of disciplines.

A useful model for teaching and learning, biomimicry, has already been established as a successful method for solving problems, especially in the field of product design and architecture. Some examples of using biomimicry as a methodology are: IDEO’s Nature Cards (IDEO, 2014), Biomimicry Toolbox (Biomimicry Institute, n.d.), Slow Design...
Movement, and the use of Parametric and Generative Design in architecture. Designers and architects adopt principles of biomimicry on different levels: from mimicry of the specific organism, to the behavior of organism at the ecosystem level (Zari, 2007, para 24).

According to the Biomimicry Institute, designers need to understand systems in order to come up with true innovation. “Since the world is full of complex systems, taking a systems view can be a very effective means to understand a design challenge at a deeper level” (Biomimicry Institute, n.d.). Taking a systems view is not possible without taking a transdisciplinary approach, yet, educators face obstacles if no structures exist even for cross-disciplinary education at their institution. According to Dr. Gioko Muratovski, design researchers may have challenges “establishing collaboration with other researchers due to lack of knowledge of other disciplines, divergent standards, different methodological approaches, or simply due to negative attitudes and prejudices that are present among the disciplines” (Muratovski, 2014, p. 3).

Because design is a non-linear process it is well positioned to be on the leading edge of human activity. Applying biomimicry methods to education can be a novel way to expand how design is taught in the classroom, outside the classroom, and across curriculum. Although these case studies were not designed to assess the long-term impact of such an approach, observations following the execution of these projects showed an improvement in student engagement and student interest in multidisciplinary classes.

The case studies presented in this paper are an attempt to look at the university as an ecosystem, identify existing structures for cross-disciplinary education, and test new initiatives for integration of design into other disciplines and other disciplines into design.

1.1 Framework 1: Biodiversity

**Case Study: Nature in the Classroom - Educational Toy that Works with the Nature of Children’s Behaviour**

My guiding principle for this framework was that the need to practice divergent thinking can be illustrated to students by showing examples of multiple solutions that coexist in the natural world. Function is an essential underpinning of biomimicry and is one element that distinguishes biomimetic design from biophilic and biomorphic design” (Biomimicry Institute, n.d.). For the purposes of my framework, the educational toy can be viewed as function of the organism in the context of biomimicry. One of the goals of this project was to show students the need of divergent thinking and generating multiple solutions while staying open-minded to welcome failed experiments in the co-design situation. The need for multiple solutions was easily explained as biological strategies that performed the function. Preparing students for the complex world means fostering critical thinking which is a required component of both creativity and objectivity, or design and science. This methodology was used because the group of students had limited design knowledge but some understanding of the scientific method. The methods I used in this case study are human-centred design and co-design with audience, rapid prototyping and experiments designed to test audience behaviours. Other disciplines integrated are: early childhood education, and STEAM (science, technology, engineering, art, and mathematics).

1.2 Framework 2: Interconnectivity of Nature

**Case Study: Design Integrated into Other Disciplines - Faculty Research Initiative**

Testing and prototyping ways to establish cross-disciplinary collaborations through faculty research projects, I investigated possible intersections of design with other disciplines at the university where few cross-disciplinary projects existed. Approaching this project as an experiment I identified possible points of connections, first by dipping into other non-design classes and later through design and science collaborations, participatory design, gallery installation, programming, the use of non-classroom spaces and outdoors. I recognize that this work is ongoing but some practices and outcomes are shared in this paper in case others want to implement similar approaches at their universities. The case I am making here is based on the principle of biomimicry that in the complex world, both understanding the problem and proposing an impactful solution cannot be done in isolation, (Biomimicry Institute, n.d.) yet, there are barriers that exist to creating truly interdisciplinary classes. That is why I experimented with alternative ways to collaborate rather than co-teach a class. Methods used for this case study are: participatory design (both facilitated in advertising class taught by communication professor and through installations on campus), cross-disciplinary events such as BioBlitz with design and biology students, access to the biology lab, and collaborations with advanced photography students.
1.3 Framework 3: Nature Cycles of Fast and Slow

Case Study: Design Across Curriculum - Using Design Thinking Methods to Help Non-Design Faculty Visualize Flow of the Activities in the Classroom that Work with Nature of Different Learning Styles

Timing and sequence of classroom elements are difficult. The order of activities, and duration of each, is a critical consideration in engagement. Experimentally, the process of designing the classroom experience can be approached similarly to designing the user experience. John Thackara states that “Multiple tempos—some fast, some slow—can coexist, but they have to be desirable and they have to be designed” (Thackara, 2015, p. 44). This case study shares a process I used to prototype a visual syllabus in order to engage students in their learning. Specifically, designed for non-design faculty, this case-study focuses on the methodology used to prototype the tools for students and teachers to visualize a sequence of activities for time management purposes. This project shows some prototypes of the visual lesson planning. The larger trends of the use of such tools as learning outcomes and assessment in undergraduate education setting was not the focus of this small case study. Methods used in this case study are: human-centred design, visual design, and prototyping.

2 Case Study 1: Educational Toy Project

Nature offers countless examples of evolutionary strategies at work fostering conditions conducive to life. (IDEO, 2014)

What happens if you try to introduce concepts of participatory design and co-creation with the end-user to a group of students for a first time? The biggest challenges I encountered while teaching that class:

- Students resist when asked to keep the project open-ended and want to focus on predetermined outcomes.
- In order to approach design critically, students were required to generate ideas that resemble scenarios or systems to allow co-design by the audience and not a finished product. Many students at this level were not comfortable with this type of approach.
- It is challenging for students at this level to practice divergent thinking and generate a large number of concepts.

Through a series of experiments, rather than a specified design brief, Communication Design students had to work with the nature of children’s behaviour and let go of all pre-existing assumptions and notions about the design process. Tim Brown of IDEO tells us that we should treat design process as “experiments designed for failure” (Brown, n.d., para 1). So instead of assigning a toy project, I asked students to treat it as a science experiment. Using the example of biodiversity as a model, I was hoping to make students recognize and appreciate the diversity of ideas in the classroom, the value of other college disciplines and perspectives, and the value of the failed experiments.

2.1 Project Structure

This was a seven-week project that happened in the middle of the 14-week semester in the second year of Graphic Design undergraduate course curriculum. The studio class met for four hours, once a week. Each class was a mixture of short lectures, discussions and studio work time. On the days of the pre-school visits (three visits over the seven weeks), students worked with a partner to set up their experiments and the group of about fifteen children, ranging in age from four to six, interacted with students’ objects. Students took turns observing and facilitating if needed. Each session typically lasted an hour and a half. Students were also encouraged to observe the overall behaviour of the children when not interacting with their prototypes(s), during the children’s free play time. Students kept journals to reflect on their observations. Later they used these reflections to inform their design decisions. Part of the class was dedicated to group-work where research and observations were shared but each student was responsible for the refined prototype and research documentation. This project was a collaboration between undergraduate design studio classes at Stevenson University School of Design and a local non-profit partner, Irvine Nature Centre, with pre-K school students focused on outdoor classroom learning.

2.2 Project Schedule

Before this project was introduced, students discussed and wrote short responses to the texts and articles about Design Thinking (DT) methodology such as excerpts from Victor Papanek, Tim Brown, and IDEO’s Human Centred Design toolkit (HCD). After the project was introduced, students read a few education primers such as a short chapter from Maria Montessori and articles about teaching science through inquiry. First, students were asked to identify several subject areas to focus their educational aspects of the toy each would be designing. They were encouraged to allow children to learn through inquiry. Examples include: science, math/pre-math, health, cause/effect, etc.
A short workshop was conducted where students created open-ended experiments to observe children’s interactions at pre-K school. Students came up with simple hypotheses on children’s behaviour in a given scenario and created experiments to test their hypothesis. They had to plan and prepare to facilitate the experiments with the children the following week. The point was made to students that this was not a toy design project but an open-ended experiment on children behaviour. For that purpose, I will call all work-in-progress designs and interactions prototypes.

**Week 1:**
- Readings.
- Students wrote a short hypothesis of how children would react and interact with prototypes. Students were asked to think of several ways to get responses from kids on their ideas.
- Students planned and prepared everything needed to facilitate experiments. Students made prototypes from inexpensive and found materials.

**Week 2:**
- Visited the pre-K school and session #1.
- Documented process with a team.
- Analysed the findings and observations in writing. Emphasis was placed on failed experiments.

Only after students were able to test (Figure 1) and reflect on what they observed, did the design process start.

*Figure 1. Initial testing and observation with participating child. (Le, 2017).*

**Week 3**
- Based on the behaviour they observed, students generated multiple open-ended concepts for their audience.
- Students developed another round of experiments to test with a goal to narrow down their concepts.

The most challenging part of this stage was keeping students from choosing one solution too soon without practicing divergent thinking. Students struggled to generate multiple design solutions even though this was what was expected from designers, especially in the complex world. As Hugh Dubberly explains, the end state of the project is no longer about completion but adopting or evolving (Dubberly, 2018, para 23). That was where examples of biodiversity as an evolution of ideas and ever-evolving nature of design were helpful. When the project allowed for co-design, my students observed how pre-K children came up with all kinds of their own designs and invented games in front of my students.

**Week 4**
- Visited the pre-K school and session #2.
- Worked in teams and took turns facilitating the testing; one student helped children interact with objects and the partner took notes.
- Analysed the findings and observations in writing.
- Researched more HCD tools to identify what could be useful at which stage of the process.
Nature as Framework for Teaching Design

Week 5
• Refined prototypes of the concept according to observations.
• Developed testing methodology and prepared for the next round of tests.

Week 6
• Facilitated pre-K school session #3.
• Tested with refined prototypes for objects and instructions.
• Analysed the findings and observations in writing.
• Incorporated findings to inform design development.

Week 7
• Students organized the research and presented their process (Figure 2).
• Students refined their prototypes and exhibited them in the public space on campus. Students also presented the process documentation.
• Finished prototypes were refined as a separate exercise for the portfolio but, not as central to the research and the documentation of the process.

The goal of this project was to create engaging experiences informed by the behaviour of the child and there were several critical points in this process. The children needed to experience the object with minimal instructions and guidance. In the previous instances of teaching this project, the biggest challenge was to make students comfortable with the unknown. Discovery takes time but projects have deadlines. After re-framing projects as experiments designed to observe the nature of children’s behaviour rather than the design project, students were able to draw their own conclusions, having discovered how children behave in multiple sessions. Students became much more comfortable with presenting unfinished rough prototypes and making changes on the fly. The topics that were difficult for students before, became self-evident. The resulting projects were nothing like the toys that the previous groups of students had designed; they resembled systems that allowed multiple ways of interaction and were open-ended rather than single-function toys. Most of the time their projects took 180-degree turns, not because of the teacher’s critique but because students themselves realized what worked and what did not.

The kids will guess if an object will sink or float before putting the object in the water, and they will naturally separate them into two categories.

Research
During a child’s early sensory motor stage, introducing science concepts through water play is important. According to observations, age, “They explore elements of science such as buoyancy and volume as they experience why some objects sink and others float.” During an experiment that involves water, pupils become more complex science concepts. There are multiple sink and float games that are currently available. As my called “Sink or Float Test” has kids guess if a virtual object will float or not. Also, there is a game called “Great or Not Super Challenge” that teaches volume, density, and displacement. The game is for ages 5 to 12 year-old preschool educators. There are younder grade levels books such as, Science for Little Hands by Janet Elder and Jennifer Adams that teach floating and sinking. Lastly, there are online options of sink and float activities.

Bibliography

Figure 2. The process documentation by a student at the end of the project (Michelson, 2017).
To make this approach successful, students needed to be exposed to HCD earlier in their education so that they could benefit more from the opportunity of interacting and co-creating with their audience. This project required outside partners that were willing to collaborate with students. The practice of participatory design and co-creation was the most engaging process for students. What would be helpful to do in the future is to have more classes that students could take concurrently where students could frame problems by themselves and use the same DT language across the curriculum.

3 Case Study 2: OVERLOOKED Gallery Installation and Programming - Prototyping Ways to Integrate Design into Other Disciplines

Designers should recognize “interdependent relationships among people, places, things, and activities in a complex system.” (American Institute for Graphic Arts, 2017, para 17)

In recent years we have observed an emergence of multidisciplinary programs and experimental initiatives that have been able to bring designers and scientists together. Many design schools established some sort to interdisciplinary labs and maker spaces where “...collaboration between science, engineering, art and design will provide exciting and innovative ways to address and present complex subjects” (Hopkins Extreme Materials Institute, n.d.). What makes these new initiatives slightly different from other maker spaces is an addition of living materials (Healthy Materials Lab at Parsons School of Design, n.d.) and newly recognized need for engaging in “organic systems ethos” (Dubberly, 2018, para 16) and their even bigger focus on sustainability. Looking at the university as a system to identify opportunities for collaborative lab spaces and projects, I initiated a faculty research project to experiment with already existing techniques of mycelium-based materials. A year-long collaborative project tapped onto the expertise of biology faculty and laboratory services for bio-material experiments and hands-on workshops. Getting access to the lab and greenhouse spaces was critical to this project. While working on multiple components of the project I approached it as an experiment, both literally in the lab and as an experiment on different ways to integrate design into other areas at the university. Using a nature’s framework of symbiotic relationships, installation “OVERLOOKED” engaged students and faculty across such disciplines as photography, biology, digital media, graphic design, and advertising. Generated work was featured in a gallery space and was accompanied by multiple workshops and programmed events ranging from nature walks, sourdough breadmaking, and lichen art exploration. The exhibit itself had many participatory stations where the public was asked to “blend” waste and food in a marble-run game to learn about circular economies, reflect on the overlooked connections by connecting the dots in another participatory station, and look under the microscope at nature’s structures such as polypore fungus spore surface and imagine how human-made structures could benefit from nature’s engineering. “Mycelium Running” installation shows the process of growing shapes using fungi mycelium and local straw.

Since this was a faculty-run research project and not a class, I had to find a model that would work for design faculty. Integration of design had to be facilitated by scheduling groups of students from different disciplines to explore nature together. One example was a nature walk with students from Biodiversity and Digital Design classes. This was not a co-taught class but a cross-disciplinary event that worked with both classes scheduled together. Biodiversity students conducted a BioBlitz (Wikipedia contributors, 2018, para 1) while design students found objects in nature and used them as patterns for a design exercise. Both groups worked together and later reflected on the role of the species in the ecosystem, both from human and non-human points of view. Dipping into Diversity of Life class to look at SCOBY (Symbiotic Culture of Bacteria and Yeast), sourdough yeast and other kombucha organisms under the microscope, created the opportunity to show a new perspective to students on why fungi are important and worth learning about.

I was able to dip into more classes, by working with advanced photo faculty and students, by first, creating project briefs, offering critiques and later assisting in photoshoots. For the project “Overlooked Species Zoo” photography students worked with speculative scenarios where nature reversed biomimicry rules and borrowed human tools of advertisement and marketing to advance nature’s agenda. This was an opportunity to engage students in critical design. As Anthony Dunne and Fiona Raby mention in the book Speculative Everything, “critical design uses speculative design proposals to challenge narrow assumptions, preconceptions, and gives new about the role products play in everyday life.” (Dunne & Raby, 2013, p. 34). In this series, students gave organisms the stylization of a magazine advertisement to showcase their important—but often overlooked—role in the environment. Each work juxtaposed an organism with everyday objects in an unexpected way to create a surreal scenario in which nature has borrowed human ideas and environments. The example (Figure 3, left) is a portrait of a burdock plant where seed pods of burdock “pretend” to be Velcro to show their usefulness to humans reversing a most familiar application of the plant as the inspiration for the invention of Velcro by Swiss engineer George de Mestral in 1941. Broadleaf
plantain, which is both a common lawn weed and a medicinal plant used throughout the world, is presented as healing first aid antiseptic bandages (Figure 3, right).

![Figure 3. Left: Burdock (Arctium lappa) photo by Volkova & Alesina, 2018. Right: Broadleaf Plantain (Plantago Major) photo by Hadel & Sonntag, 2018.](image)

An informal survey of the biology students and faculty showed that students were inspired to see how biology relates to design and this experience gave students a new perspective. Mycelium hyphae depicted in the exhibition provided a great visual for students to understand their role in plant nutrition and more. In the future we plan to have bio students come up with the biology behind what they were doing (breadmaking, fungi, gluten) and design students to collaborate with their peers to create new scenarios and shapes of fungi to grow.

Reflecting on this experience, I recognize that student engagement was achieved because of design integration and collaborative learning. While it was not a part of the teaching load, visiting colleagues’ classes were an essential step to get these cross-disciplinary initiatives going. Now with more interdisciplinary classes in the works I will be looking for the best practices to overcome several issues that came up:

- It was hard to find classes that could be brought together once or twice in a semester. Scheduling was very difficult.
- If classes were scheduled together, it required more planning and flexibility.
- Dipping into was easier than team-teaching multidisciplinary classes, because roles were more clearly defined and there was no need to develop and approve new classes; but it required extra effort by the educators and students.

Symbolically, the beautiful collaborative processes such as lichen and mycelium found in nature become visible through this project and in turn inspired more symbiotic relationships between faculty from different schools. This dipping into initiatives served as prototypes for future interdisciplinary classes where design can use alternative spaces such as science labs, galleries, outdoors, photo studios, events and more. Starting with one project per semester and being flexible, I hope more design faculty will be interested in finding ways to bring design into other disciplines and other disciplines into design.

4 Case Study 3: Visual Syllabus

The design challenge is not to slow everything down, but to enable situations that support an infinite variety of fast and slow moves - at a rhythm dictated by us, not by the system. (Thackara, 2015, p. 44).

Similarly, to the way that writing is used as a method of learning in the writing across curriculum (WAC) movement (Bazerman et al., 2005, p. 18), teaching design across curriculum (DAC) offers opportunities for students to learn experientially and connect design to real-world problems. Especially useful for non-design students, design can help understand complex concepts, and connect what they learn in one class to other disciplines and everyday life. DAC uses systems thinking and creativity, and provides resources and methodology to address wicked problems in the world, in our profession, and in the classroom.
Still, the biggest contribution of design integration in other disciplines was student engagement, yet it could be met with resistance because introducing hands-on activities to the typical non-studio class has a significant problem: the timing and planning. Palmer Parker in *Courage to Teach*, talks about opening the space: “… even before the class begins—in conceptualizing the course of study, selecting materials, framing assignments and experiences, and blocking out the time. If I do not make these decisions in ways consonant with opening space, the space will disappear before the class begins” (Palmer, 1998, p. 133). This looks like a typical design problem and this case study shares the tools for redesigning a class experience that can be approached as a design problem: timing of the activities. Looking at nature as a model where different tempos co-exist, I developed tools to visually plan a course syllabus to allow more flexibility and increase student engagement.

The goal was to create opportunities for students who prefer different learning styles to find a home that allowed them to be creative and experimental, and to explore different modes of thinking. Another goal was to give simple visual tools to teachers to try different scenarios when faced with the need to adjust a class flow depending on the time of day, the number of students, the energy of the group, and other factors. Designing a class is not different from designing any user experience. The timing and sequencing of classroom elements can be difficult. The order of activities, and duration of each, are critical considerations in engaging students. Mapping and diagramming lessons, using colourful Post-its, markers and highlighters is natural for designers; we advocate for being fluid between the analogue and digital technology. Since this is an iterative process, color-coded Post-its allow keeping things fluid.

Here is a breakdown of my approach to syllabus building through a DT lens. Focusing on issues of visualization of components and timing, I went through a series of steps:

- Make a list of formal learning outcomes (LO) and put them in a simple grid.
- Make a list of subjects we will cover and projects I am planning to assign for each LO (Figure 4).

![Figure 4. LOs with subjects and related projects organized in a visual way.](image)

For this visual syllabus, I simplified LO’s language into teacher’s priorities to make it easier to talk to students about why outcomes matter to their education. The teacher’s priorities are for my students to:

- Collaborate.
- Care about the world and practice empathy.
- Have a general understanding of the design process.
- Offer critique and be open to feedback.
- Practice self-directed research.
- Become a visual thinker and a maker.
This is followed by a list of the types of activities I plan to employ in this class:

- Discussions — talks, critiques, presentations.
- Individual students thinking and making — sketches, mock-ups, collages, image making.
- Group activities — brainstorming, games, etc.
- Teacher talking or a video — demo, lecture.
- Computer time — practice software skills, visual research, execute projects and exercises.
- One-on-one time with a teacher.

Color-coding each activity made it easy to take a glimpse at the lesson and visualize the flow. I also somewhat arbitrarily grouped them by the kind of the pacing and interactivity. For example, a lecture and one-on-one interaction is more passive for students, while the individual sketching and journaling is slow, and requires concentration. Discussion and high-energy activity can be fast and more playful. Thinking of the best sequence for a class made me realize that different sections of the same class can have different desired sequences depending on many factors. Looking at examples of three different lessons I visually mocked-up three different sequences (Figure 5). Purple color signifies a lecture, yellow is focused activity and grey is a computer time.

As I populated every week with activities it became evident that having a color-coded tool provided me with feedback that was easy to understand. For example, I can see how I can make my lectures more effective by incorporating activities before, after or even during my lectures. I also can see how some classes are structured in such a way that keeps students in front of computers for too long.

That realization quickly led to the next exercise about the timing. What if my class could be planned with flexible time sections that could be re-arranged according to the needs of students? From Post-its I moved to Adobe InDesign, where I created a multi-page document with each week represented as a spread. I made a master page template with my LOs and timelines organized in 15-minute intervals. As soon as I populated my weeks with activities from my agenda and mapped each activity to the LOs, a clear pattern began to emerge.

- All of my activities were very heavily organized around the design process and computer time.
- I had not allowed enough time for students to reflect on or discuss things.
- Individual thinking and making became computer time, unless I specifically designed it not to be so.

Below is an example of one week’s agenda mapped and visualized using Adobe InDesign (Figure 6).
Once I mapped the class I had already taught, I started to see patterns and things I needed to change. This tool allowed me to move things around and visually see the problems. Improvements to this prototype could be made as needed. As long as the tool stays flexible it will be improved upon and evolve. Here are few things that I learned:

• When incorporating hands-on and group activities, timing needs to be carefully considered.
• After several semesters of using this tool and by sharing it with colleagues I have gathered information about developing it further. An informal survey shows that this tool could be helpful to new faculty and when developing new classes.
• My assumptions that students would benefit from a visual course schedule were false. Most students did not care to see it visually. Perhaps in the future, this syllabus would need to be introduced several times during the semester when students could be reminded what the LOs of the class are and be more engaged in the learning process.
• It is important to remember that this is a tool, similar to a calendar app and needs to be seen as such. Teachers who use it need to understand that the goal is to be flexible and observe the classroom for how students are engaged.

5 Conclusion

Taking a closer look at every step of the learning process, I observed that dipping into another discipline made students more engaged with the theory and practice of design. When given an opportunity to reflect on their experiences, students mentioned that they not only valued those experiences but understood the wider effect of their design practice. It is difficult to establish the measure of the influence of this approach on the change in students’ design practice over the long-term because during the four-year program at the university, students were exposed to a variety of approaches in different classes.

Applying biomimicry methods to education may not be so different from human’s adaptation of nature’s problem-solving abilities such as Velcro or honeycomb structures. In biology, many structures, materials, behaviours, and other entities are observed, explained and quantified, so in the design field creativity can be explained as the biodiversity or evolution of ideas. One example of this approach is when students found it easier to understand the form-follows-function methodology where the function is presented as a design problem and biological strategies are explored as design solutions. Implementation of biomimicry principles at the level of ecosystem is more complex. Similarly, to the way that writing is used as a method of learning in the writing across curriculum movement, design across curriculum
can be explored as a mode of thinking and a tool for investigation or an inquiry that seeks to create new ideas in any field. If the field of design is “pervasive and profound” (Willis, 2015, p. 80), design education needs to mimic the design pervasiveness.

Looking at the natural world where everything constantly evolves and adapts, designers not only evolve and adapt their practice to human and societal needs, they become the connective tissue between different disciplines. That means that design educators need to look for new ways to expand the way design is taught in the classroom and across curriculum—in this case resembling the way nature works.

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References


About the Author

**Inna Alesina** was born in Kharkov, Ukraine, where she studied industrial design. 2018 Red Dot Design Award winner, Alesina works in many disciplines including object design, performance wear, ergonomics, communication design, food systems, and bio materials. Alesina co-authored a book, *Exploring Materials: Creative Designs for Everyday Objects* (PAPress, 2010). Alesina is an Assistant Professor of Graphic Design at Stevenson University, USA.
Abstract: Design thinking is the process by which a designer clarifies a design problem, proposes a solution or observation, and makes a design decision. The process of design thinking can also be considered as the process of sketching. The sketch helps the designer to reflect on the design to get the optimal solution to the design problem. The process of sketching requires visual involvement. Visual thinking is a way of thinking through visual perception that helps designers filter what they see. Nowadays, product design students present their design results and sketch quality at the time of independent creation far below their level at facsimile. Therefore, this study explores the visual thinking strategies used in the creative processes of experts and students by the audio-visual retrospective protocol analysis method, trying to clarify the differences in visual thinking processes between product design students and experts during sketch creation. Design educators improve their design courses and improve the quality of sketches for product design students. The research results show that the expert’s visual thinking strategy is trend to visual imagery, while the novice visual thinking strategy is intuitive perception of the visual. The research results clarify the shortcomings of visual thinking in the sketching process of students, providing a scientific reference for design thinking education that teachers can use to improve the teaching structure of the curriculum.

Keywords: visual thinking; protocol analysis; product design

1 Introduction

The development of design is a process in which designers use the cooperation of their hands and brains to repeatedly compare, refine and modify the thinking that makes abstract thinking materialization. It is also called the process of design thinking. Liu (1996) believed that the core of design thinking was how the designer thought of the problem and the resulting solution. Stempfie and Badke-Schaube (2002) showed that the basic elements of design thinking were generation, exploration, comparison, and selection. They thought that generation and exploration expanded the problem space, and comparison and selection reduced the space for the solution. They also believed that when you extend a problem, a solution is generated and the relationship of the solution and the target can be checked. Then, during the iterated design thinking, new solutions could be modified or developed until an optimal solution is found.
Therefore, it requires the designer to clearly define the design problem before all the steps to finish the process of design. After that the designer needs to collect information to expand the problem, and then generates a solution. Razzouk (2012) showed that there was a strong interaction between unexpected discovery during design thinking process and the need to solve problems. During the sketching process, the designer will contemplate the sketches. When the designer constantly reviewed the points, lines or other graphics drawn on the paper, new combinations and relationships between these elements were created which was an unforeseen or planned accident. Designers could see some meaningful points, lines, and markers from the image. These elements would lead the designer to convert the previous image by adding, deleting, modifying, or replacing, which made the accidental discovery become the driving force for solving the problem or demand. Sketches promoted designer self-reflection, self-dialogue, and self-criticism, helping to express the designer's intent to identify their own thinking structures and insights to create new combinations. Therefore, the process of sketching could also be considered as the process of design thinking. Designers constantly looked at sketches, stripping and analysing them, all of which require visual thinking. The visual thinking here was different from perception, which was to some extent an interpretation of direct vision. Visual thinking was thinking through visual image and it favoured an insight that was a selection by people’s watching. Miller (1986) thought that psychological intentions had usually visual intent, and it was rational and systematic. At the same time, it helped designers to make intent reasoning. Casakin and Goldschmidt (1999) demonstrated that visual thinking assisted designers re-identify and reconstruct images to stimulate unintended inspiration. Göker (1997) found that experts relied more on their experience and visual information thinking in their design thinking. In contrast, novices relied more on abstract reasoning (the visual thinking here referred to the inference of ideas based on generation of ideas, which gave a great help to make a creation of forms rather than presentation in design). Seitamaa-Hakkarainen and Hakkarainen’s (2001) research on weaving design showed that experts paid attention to the alternation of visual and technical elements in design thinking. It was thus reported that visual thinking was important for the design thinking process for the expert. Nowadays, it happens frequently that most students who major in industrial design with enough drawing skills have no idea of sketching, and their final sketches, as well as design results, are poor. Is it because of the lack of visual thinking in students? Therefore, this study used audio-visual retrospective protocol analysis method to study the conceptual sketching process of product design students (novices) and senior designers (experts), trying to clarify the similarities and differences of visual thinking strategies during their process of sketching in the process of conceptual sketch creation, in order to understand the shortcomings of students' visual thinking, to improve the design of students' visual image reasoning and optimize design thinking education.

2 Experimental Process

In order to understand the similarities and differences between visual thinking strategies of novices and experts when creating sketches, this study invited two subjects to be tested by audio-visual retrospective protocol analysis method to analysis their sketch creation. One of the tested persons was a senior designer of industrial design with more than ten years of design experience, while the other was a senior who majored in industrial design with more than three years of design experience. Because the visual thinking of the research discussion refers to the thought and reasoning process that the designer produces after seeing something, the subjects were first invited to view the same picture as a visual clue, as shown in Figure 1.

Figure 1. The visual cues

In addition, Seitamaa-Hakkarainen and Hakkarainen (2001) pointed out that design thinking is composed of two elements: visual thinking and technical thinking. Therefore, the experimental topics are chosen as a seat design with simple structure and sufficient knowledge reserve for both experts and students. The experimental equipment we chose was a hand paint tool such as a marker and a pencil. The whole experimental process was recorded as a video. Then, we asked the subject to watch the video and synchronize the thought process at the time. Finally, we would combine with the recording data and oral data for coding analysis. When analysing video and audio materials, when a
design intent transfer is regarded as the beginning of a sentence, and when there is a different description of the same item, space, or topic, it was treated as a different sentence (Gero, 1990), and the study uses design intent to transfer as sentence punctuation.

### 2.1 Coding System

The main purpose of this study is to explore the differences of visual thinking strategies between novice and expert designers in the process of creating sketches, therefore the research uses two sets of coding systems (Tables 1 and 2):

<table>
<thead>
<tr>
<th>Category</th>
<th>Definition</th>
<th>Category</th>
<th>Definition</th>
</tr>
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<tbody>
<tr>
<td>S</td>
<td>Backtracking visual cues or past design knowledge</td>
<td>T</td>
<td>Change or answer the problem</td>
</tr>
<tr>
<td>P</td>
<td>Establishing the correspondence between goals and similar goals</td>
<td>Cs</td>
<td>Consider more conditions than originally</td>
</tr>
<tr>
<td>Cc</td>
<td>Using figurative image language</td>
<td>A</td>
<td>Think from different aspects, such as drawing the relationship between elements and the spatial relationship of elements</td>
</tr>
<tr>
<td>M</td>
<td>Transforming the problem or answer elements</td>
<td>I</td>
<td>Consider from functional or aesthetic aspects</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Category</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Ms</td>
<td>Transfer the thinking into graphic</td>
</tr>
<tr>
<td>Mr</td>
<td>Repeat the drawing of the picture</td>
</tr>
<tr>
<td>Mm</td>
<td>Modifying the elements (size, shape, etc.) of sketch</td>
</tr>
</tbody>
</table>
2.2 The Research Process of the Novice

The total experimental time of the novice is 23.58 minutes. The experimental process is divided into three stages, which are: the early stage (0min-8min), the middle stage (8min-16min), and the later stage (16min-23.58min). The visual thinking strategy is shown in Figure 2: In the early stage, the first step is to carry out the knowledge backtracking, and then answer the knowledge of the problem (00.00-00.14, “I want it to be a single chair, a stone single chair, I think of the stone pot I saw before, so the chair surface should be smooth, the shape of the chair, the amount, I want to reflect the irregular feeling of the stone”). The first design idea was completed at 04.02 min, as shown in Figure 3.

In the early stage, the novice carried out two backtracking (S); in the first eight minutes -explaining the cognition of the problem (T)- the cycle of drawing element thinking (A), and performed two inspection actions. In the middle stage, firstly, the middle visual thinking actions of the novice is similar to the early stage, and there are more backtracking actions. The main visual thinking action is the process from inspection (“The last two lines are not drawn, so I want to redraw”) to constraint (“I wanted to draw a chair leg on the new chair, but I want to be clearer, so I will draw a chair again”), and backtracking (“Because of the plain feeling, there is wood and stone”) to concretize (“Then three legs and round legs”) to backtracking (“Because the first chair is like this”). In the middle stage, the novices are more concerned about the specification of thinking. In the later stage the novice continues to modify the shape (finally, combine the lower chair and legs, and then draw a little bigger; then thicken the chair because the stone is thicker), second, inspecting (“The line just doesn’t look good”). In the later stage, there was only one action that was thought from the previous experience (“The chair has just said that it should be irregular, just like the first chair”). The rest of the movements are based on the aesthetics of the sketch and are reviewed and modified from the aesthetics of the picture (“The lines are not good, the uneven surface here should be thicker, and the lines should be smoother with the side”).

The drawing action in the visual thinking process of the novice is shown in Figure 4: in the early drawing stage, the novice uses the object creation (Ms) and the repetitive drawing (Ms) cycle action frequently. During the first ten minutes of the creative process, the majority of the raw hands are repeated. In the middle and late stages of drawing, the object creation (Ms) and object modification (Mm) actions are repeated.
2.3 The Research Process of the Expert

The total time for the expert’s creative experiment is 22.55 minutes. The experiment is also divided into three stages: the early stage (0min-8min), the middle stage (8min-16min), and the later stage (16min-22.55min). The expert visual thinking strategy process is shown in Figure 5. In the early stage, firstly, the action of the expert is similar to the novice, using backtracking (“In this time, I remember the picture which I saw before, like a puppy dog”). Then, defining the perception of the problem (Then, I want to drawing a double chair). From 00:05 to 01.56 min., the expert completed the first design idea, as shown in Figure 6.

After that, the expert turns into the mapping step, which is building the correspondence between target and similar target (it is modularization of fabric chair). After mapping step, the expert turns into constraint stage, visualizing thoughts based on constraints. In the first eight minutes, the expert focuses on reviewing past experiences, transforming them, and building relationships between past and present goals. During this period, the expert visualized the thinking but rarely evaluated the sketch. There are only two times abstract thinking (A) and one time backtrack (S) actions occurred.
The middle stage is the stage in which the expert is concretizing visual thinking, that is, the sketching stage. In this stage, visual thinking strategy mainly focuses on backtracking (S), adding constraints (Cs), abstract (A), inspection (I) and modifying (m) actions. At this stage, the expert first carries on the experience backtracking (“Such as this soft sofa bag on both sides of headrest is stereo, and the coherent degree is consistent”). Then the expert adds the constraint conditions (“The soft bags on both sides of the headrest can swing toward the middle or both ends”). Then, the expert sketches within the bounds of the constraint, and carries out inspection (I) and modification (M) actions. At this stage, the expert was seen three times backtracking (S) and three times making modification (M).

In the later stage, the expert first examines the modelling, and then visualizes further, that means makes development of the details. At this stage, the visual thinking action of expert has a certain span, from inspection (S) (“It’s important to have a faceted structure when you’re drawing”) turn into transfer (T) (“The part of chair leg should stretch, because of the chair seat becoming longer, the chair leg cannot use trigonometry to support like single person chair leg. So the chair leg of this should be the big four corners, but the basic style is the same”) step. After that, the expert turns into abstract (A) action (“The other side of the leg of the chair is invisible through perspective, so there is no need to draw”), and then, the expert visual thinking action enters backtrack action (“If you want to split the bottom of the chair, it can be divided into a piece of wood, the normal lock 4 empty”). Secondly, in the later stage, expert still has two thinking establishment (Ms) movement throughout the creation process frequently, and each time it appears, it lasts for a long time. Secondly, expert often uses repeated action, that is, modifying the picture which is already drawn, and seldom modifies elements such as shape and size. The entire drawing action has only one modification action (“The camber surface of the chair can be enlarged”).

3 Experimental Result and Discussion

From the perspective of the above visual thinking strategies, the thinking process of experts and novices is quite different. According to the definition of Lu and Guan (2008), visual thinking strategies can be divided into three types: experiential thinking, imaginative thinking and visual thinking.

The visual thinking process of novices is dominated by inspection thinking, and the inspection action runs through the whole design process. From the early stage, the novice defined stone bionics as the main divergent element, and then carried out inspection actions around the expression of stone elements until the later stage. From the inspection actions, the novice tried to better display the shape of stone. In the whole drawing process of the novice, only the function of the product is paid attention to in the selection of chair legs, and the rest of divergence is based on the expression of aesthetic feeling. Therefore, the drawing process of the novice is more about thinking of the concrete form of visual clues. Secondly, the visual thinking route goes into backtrack (S) action from the perspective of inspection (I) or abstract (A), that is, the novice pays attention to the expression of picture elements rather than the extension of creativity. What the novice thinks back in the given elements is how to better express the painting style. In addition, the novice is more likely to recall visual cues during backtrack step. For example, in the protocol data, the novice said there are pictures of the stone that comes to mind. From the drawing action of the novice to the object establishment (Ms), repeated drawing (Mr) cycle of action, it can be found that the inspection prompted the designer to repeat the drawing action, to a certain extent affecting the fluency of the drawing process. In addition, the quality of composition also affects the presentation of the final sketch. Figure 8 and Figure 9 show the final design result of the novice.
In addition, we combined with the protocol data of the novice to analyse the drawing action: Between 01.22-01.26 min., the novice stopped her painting movement. From the protocol data, the novice thought that the line painting behind the chair was not good and there is no feeling of perspective. Then, the action of drawing and modifying the image appears repeatedly between 01.27-01.34. Between 01.52-03.50, she made repeated modification of the drawn image again, and said that the image was not beautiful enough to draw (she said that the irregular shape did not perform well here, so she wanted to redraw between 01.52-02.03; she also tried to clarify the irregular shape of the chair foot between 02.31-02.35; and focused herself on strengthening the feeling of irregular chairs and added some details between 02.46-03.28). From the drawing action that appears above through the entire drawing process of the raw hand, we could see that the most frequent thing the novice did in the drawing action was modifying the shape and size of the existing graphic which had already been drawn. It could be seen that the novice tends to directly perceive the image rather than understanding and reinterpreting the image during her visual thinking process, which meant that the novice was biased towards the visual sense.

From the type of visual thinking, the expert’s visual thinking is dominated by experiential thinking and imaginative thinking. The expert first looks for the answer to the question from the backtrack and establishes the target relationship corresponding to the question. For example, if the puppy in the previous picture comes to mind in the protocol materials, the expert draws a double chair with modular soft bag. The expert abstracts the dog’s form and then concretizes the thought to push out the final design. At this time, the expert showed a tendency to abstract visual cue thinking strategies. The expert tended to recall the experience in the backtrack, such as the normal board locking four holes. And the expert paid attention to the extension of sculpt and function, protocol materials show that, for example, this structure can be expanded into two parts, which are connected by knobs and recorded with friction pads at the bottom. At this time, the visual thinking of the expert presents multi-aspects thinking strategies.

In the later stage of the sketch process, the expert combined with the inspection thinking, analysed the drawing elements of the completed sketch, and further improved the sketch by using drawing technique. In the drawing action, in the early stage the items establishment is the primary movement of the expert’s drawing process. This indicates that the expert has more fluency in the drawing process than the novice. In the later stage, the expert is
focused on modifying and perfecting the sketch. Therefore, the drawing actions of the later stage used are object modification (Mm) and repeated drawing (Mr). In addition, the expert also used text-assisted method to help the presentation of sketches, which is not seen in the visual thinking strategies of the novice. Figure 10 shows the design result of the expert.

![Figure 10. The final design result of the expert](image)

Combining the expert’s protocol data to analyse the sketching action, it is found that the expert will perform the see action after completing the sketching action. For example, the expert stops drawing during 02.39-02.56 min. and discovers new elements from the sketching (“This basic element also belongs to this, you can also do the whole expansion, the expression of the single chair or multi-functional chair form, or the shape of the back of the chair can be richer”); between 04.28-04.41 min. the expert stops drawing, and carries out design thinking expansion again (“Then, if it is expanded by the form of a single chair, it can be turned into a child’s chair or a form of a single recliner”). The expert uses the visual sense to get clues from the images, which is the unexpected discovery described above, and the new product form is inferred from the clues. The expert pays attention to the depth interpretation and form extension of the image in the sketch creation process and is good at changing the original graphics by combining new elements in the completed sketches.

From the analysis of the results, it is found that the visual cues do not have a deeper understanding in the visual thinking of the novice, and only focus on the aesthetics of the picture. The expert uses visual insight to find new elements from the original image. When backtracking, experts will perform multiple information extraction and problem reconstruction for the problem. This is the reason that experts can continue to extend the design. And the expert’s creative process is clearly divided. The early stage belongs to the design clue extraction, the design thinking divergence stage, the medium term is in the concrete thinking stage, and the later stage is the performance of the technique and the styling details. This was not seen in the sketching process of the novice. Therefore, it can be concluded that the expert trend is to use the visual intention reasoning of visual thinking. On the contrary, the novice cannot deconstruct the visual cues, and performs on the aesthetics of the sketch, and modifies the sketch again and again until satisfied.

4 Conclusion

The research uses practical design cases to observe the differences of visual thinking between the novice and the expert in the sketch design process, the result will contribute to students’ design thinking education. From the experimental results, it is found that the expert’s visual thinking strategy favours the visual intent reasoning and finds new clues from existing images to generate new ideas. Therefore, the expert’s sketching process is generating different ideas and extending the design creativity. The visual thinking strategy of the novice is intuitive perception of the visual, without information filtering. Therefore, the sketching process of the novice pays attention to the modification of the aesthetics of the sketch. However, this way leads to the failure of the design thinking of the novice to divergence, which in turn affects the final design result. Therefore, in design education, teachers should focus on cultivating the visual intentional reasoning of design students and strengthen their ability to interpret and extend information clues. This conclusion provides a new reference guide for design educators on the reform of design curriculum.
References


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A New Approach in Design Learning: Childhood Pretense

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Abstract: In this paper a creative problem-solving approach to design learning is proposed, based on the integration of childhood pretense and creative problem-solving processes both from design creativity research and cognitive psychology. Evaluation of human creativity is strongly associated with children’s pretense which involves flexible and divergent thinking abilities. Childhood pretense in the form of pretend play is used for enhancing creative abilities in children. Likewise, enhancing creative problem-solving process in design is associated with improving flexible and divergent thinking skills. Thus, a broad review has been done to identify the features and similarities of childhood pretense in the framework of affordance and adult designing activity that led us to a new approach in design learning to develop designers’ creative thinking capacity.

Keywords: pretense; creative problem solving; design learning; affordance

1 Introduction

Designing is most commonly defined as a creative problem-solving process (Simon, 1969; Thomas & Carroll, 1979; Dorst & Cross, 2001; Hasirci & Demirkan, 2007; Dorst, 2009). World Design Organization (WDO) states industrial design as a strategic problem-solving process that applies creativity to resolve problems and co-create solutions with the intent of making a product, system, service, experience or a business. “It is widely recognised that design problems are ill-defined, ill-structured and wicked” (Cross, 1982, p. 224). This ill-defined nature brings the need for creative thinking (Cropley, 1999) as opposed to analytical problem solving. Condoor and LaVoie (2007) describe this problem-solving process as formulation of a problem in a conceptually new way through designer’s insight, rather than invention of a new configuration. As the central concern of this activity is being creative, enhancing creativity is a significant issue in design research (Lawson, 2005; Cross, 2006).

According to the situated account of design problem depiction, designers examine and interpret the design situation. They construct the design situation by setting the dimensions of the problem space, seeing it from multiple perspectives and creating the moves to find solutions (Schön, 1983; Schön & Wiggins, 1992). The see-move-see sequence of designing process is also described as “the art of seeing the design situation in multiple ways or seeing as”

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by Lawson and Dorst (2009, p. 26). Focusing on the seeing as action, posed the question of whether this can be interrelated with the seeing as if ability, referred to as pretense in cognitive psychology literature, also outlined as childhood pretense is an exemplar of human creativity (Carruthers, 2002).

Pretend play or sometimes pretense can be seen as a kind of acting as if something is the case when it is not (Leslie, 1987). Recently, children’s pretend play has gained a considerable attention in creativity related research areas (Russ, Robins & Christiano, 1999; Russ, 1996; 2004; 2014; Carruthers, 2002; Picciuto & Carruthers, 2014; 2016). Pretense, pretend play or acting as if is associated with the notion of affordance (Szokolsky, 2006; Rucińska, 2015). Children are aware of the affordances of different objects and explore the various action possibilities of objects for their different kinds of play events (Szokolsky, 2006). The common definition for affordances is, they are possibilities for actions (Gibson, 1979; Norman, 2013; Rucińska, 2015; Gläveanu, 2016). Rucińska (2015) indicates that pretend play of children enables seeing beyond the known uses of objects in different contexts.

Similarly, in the design process it is important to see potentials of different actions in objects, considering that the interaction between an object and its user enables the action. New possibilities and actions could bring creative solution domains. As there is no single or optimal solution to a design problem, to create new or alternative contexts, Picciuto and Carruthers (2014) claim that it is essential to be open to alternative ideas or behaviours and concurrently bypass more obvious ideas to see the other alternative possibilities.

The observed relation between the object; its possible affordances and the ability of seeing affordances in object forms in different contexts, is the main subject of this study. It is hypothesized that children’s pretense or acting as if has significant similarities with designers’ initial designing process. Developing a method to use pretense in design learning could enable designers to see the action possibilities in new context of use and enhance their creative thinking capacity.

In the present descriptive paper, we sought to assess the hypothesized relationship to propose a novel methodological approach for fostering creativity. However, prior to this, the related literature has been reviewed thoroughly including the cognitive processing of design activity, childhood pretense, and affordances.

2 Pretense

2.1 Childhood Pretense

Generally, when the term pretense is used, children’s pretend play is the first that comes to mind. Around the middle of the second year all normal children commonly engage in pretense as a form of play (Carruthers, 2002; Picciuto & Carruthers, 2016). Mitchell (2002, p. 8) argues that pretense could be equated with the definition of “seeing or experiencing something as something else”. Pretend object play or object substitution means treating one object as if another one (Mitchell, 2002). In other words, an agent uses the object differently than its everyday known use. In pretend play we can see a child treating a banana, basket or cup, differently than its everyday use identity. The literature states that children can automatically do this process (Carruthers, 2002; Mitchell, 2002; Weisberg & Gopnik, 2013; Rucińska, 2015).

Perner’s (1991, p. 43) description of pretense is “knowingly acting as-if the world were different than it really is”. According to Dansky (1999), adopting the as if frame in play may open the door to a mode of problem solving where one can play with ideas and possibilities, so this process enables creative solutions to real life problems. In pretend, an agent uses objects differently than what it usually affords in everyday life. Also, Perner (1991) mentions that pretend can refer to two different kinds of substitutions: a symbolic (or representational) substitution and the substitution of a hypothetical (imaginary, nonreal) situation. Symbolic representation refers to the object substitution. For example, a banana substitutes for a telephone. While a child is pretending that a banana is a telephone, she sees the possibilities of telephone-like actions in the banana. Szokolsky (2006) suggests that as a cognitively driven activity pretend object play implies the ability to,

- Think of one object as two things at once;
- Think of one object as representing another; and
- Make mental representations.

In acting as if the object is another, the pretend object supports the pretend act with substitution. So how do children pretend or treat one thing as another? Their imaginative capacity has the role of seeing one thing as another (Currie, 2004). “Through play, children develop combinatory imagination, the ability to combine elements of experience into
new situations and behaviours” (Russ, 2014, p. 36). In pretend play, imagination is required for the capacity to treat one thing as another and it enables to see things in novel ways (Rucińska, 2015).

Accordingly, Perner’s (1991, p. 59) statement of “pretend representations are not representations of the world as it is but of the world as it might be”, resembles Simon’s (1969) definition of design, is the ability to change existing situations into preferred ones. The learned ability of designers to see things as other things, as other forms, in other context, in another reality simulates children’s pretend play. But, while children can automatically do this process until a certain age (Carruthers, 2002; Mitchell, 2002; Weisberg & Gopnik, 2013; Rucińska, 2015), designers learn it. In the simplest description, designers want to see an artefact/experience as if it is something else, try to change the built environment according to preferred needs, trying to see new affordances in objects, environments, human beings as if it does not exist, just like children do in their pretend play.

The literature on childhood pretend play interestingly claims that engaging pretend play facilitates creative thinking skills in children (Dansky & Silverman, 1973; Dansky, 1999; Russ, 2004; 2014). Do these findings contribute to design creativity in the context of our hypothesis? Could practising pretense skills facilitate creative problem solving?

2.2 Pretense and Creative Process

Creativity is defined as the ability to produce work that is both novel (i.e., original, unexpected) and appropriate (i.e., useful) (Amabile, 1983; Sternberg & Lubart, 1999; Runco & Jaeger, 2012). Carruthers (2002, p. 226) suggests that “creativity will normally manifest itself in new types of behaviour, going beyond mere re-applications of established scripts or action-patterns”. Many researches made it clear that pretense or pretend play uses cognitive processes that are involved in creative thinking (Russ, 2004; 2014).

One of the major important cognitive process in creativity is divergent thinking (Guilford, 1968) and pretend play is usually associated with the enhancement of this capacity (Pepler & Ross, 1981; Russ, 1996; Russ et al., 1999; Hoffmann & Russ, 2012; Russ, 2014). Divergent thinking represents the potential for creative thinking and problem solving (Runco, 1999) and it enables our minds to go far from the pre-constructed patterns of thinking. As well as it’s relation with pretense, divergent thinking is generally associated with the design process (Pereira, 1999; Lawson, 2005; Liikkanen, 2010; Choi & Kim, 2017). Since there may be more than one optimal solution to a design problem (Lawson, 2005) divergent thinking is used to see alternative ways to produce a wide range of different ideas. Understanding the nature of design problems, opening up solution spaces and developing self-awareness through divergent thinking is also important in design learning.

In addition to divergent thinking, cognitive flexibility and insight emerge in pretend play and in the creative process (Russ, 2014). Russ (2004) mentions about some important cognitive, affective and personality processes that occur in pretend play. The cognitive processes are,

- Divergent thinking;
- Symbolism, for example: transforming ordinary objects into representations of other objects;
- Organizing a logical story; and
- Fantasy/make believe (like the ability to engage in as if play behaviour).

These processes are expressed in pretend play and all involved in the creative act (Russ, 2004). While divergent thinking is about fluidity of thinking, transformational abilities involve reorganizing information and breaking out of old ways of thinking (Russ, 2004; 2014). Russ (2004) emphasizes that practicing with free associations, recombining ideas, and manipulation of object representations help children become more creative. Also, these processes are important in creative production for the design process. To see the new ways of problem solving and come up with novel ideas could be possible with these processes.

Carruthers (2002) believes that adult creative thinking and problem solving and childhood pretend play share essentially the same cognitive basis, they both involve exercises of imagination. The capacity to generate, and to reason with, novel suppositions or imaginary scenarios are the same cognitive underpinnings they share (Carruthers, 2002). During play, a child may suppose a banana is a telephone or a broom is a horse. Pretense also enables to exercise the abilities for suppressing habitual or obvious responses and selecting more unusual possibilities and this is called bypassing the obvious and selecting the non-obvious (Picciuto & Carruthers, 2014). Similarly, designers also try to see beyond the conventional uses of objects and imagine other possibilities.
Practicing with supposition and reasoning mechanisms in pretense also support both the generate and explore components of the Geneplore Creativity Model (Picciuto & Carruthers, 2014). Geneplore model is developed by Finke, Ward and Smith (1992). According to this model, in the generative phase, mental representations of novel ideas are produced; in the explore phase, the idea is developed, and conceptual interpretations and functional inferences are made (Finke et al., 1992).

Furthermore, another possible explanation for childhood pretense involves counterfactual reasoning. There are some studies that discuss the relationship between pretense and counterfactual reasoning (Weisberg & Gopnik, 2013; Weisberg, 2015). Weisberg and Gopnik (2013) argue that pretense and counterfactual reasoning both involve considering events that have not occurred yet and thinking about what would be the case if they had. They share the same mechanism: disengaging with current reality, and making inferences about an alternative representation of reality (Weisberg & Gopnik, 2013). Thinking about hypothetical scenarios and reasoning about them could be seen in the design process, too. Thinking about the possible world scenarios and imaginary situations are necessary to bring novel solutions to ill-defined problems, therefore designers need to think about what if scenarios creatively.

### 2.3 Affordance-Based Explanation of Pretense

The concept of affordance is first introduced by Gibson (1979); he used this term in his theory of visual perception. Gibson (1979, p. 127) points out that “the affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill”. His term of affordance implies the complementarity of the animal and the environment (Gibson, 1979).

Chemero (2003, p. 184) emphasizes that “affordances are not properties of the environment, they are relations between particular aspects of animals and particular aspects of situations”. In the design process, the possible uses of an object depend on its affordance referring to a relationship between the properties of an object and the capabilities of the agent. Also, the interaction is important while addressing the term affordance. Affordances actually mean the possibilities in the world that represent the way of interactions of an agent with something. At the same time this relationship shows that different affordances can be produced even if they are associated with the same object (Norman, 2013).

Costall (2015) mentions about the canonical affordances that are not relative to any individual agent, but relate instead to shared social practices. Known object uses like chair for sitting, knife for cutting, etc., represent the canonical uses. But on the framework of creativity, as Glăveanu (2016, p. 15) puts emphasis on canonical affordances, “the conventional is often associated with less creative because of the material properties, and known intentions.” For going beyond non-creative thinking, discovery of action potentials in objects and generation of objects with novel affordances are essential. Glăveanu (2012; 2016) explains creative forms of expression as expanding our action possibilities by generating objects with novel affordances, and exploiting existing affordances in new ways. For uncovering and exploring affordances of objects one needs to look at objects in different ways. In this respect, the explanation of pretense within the framework of affordance could bring a new perspective for creative thinking.

Rucińska (2015) explains pretense with a new proposal of a sensory-motor account of imagination and its explanatory concept of affordance, and defines the imaginative role of pretense as taking account of the capacity of see affordances-in. “Affordances are defined as action potentials in relation to the particular actor at a more basic level of on-line coordination with the object world” (Szokolsky, 2006, p. 68). Related to this definition, Rucińska (2015) associated the affordance-based explanation of pretense with objects’ various uses that are afforded in different contexts. Thus, it can be said that children can treat one thing as another because they see the action possibilities, in other words, affordances in objects while playing in new contexts. She explains pretense with the mutuality of the child and the object in the right pretense context, which involves meaningful interactions.

Tomasello (1999) used the term intentional affordances, based on child’s understanding of the intentional relations other people have with that object or artefact. In pretense “the child perceives and understand the intentional affordance of the pretend object and then decouples it from the object so that affordances can be used with inappropriate object playfully” (Tomasello, 1999, p. 85). This means that, the child searches to match the affordances of a pretend object with a real object suitable to her capacities. “In pretense, the functional fitness of pretend object depends on the structure of the intended action, the action capabilities of the child, and the affordances of the object” (Szokolsky, 2006, p. 73). This implies that in pretense the child follows the affordances revealed by an object.

There are many object forms around us but the significant part of this pretense process is to discover the affordances of these object forms with seeing as. Olteteanu (2015) argues that creative problem solving is a kind of seeing as
A New Approach in Design Learning: Childhood Pretense

process which involves looking at something we already know in a different way. Also, Sawyer (2012) states that creativity is about combining existing elements and generating a new combination.

In everyday use, the laundry basket is used for putting the laundry in it. However, in play context a laundry basket could be used in another way: as a boat. This is because the child looks at the object and sees the other possibilities for action in the laundry basket and manipulates it in relevant ways. Her effectivity matches with its affordance in her pretend play context so now the laundry basket has a new meaning in play. This situation is supported by Chemero’s view (2003) of affordances as relations between the abilities of the subject and the features of the environment. In the pretense context, a child is not just seeing the properties of the object but also what she can do with it (Rucińska, 2015). Different contexts of use can invite different behaviours.

To outline, in different pretend play contexts a child can play with various kinds of objects seeing the action potentials in them. It is seeing the affordance potentials of objects’ relation to the agent that enables pretense behaviour. There are many possibilities for action that objects afford to people and in terms of design. It is important to be able to see these possibilities in different contexts. An affordance depends on both the artefact and the user. There is a dynamic relationship between them. The concept of the affordance-effectivity pair is the main point here, they complement each other (Gibson, 1979). So, in the design process the essential part is matching the affordance of object and effectivity of user pairs under the right conditions of use. Different contexts of use can invite different action possibilities, so for designers it is essential to discover these possibilities of objects. Based on Rucińska’s dissertation (2015) pretense as seeing affordances in objects could be a useful way to practice for creative problem solving in design learning.

3 Discussion: The Integration of Pretense, Affordance and Creative Problem Solving in the Design Process

Design is inherently a creative activity. Design problems are real life problems, usually faced in everyday life (Cross, 2006). Real world problems are rarely neatly presented and as Sawyer (2012) argues, most creativity occurs when people are working on ill-defined problems. In the design process, creative thinking is crucial for changing environmental demands with novel solutions. There may be different solutions to design problems and designers always try to broaden the point of view to find possible solutions. Thomas and Carroll (1979) are concerned with describing design as a way of looking at a problem instead of a particular type of problem. Designers deal with questions like what might be, could be, and should be, instead of what is, how, and why (Lawson, 2005). Therefore, it can be understood that designers imagine and think about the possibilities and create the possible solutions to design problems and satisfy the varied needs of users.

Transforming the way of thinking, re-imagining the problems and creating alternative solutions is a complicated process. Sometimes well learnt object uses and properties cause fixation and people are unable to see new ways of using objects (Purcell & Gero, 1996). Pretense encourages the generation of new ideas while enhancing other cognitive capacities such as suppressing obvious responses while selecting and developing unobvious ones which are important in the creative process (Picciuto & Carruthers, 2016). “Pretense can be viewed as the unconventional use of an object in place of another object in order to achieve a goal” (Szokolsky, 2006, p. 81). Sawyer (2012) claims that creativity is more likely when one rejects convention and there is the belief that children are more creative than adults for this reason. In pretense children can see unusual uses of objects, and go beyond the everyday functions of objects for their purpose. In the design process the designer aims to reach this flexible way of thinking. As it is mentioned before, while children pretend spontaneously, designers learn to do it in the creative design process.

The similarities between children’s pretend play process and designers’ pretense in conceptual design phase, as this study hypothesized, are shown in Figure 1 and Figure 2. Figure 1 schematizes the children’s pretense process. To make a phone call to someone in a play scenario, first the child searches around for the affordances of phone in other objects. Then if the affordance matches with an object (e.g. banana) then he/she uses this object as if it is a phone in her play. Figure 2 schematizes the hypothesized pretense process in the initial form search process in the designing activity. As shown in Figure 2, at the initial form giving process, the designers search for the affordances of the intended use and intended product as well as intended user behaviour. This search process can be seen as childhood pretend play. Designers, like children, try to discover new action possibilities in different contexts. Both children and designers try to switch between ideas, because they look for affordances and they are both pretenders.
In the design process, thinking in a flexible way like children is important for designers because as Lawson (2005, p. 5) puts it: “Designers have to learn to understand problems that other people may find it hard to describe and create good solutions for them”. As a consequence of designing for different users, designers try to see these action and interaction possibilities that give designers guidance for problem solving. Tschimmel (2010, p. 223) argues that “Design thinking is thinking in variety and in new semantic and material combinations.” Also, she continues that as a basis for innovative design, designers need to liberate themselves from routines of perception to think about the possibilities. Therefore, pretense could be an effective practice to inhibit canonical or pre-defined ways of use and may lead to the discovery of new ideas in the design process.

Hoff (2013) discusses that seeing the surrounding world and oneself in a flexible and transformable new way like in children’s pretend play, could be a way for creative approach. Pretend play of children is a way of making non-obvious connections between seemingly unrelated things and this process resembles to creativity. Creative thinking requires the ability to associate mental elements into new combinations which either meet specified requirements or are in some way useful (Mednick, 1962). Thus, in the creative design process one needs to break away from existing ideas
and beliefs to discover new action possibilities of objects. In the frame of pretense, this statement could be explained by Rucińska’s suggestion (2015) about the role of pretense that enables seeing many possible interactions with objects.

Gero (2010) claims that the interaction of user and design could take many forms and creativity occurs as a result of this interaction: affordance. Rucińska (2015) explains childhood pretense in the framework of affordance and shows how the effectiveness of an agent with the object’s affordances in the suitable context could bring about the explanation of pretense. Children are open to meaning of forms and they can see affordances in objects in a flexible way. An object can have many affordances and in the design process it is important to see these affordances in different contexts related to different users. Designers should consider the mutuality of user effectiveness and object affordances in different context of use. They should ask themselves what if questions and think in a flexible way for possible scenarios.

It is essential for designers to consider the affordances which exist to make the desired actions possible (Norman, 2013). Gibson (1979) stated that an affordance exists even if it is not perceived by the user. In other words, the object could have the affordance even we cannot notice right there at that moment. Thus, in the design process designers should try to think about the action possibilities of objects and discover the new potentials in different contexts.

As Goldschmidt (1999) places particular emphasis on creativity in relation to design, new artefacts are often expected to be innovative and original. Therefore, it is important for designers to be creative while exercising creative processes (Goldschmidt, 1999). In the design process it is essential to go beyond the typical ways of thinking so there is the need to bring new approaches for design learning to encourage designers.

Lawson (2005) mentions that for creating solutions to design problems it is important to consider the principles and strategies to help designers use in their mental processes. There are many models and methods developed to enhance the creative design process, or divergent thinking processes more generally. Some creativity techniques used in the design process are: Brainstorming (Osborn, 1953), Morphological Analysis (Allen, 1962), and Synectics (Prince, 1967), Mind Mapping (Buzan, 1983). These techniques are widely used in the design process both in practice and education, in order to generate novel ideas. As it is previously mentioned, childhood pretend play asserts the facilitation of creative thinking through engaging in play (Dansky & Silverman, 1973; Dansky, 1999; Russ, 2004; 2014); conceptualization of pretend play in the framework of affordances in the design process could bring effective practices for designers and design students as a way of creative thinking.

In this particular context, this study provides the first explorative research creating a conceptual framework on the integration of design creativity and pretense, pointing to an important interdisciplinary topic for enhancing creativity that can benefit many creativity related fields and education. As this paper is a portion of a larger experimental study, future work could establish a structural model of pretense in enhancing creative thinking skills.

References


A New Approach in Design Learning: Childhood Pretense


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Making the Students of Interior Architecture Design Seating Furniture

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Abstract: This study suggests that students of interior architecture can be led to design furniture through two different techniques. The first technique is applied by guiding them on the basis of a direct analogy and the second one, by making the students produce fairly original designs through motivating them to move their ideas beyond their familiar thinking. The study reveals that it is rather hard to break the conditioned thoughts of 34 students divided in two groups. First, the students were provided with the information on definition, history and types of furniture classified according to the periods. Next, in the first stage, students were led to design contemporary seating objects by a method of direct inspiration from an existing piece of furniture constructed in the prehistoric period. In the second stage, synectics method was applied. Derived from the Greek word synecticos, synectics means the bringing together of diverse elements. It is a creative problem-solving technique. Upon a quick decision, the lecturer leading the session added a new stage to the methodology and told the students to draw the pictures of their souls as they cannot reach a satisfying result with the previous form of the methodology applied. The authentic result of this study was obtained by the designs developed from the pictures of souls added to the synectics method. The students’ interests are triggered by a sudden decision of the lecturer so that they can reflect their souls, which constitutes the essence of their entity and their ideas, on the designs they produce.

Keywords: furniture design; synectics method; pictures of souls

1 Introduction

This study investigates how to make the students of interior architecture design objects in a crowded class environment and how to reach satisfactory outcomes.

In addition, sustainable art works inspired by past and reaching present exposing the contrast between past and future have been noted as well as works showing the impact of nature on art. The opposition between past and present and the essence of creativity have been among the points affecting also the design process during the class, and the design started with the historical information on itself. The first technique, i.e. taking inspiration by seeing is a preparation for the start. And the second technique i.e. the application of the synectics method through which unrelated elements come together and conditioned ideas are made free. The application of the synectics method to design education has not been a common practice in Turkey. In this regard, the study evaluates two fundamental techniques applied to guide the aforementioned students through the design of furniture.
1.1 Methodology

The study was carried out on the basis of three methodologies. The first one was hermeneutics. *Hermeneutics* can be regarded as a philosophical concept which refers to understanding, explication and interpretation of a problem on a structure of meaningful relationships even over different periods of time. Interpretation means the disclosure of a text’s or statement’s meaning through the words of the interpreter. A statement can originate from a creative idea inspired by a visual stimulus. The scope of hermeneutics covers a very broad area since interpretation can be said to be the synthesis of language, history and understanding and thus, it cannot exist without “human hopes, fears and expectations” (Arslan, 2007, pp. 47-49). This means it is important to interpret the applied information and reflect this interpretation to the result. Hermeneutics, which is the interpretative methodology of the study, was improved and refined by Dilthey (1999). Being a major thinker of analytical history of philosophy, Dilthey questions the role of the historian in respect to her acts of processing information. He also carries out a criticism of methodology and develops a critical perspective on history. This study is based on Dilthey’s ideas. The ideas of Dilthey on hermeneutics are considered to form the basis of this study. Dilthey explains that a person perceives herself as being different from nature and argues that the person’s entity as well as all historical and sociological phenomena are tied to the nexus of consciousness and they reveal all the spiritual skills of a human being. Accordingly, Dilthey (1999, p. 13, pp. 86-90) defines hermeneutics as follows:

> Understanding is defined as the method to provide the necessary inner awareness through the external sensory signs... The art of understanding manifests itself in the interpretation (the analysis of understanding) of the written heritage of the human knowledge... The science of hermeneutics resulted from the conflict between various forms of approach and the necessity for establishing the rules during the interpretation of crucial works. Hermeneutics is the discipline aimed at interpreting written works.

The main feature of the hermeneutic method is primarily related to understanding. Dilthey’s concept of understanding has four main features: “The first is that understanding is foremost a process taking place in the common functioning of daily life. It is the source of all basic knowledge that a human being has; any other concept cannot replace understanding, its uniqueness reflects the authenticity of the respective process; understanding is an indispensable and essential part of the methodology of human studies” (Acar Vanleene, 2012, p. 162, pp. 159-171). As for the second methodology of this study, the students were provided with the drawings of the oldest furniture in history and were asked to design a seating object adapted to the present day. It was a direct analogy, or more accurately an inspiration method. The reason why furniture was provided as a drawing was to prevent the students from being affected by the detailed information in a photograph.

The original name of the third method is synectics. Synectics, which is derived from the Greek word “synecticos”, means syntax. It denotes fitting together diverse elements. Being a creative problem-solving technique, synectics should be applied in nine steps in order that it could be totally effective. In the study of Wilson, Greer and Johnson, (2016), participants are introduced a problem by a leader as an excursion. The leader conducts an excursion of the group. The participants attempt to find out a solution to a problem through a series of steps. The synectics method tends to move gradually the participants’ ideas away from the common ones so that they can be transformed into different perspectives. The method aims to provide the students to come up with new ideas independent of conditioned thinking. The steps are explained in the methodology in Section 3.2. New ideas bring in new solutions. This procedure consciously stimulates creative thinking. The authors explain that for a better understanding of the method’s role, *Synectics Flow Chart* should be devised by an experienced leader who applies the process. The order of the flow chart is in relation to the thinking procedures of the participants approximating to their personality traits. More importantly, participants are led to move away from themselves step by step and all of a sudden, they seek an answer with an identity other than themselves. The methodology in Wilson, Greer and Johnson’s (2016) study has thirteen steps. In the development of the method, at the eleventh step, the leader poses questions which evoke creative thinking thorough analogies. This is a sort of forcing the participants to be fit. This step is for simplifying and testing the selection of examples. The nine-step method in general has been applied in this study. All the steps will be presented in the case study.

It can be said that the application of the synectics method is not seen very often in Turkey. Recently, a (sort) of brainstorming session has been held by using the synectics method. Four analogy charts including eighty-one examples of analogy have been obtained. According to the determined functions of the session, these examples of analogy have been inspired by nature, human body, solutions to problems and imaginary examples (Börekcioğlu & Derviş, 2018). As for the methodology of this study, two distinct applications of the synectics method have been carried out in two separate classes with seventeen inexperienced students in each.
2 Seating Area Furniture and Using Imagination for its Design

Since the oldest ages of history, individuals need to sit down. This need has developed in direct proportion to human skeletal structure. Although seat height, seat depth and back height differ between the smallest and largest human dimensions, the standard measurements can provide seating area furniture suitable for use by a large number of people. The evolution of seating area furniture has witnessed an unprecedented pace of transformation from the second half of the twentieth century to the present.

In “The Poetics of Space” Bachelard’s (2017, p. 37, p. 87, p. 172) poetical definitions are as follows: “I am the space where I am”, “An imaginary room rises up around our bodies, which think that they are well hidden when we take refuge in a corner. Already, the shadows are walls, a piece of furniture constitutes a barrier, hangings are a roof”. In this regard, furniture can be conceived as a fence and many more things. Grassi (1979, pp. 184-185) indicates that the concept of fantasy (phantasie) constitutes the basis of imagination and imagination shapes a non-existent as existent.

Aristotle’s quote: “The soul never thinks without a picture” explains the relationship between an image and soul (Grassi, 1979, pp. 184-185). Byars (1997, p. 7) states: “Chairs are objects with a soul […] not only […] because they nurture us with their form and comfort but also because they possess an inner, well-conceived technology.” In fact will this profound perspective be sufficient to obtain the students’ pictures of souls? Do the students have a fertile imagination to support their souls? With a long-time experience on the teaching of design, will the lecturer who guides the practice be able to transform the pictures of the students’ souls into objects? The answers to these questions will determine the results of this study. In this context, the symbolic depictions of the concept of spirit in the sense of vitality as the essence of entity are of significance. The word spirit means breath, break, wind, breeze, fragrance. In western languages the term holy spirit is pictured as a dove flying through flames. For Hindus, the spirit is the wild stallion. The animated film “Spirit: Stallion of the Cimarron” produced by DreamWorks Studio in Canada can be considered as one of the most lively representations of the concept of spirit.

![Figure 1. Left: Description of holy spirit; middle: The wild stallion of Hindus; right: Animated film: Spirit: Stallion of the Cimarron.](image_url)

From an epistemological perspective, the subject matter of this study can be tackled on the basis of a subject who knows and an object which is known. Hence, it can be said that the framework of the case study is epistemological and it affects the study indirectly, as the application of the methodology aims to stimulate the soul which is the essence of entity. In fact, this study prioritizes the subject and shows an idealistic dimension. Operating with the essence of entity, the pictures of souls are attached to a known method. In terms of epistemological perspectives focusing on the object level, these pictures of souls reveal that something which does not exist as an entity can be transformed into a factual entity. The invisible associations of ideas have also similar quality.

2.1. A Brief Look at the History of Seating Area Furniture

The history of furniture dates back to prehistoric times and the furniture of Egyptian pharaohs illustrate significant examples in the history of furniture. No matter how primitive it was, since the early periods of humanity, furniture has existed as humans need to sit. Egyptian furniture produced for the Pharaoh’s family and his surroundings constitutes the best examples of prehistoric times. The students were provided with general knowledge about furniture covering the Renaissance and the Industrial Revolution.

Boyla (2012, pp. 113-143) studies the history of furniture under the four following parts: prehistoric times, palace styles, industrialisation, and information age. The fundamental feature of human skeletal structure and the need for sitting resulted in the production of seating area furniture during the prehistoric periods.
Miller (2005, pp. 8-11) starts the history of furniture from the data about the seated positions of goddess statues. After that, the following distinctions are made: MÖ 4000-MS.1600 Ancient Furniture; 1600-1700 17th Century; 1700-1760 Early 18th Century; 1760-1800 Late 18th Century; 1800-1840 Early 19th Century; 1840-1900 Mid 19th Century; 1880-1915 Art Nouveau; 1919-1940 Art Deco; 1925-1945 Modernism; 1945-1970 Mid Century Modern; 1970 Postmodern and contemporary. The students were provided with the necessary information about the history of furniture. Egyptian Pharaoh furniture was regarded and tackled as the oldest and significant example.

**Egyptian Pharaoh furniture**

The most typical example from the prehistoric period was Egyptian Pharaoh furniture. The photos and drawings of this furniture were shown as examples (Figure 2). It can be said that Tutankhamun’s furniture of very high artistic value has had a fundamental effect on today’s furniture construction. The legs of the chair with frame construction were shaped like animal claws to symbolise power. The folding chair fulfilled various functions with its technical construction supporting the buttocks. For the first assignment the students were inspired directly from Tutankhamun’s furniture shown in Figure 1.

![Figure 2. The drawings of Egyptian Pharaoh Tutankhamun’s (BC 1341-1323) seating furniture (Crochet, 1999; p. 13)](image)

### 2.2. Contemporary Seating Furniture

According to Miller’s (2005, pp. 8-11) study, the period of contemporary furniture operated in the 1970s and onwards, yet the students were informed about furniture history beginning from the mid 19th century, with the history of Thonet Furniture.

“The United States and much of Europe experienced new prosperity and optimism, which fuelled the growth in consumerism and youth culture” (Miller, 2005, p. 450). In the 1970s designers in Italy either belonged to a group or they were socio-critical or revolutionary. Andrea Branzi founded Archizoom group in 1966 and described themselves as avant-garde. Branzi stated that they discussed methods of international modernity and started to realize the possibility of using many different tools of expression even apart from kitsch, which involved extraordinary mediums of expression (Cologne, 1994, pp. 88-89). In his study titled “Programming After Program: Archizoom’s No-Stop City”, Varnelis (2006, pp. 82-91) compares No-Stop City with Hilberseimer’s “Hochhausstadt”: “Hochhausstadt still acknowledged the critical importance of urban space and the street, whereas No-Stop City rejected it”. Hochhausstadt’s representations focused on the exterior while “No-Stop City” rejected the critical significance of urban space and depicted the cities as interior images (Varnelis, 2006, pp. 82-91). In respect of this, “Quaderna” furniture was used intensively.

It can be said that this prosperity development of the 1960s shaped the 1970s and 1980s to some extent as the colourful laminate furniture of Memphis Group seemed to continue this new prosperity and optimism experience. With Memphis, cultural explanatory power of design and its semiotic surplus value were also attributed to design as it was already done so, to literature, theater, cinema and visual arts. “Design is no longer just to optimize the benefit processes but it is a matter of different cultural decisions in relation to different social conditions and still missing today” (Albus & Fischer, 1995, p. 15). In 1981 Memphis group came together and held their exhibition. The fresh, optimistic and crazy objects they put on display were welcomed with a hysterical enthusiasm by an avant-garde group of people. On the other hand, “Today, Memphis is still considered to be a joke by many design critics... Functionality, International Modernism took farewell of design... Ettore Sottsass, the pioneer of Memphis left the movement he...
backed after a while. He said that he loved the copies as they ruined and revived him to a certain extent” (Cologne, 1994, pp. 108-109).

3 Furniture Design Course at the Department of Interior Architecture, Faculty of Architecture and Design at Fatih Sultan Mehmet Vakıf University

The methodology in the practice consisted of two stages. In the first stage, a number of presentations were given on the history of furniture beginning from Egyptian furniture in the prehistoric times up to the Industrial Revolution. The object was to convey an impression of the image of the oldest examples of furniture to the students’ minds. Some information on the constructive structure of that furniture and the extent of inspiration was also provided.

3.1 The First Practice During the Furniture Design Course

The students were inspired from two pieces of oldest Egyptian furniture. A contemporary approach in relation to a direct analogy or inspiration was applied during the design process. The results of the first practice fall under three groups in terms of hermeneutic viewpoint (Table 1).

1. Inspiration primarily drawn from the back,
2. Inspiration drawn from the back, foot, leg, etc.,
3. Other inspirations.

<table>
<thead>
<tr>
<th>Table 1. The students’ projects, from the first practice, inspired directly from the drawings of the Pharaoh Tutankhamon’s throne chair: Inspiration primarily drawn from the back</th>
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<td><img src="image5" alt="Chair 5" /></td>
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<td><img src="image9" alt="Chair 9" /></td>
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3.1.1 Furniture Design - Evaluation of the Inspiration Drawn Primarily from the Back

A splat, the central back support inspired primarily from the back parts of Tutankhamon’s furniture can be observed in those designs. More contemporary traits can be observed in the feet of these pieces of furniture. Inspired by Tutankhamon’s furniture going as far back as 3360 years ago, the students’ pieces of furniture displayed very improved designs affecting the contemporary life. It can be said that this has had a positive impact on the students who will begin their design career (Table 2).

<table>
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<tr>
<th>Table 2. The students’ projects, from the first practice, inspired directly from the drawings of the Pharaoh Tutankhamon’s throne chair: Inspiration primarily drawn from the back, foot, leg, etc.</th>
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3.1.2 Furniture Design - Evaluation of the Inspiration Primarily Drawn from the Back, Foot, Leg, etc.
The projects of furniture (Table 3) are quite different from the rest of the class in terms of inspiration drawn from the back, foot, leg, and so forth. To illustrate, two students preferred to use bars touching the ground. Six students preferred to interpret diagonal lines in the legs. Two chairs have legs connecting to the arms. Three other students fortified the legs. The last picture shows a simplified design of chair feet inspired from wild animal claws. Overall, similarities in the middle axe were especially noted in terms of inspiration drawn from the chair back.

Table 3. The students’ projects inspired directly from the furniture of Tutankhamun: The other inspirations

3.1.3 Furniture Design - Evaluation of the Other Inspirations
The students’ projects in this group demonstrate the students’ desire to be more independent. The leader of the project could not insist on students, she could not dictate to the students what to do or not. Yet, she could guide them through design principles. The designs in this group receded further from Tutankhamon’s furniture. In fact, the students were not demanded to design furniture similar to it.

3.1.4 Analysis and Interpretation of the First Practice in the Furniture Design Course
Although it was their first design, the students could quickly deduce how to apply the strategy of drawing direct inspiration and analogy between their ideas and the samples they were provided with. One third of students wanted to develop their own ideas. The other students were primarily affected by the seat backs. In a more determined development, ten students drew inspiration without copying and with different perspectives. They also sought forms representing power. From a hermeneutics point of view, this study analyzes and evaluates the students’ design acts on an existing piece of seating area furniture. It also explores how these design acts differ from their own initial ideas and the past form of furniture.

3.2 The Second Practice in the Furniture Design Course
The synectics method was implemented among others by G. Prince and B. Gordon based on their work at the Arthur D. Little Invention Design Group. They devised this method in the 1950s observing many sessions in the group to solve customer problems. Their objective was to eliminate the unpredictability of achieving creative solutions. The term synectics is derived from Greek word parts and suggests the bringing together of diverse elements. According to Lukat’s (1975) explanation the process has nine steps and one session lasts about two hours with 5 to 7 participants:
• The problem is introduced and defined, e.g. the existing umbrellas fail to cover their functions satisfyingly.
• Spontaneous reaction: The participants express the first ideas that come to their minds. The umbrella may look like a hat, have an inflation system, etc.
• The problem is redefined according to the solution captured from the spontaneous reaction: an umbrella not carried by hand with a new opening system.
• Direct analogy: Analogies from daily life according to the new definition of problem, e.g. furry skin like duck feathers, mushroom, greasy-feathered cover.
• Personal analogy: If the participants were one of the analogies, what would their emotions be, e.g. if they were a mushroom head, would they be cold, stoned, broken apart, breakable, bright, etc?
• Symbolic analogy: The participants are asked to draw symbolic analogies between the contrasts of a few emotions from the personal analogy stage, e.g. stoned, breakable; sturdy breakability.
• Direct analogy: The most relevant for estrangement from the symbolic analogy, e.g. sturdy breakability: satellites, Christmas tree, glass balls.
• Analysis of direct analogy: The most relevant direct analogy is analysed, e.g. satellites: surrounding the Earth, having connection to the Earth, broadcasting, etc.
• Spontaneous solution suggestion and its reflection: The relationship of the last analogy and analysis with the main problem is set up, e.g. a cap umbrella put on the head with a central rotation system like a satellite; when it starts raining the cap will rotate and the rain will be driven away.

Besides, similar to the process schematized in Figure 3, Tassoul’s (2006, pp. 63-68) study explains how analogies permit to move away from the subject in the middle of the process. It also illustrates how a force fit has to be made because of the on-going process and how new solution possibilities are obtained.

![Figure 3. Synectics process (Tassoul, 2006, pp. 63-68)](image)

Tassoul (2006, p. 63-68) (as confrontative technique) elucidates: “Analogies allow for moving away from the original problem statement and making a forced fit to develop solutions on the basis of these analogies. The synectics procedure is also based on the process of preparation, incubation, illumination and verification. Synectics is a method which can be applied to many diverse situations. However, concrete manifestations of the flexible thinking may not always occur.”

Accordingly, Adorno (Adorno & Horkheimer, 2014, pp. 46-49) says that while thinking we are doing something, “Even the most rarefied form of mental activity contains an element of the practical.” Conversely, Horkheimer (Adorno & Horkheimer, 2014, pp. 46-49) argues that a theory can only be considered a true theory if it serves practice. He also states that ideas which are confirmed differ from ideas which are not confirmed. That kind of thinking has to relate to real life and look at the work in that perspective. The controversial ideas of Adorno and Horkheimer suggest that even the most abstract concept of imagination can be developed through the synectics method.

### 3.2.1. The Application and Evaluation of the Synectics Method

The students were asked to do research on contemporary furniture one week before the application of the method in order that their visual memory could improve. The students were divided into two separate groups during the furniture design course. Each group was composed of 17 students. The synectics process was carried out in nine phases. The application process for each group is as follows:
1. **Problem as defined:** The pieces of contemporary furniture have grown to resemble more each other. They do not reflect new perspectives.

2. **Spontaneous ideas:** 17 students’ spontaneous reactions led to ideas in each group. These ideas were picked and summarised as follows. First group: the new furniture should be interesting in terms of developing technology; second group: it should be comfortable and suitable for moving. The second group’s result was picked.

3. **Problem as redefined:** Considering that a human being is a living creature, the furniture should be comfortable and suitable for moving regarding the person’s movements and ideas.

4. **Finding direct analogies:** Among the first group’s analogies (water, stone, pole, kangaroo, earth, cloud, butterfly, cat, wind, air, tree, branch, wave, flower, mushroom, fire), the concepts wind, wave and fire were selected. Among the second group’s analogies (earth, moon, fire, season, wind, sun, volcano, cricket, gazelle, leaf, cherry tree, bushes, caterpillar, water, sea), the concepts free, quick-tempered and fragile were selected.

5. **Personal Analogies:** When the members were analogies, the first group selected the concepts of flying-migrating, cold-wasteful, free, tired-annoyed, and bold; the second group selected the concepts of active-fluent, transparent, greening, fading and eternal-calm.

6. **Symbolic analogies:** The first group selected the concepts slackness-stagnant, like a caterpillar, introvert, like open arms, ugly, and like still water; the second group selected the concepts trapped, becoming a lake, like a waterfall, and standing upright.

7. **Direct analogies:** The first group selected the concepts free-prisoner, lively-breathless, and hasty-calm; the second group selected the concepts runaway-stagnant, like a cloud-glaciers, and strong-numb.

8. **Analysis of direct analogies:** The first group selected the following analyses: live life lively, without extremes, frank, passionate about what they have, mutable and indecisive. The second group selected the following analyses: run away-disappear, be cold and non-reacting, be fluid like rain, release your spirit, and being without expectation.

9. **Spontaneous proposal of solution and its reflection:** The first group selected the concepts tidy, minimalist, simple, mobile, connected, entertaining, and like a blowing wind; the second group selected the concepts like a pilates ball, a seating area piece flexing from the feet, like heavy rain, like sitting on water, and sitting on a wall without expectation.

In the direct analogy phase, the students gave, for the most part, examples from nature. Personal analogies were made according to this. In the symbolic analogy phase, they used the contrasts belonging to their own ideas; here there were some inconsistencies. In the seventh phase they could not get rid of what they had felt; their emotions continued. The groups were crowded, which prevented positive development. In the eighth phase, both groups produced analysis sentences which seemed to be reflections of life philosophy. In the ninth phase, they thought about how to build their own designs, so instead of one problem, each student defined their own problem. Besides, it was noted that many students were under the influence of seating area furniture which they designed previously. Below are sketches of seating area furniture by students through Synectics Method.

Table 4 shows the figures emerging from the students’ ideas activated by the synectics method. Some of these figures would have been improved, but the leader decided to make an addition to the synectics method as she was worried about the authenticity of the designs to be developed by most of them. The leader implemented a ninth phase. The students had touched so much on spiritual topics that the leader of the project made a direct association and told the students: “Now, draw the pictures of your souls!”

This topic was surprising for all the students; how would they draw such an abstract subject? Some dashed off and scratched; some drew geometrical shapes in a great discipline. Some tried to draw by rolling and rotating fluent shapes; some produced circles and some of them thought so much that they scrawled. The main role of the leader began then. This role was to interpret all these figures, to deduce something from these figures by defining the students’ souls and to raise awareness among the students about what they wanted to design.

Table 4. The drawings of 34 students resulting from the application of the synectics method

<table>
<thead>
<tr>
<th>Image of sketches</th>
<th>Image of sketches</th>
<th>Image of sketches</th>
<th>Image of sketches</th>
<th>Image of sketches</th>
<th>Image of sketches</th>
</tr>
</thead>
</table>
Table 5. The furniture designs developed from the pictures of souls by 34 students. Table 5 illustrates the results of the workshop “Now draw the pictures of your souls” carried out with them as a continuation of the synectics method. The chairs of two hardworking students were shown with two pictures for each to make the table look complete.
Within the scope of this paper, it was not possible to include separately all the design processes of students. That is why the pictures of students’ souls and their results were presented (Table 5). The results of the synectics method, the pictures of souls and their results were ordered according to the class lists. Therefore, it is possible to make comparisons. In conclusion, although it is obvious that a 100% success could not be expected from a furniture design class with 34 students, the study shows that the students have comprehended what an authentic design is.

3.2.2. The Second Practice during the Furniture Design Course and its Interpretation

The students were very surprised when they were asked to draw the pictures of their souls. Visualising such an abstract concept was not easy for students, but they managed to draw them. Their pictures of souls consisted of round and flexible lines or sharp corners, very fine lines in the form of developing forms, multiple sharp and zigzag lines. Admittedly, it was easier for the leader to guide the students to transform these lines into an object. Some lines seemed to have wings in themselves. Some of them could only be progressing in bar lines or stick lines. In accordance with the definitions of heurmeunetics as an interpretative methodology and Aristototle’s following statement “The soul never thinks without images”, the students learnt to acquire a relevant image for their souls. The leader of the design process directed the students in relation to the research’s methodology. She supported the students to develop the images of their souls. In doing this, she also interpreted them in an artistic point of view.

4 Findings and Results

The case study of this paper was carried out by the methodology made up of direct analogy, synectics and hermeneutics. Using analogy, i.e. indirect inspiration as a tool of methodology, made it possible to provide the students with the introduction to the subjects. The paper developed mainly on the basis of case study applications through its methodology. However, as the subject matter was also tackled in a diachronic perspective, historical and educational insights were also included.

The understanding of an interpretation or understanding analysis by individuals leads to the constitution of resources for all fundamental knowledge in the form of verbal or non-verbal acts of communication. In other words, hermeneutics can be said to be an art of understanding. This paper made use of the art of understanding to evaluate the works. Synectics, which enabled to bring irrelative elements together, was deployed in this paper as a methodological tool to reveal the creative ideas of students for producing seating area furniture. The deployment of the synectics method was carried out in nine steps. The analysis of outcomes in each step to move on to the next step did not manage to remove conditioned and familiar images and patterns in the students’ thinking system. For this reason, at that point, the students were briskly and unexpectedly asked to draw the pictures of their souls which would reflect the essence of their entity and vitality. While asking this, the leader of the project was not sure whether conditioned ideas of the students could be removed totally, yet they could alter their direction to some extent. The
concept of soul as mentioned in this study referred to the essence of vitality with its definitions in different countries as breath, break, wind, breeze, fragrance and descriptions as a dove flying through flames or even an animation character, i.e. a stallion. It is noteworthy that the students preferred describing the images and patterns of their souls through geometric linear images to comparing with a distinct form of a living entity. The leader of the project interpreted the drawings which they gradually turned into objects of seating area. The application of the synectics method resulted in four or five ideas which could be developed. However, the leader did not consider them to be adequate. Thus, the leader invented a supplementary technique of emergency aiming to reveal the students’ images of souls representing the essence of their entity. This switch in the methodology increased the students’ motivation and enabled the deployment of hermeneutical interpretations for each student’s essence of entity. Interpretations were realized in the class by thinking aloud and discussing together with the students.

The subject matter may need a comprehensive explanation and yet the study made use of the methods of analogy and synectics, which unexpectedly led to the necessity of revealing the images of souls. This unexpected moment may be considered to be a surprise of design education. The main concern or perhaps the purpose of this paper was unpretentious, which was to make the inexperienced students design seating area objects as successfully as possible. Inspired by Byars’ (1997, p. 7) following quote: “Chairs are objects with a soul”, the study was developed for a long period of time through analogy, synectics and images of soul. For this reason, the paper had an unpretentious purpose, so it included and revealed a process-oriented perspective rather than a solution-oriented one.

Acknowledgments: The names of students who designed the furniture examined in this study: Heba Sofie, Muhammet Emin Onay, Gizem Erdoğan, Ebrar Karagül, Esra Battal, Hesna Çelebi, Tuğçe Metin, Rümeysa Demir, Salih Aydin, Züla Yavuz, Nihal Toprak, Rümeysa Aydoğan, Sema Özbaş, Salih Furkan Akgül, Hussam Albaghdadi, Çığdem Berk, Fırđev Arslan, Tuğçe Yerlikaya, Tuğçe Elikara, Elif Yılmaz, Kübra Alan, Rana Güneş, Belemit Dündar, Süleyyra Ahsen Çimen, Kübra Sertoğlu, Miray Dumlulu, Hatice Kansiz, Yületrun Çakmak, Ennur Naşı, Fatma Kocacık, Özürn Mercan, Muge Uzun, Ezgi Öykü Erdem, Emre Tatlına, Semra Erdem.

References

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Project Process Cards: A Self-Evaluation Tool for Design Studio

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Abstract: Industrial design education is about process rather than product. Design education requires students to follow particular paths for learning design practice during their journey to proposing design solutions. A design studio course is characterized by hands on learning, learning by doing, collaboration, trial and error, peer learning and constructive criticism. Generally, evaluation of student performance is associated with the evaluation of the final design solution. However, the process that generated the final design solution is as important and useful as the final design solution. With project process cards (PPC) we aimed to collect students’ self-reflection during the design process. The gap between students’ self-evaluation of their performance and instructors’ expectations from the students creates confusion in both parties. Project process cards are weekly self-reports that are borrowed from user experience research studies. A digital report template with two main sections, activities and reflection, is provided by the teaching staff. During the study we utilized PPC in 3rd and 4th year industrial design studio courses with a total of 101 students and the students prepared 563 cards. We received positive feedback and acceptance on students’ side, as they used the tool for self-reflection. On the instructors’ side, PPC served as a documentation and communication medium to increase the quality of communication between the students and the instructors.

Keywords: self-report; self-assessment; industrial design education; design evaluation

1 Introduction

Industrial design education is about process rather than product. Design education requires students to follow particular paths for learning design practice during their journey to proposing design solutions. Design studio, the place where the problem-based and project-based courses are conducted, is a collaborative environment that mediates students’ journey from creating concepts to product solutions.
Studio education incorporates reflection in action and learning by doing characteristics which are fundamental for the creative fields (Schön, 1987). Students learn through proposing design solutions to ill-defined problems and iterate on their projects through received criticism from their tutors and peers. Thus, the design studio is a variation of problem-based and project-based learning (Brandt et al., 2013).

A design studio course is characterized by hands on learning, learning by doing, collaboration, trial and error, peer learning and constructive criticism. Although learning in a design studio is a constant process with feedback loops, evaluation is usually a single presentation in front of a jury who are disconnected from the process.

Evaluation of students’ performance in design studio courses is a critical part of industrial design education. Generally, evaluation of student performance is associated with the evaluation of the final design solution. However, the process that generated the final design solution is as important and useful as the final design solution. There are attempts in the literature to collect information on the design process and evaluate performance accordingly (Juuti, Rättyä, & Lehtonen, 2016; Smit & Bijleveld, 2018). Our approach in the current study is to collect information on students’ journey in the design process and give them the opportunity to reflect on their journey to create design solutions.

We borrowed probing methodology from user experience research studies to understand and collect subjective experiences of students in a design course (Hutchinson et al., 2003). Probes are simple tools that are designed to collect certain aspects of user experience. Usually they are paper based (Hanington & Martin, 2012) but digital versions of probes are utilized in recent studies (Mattelmäki, 2005) with the increased availability and affordability of electronic devices with image and sound capture ability. In addition to digital probes, our approach consists of collecting students’ experiences, progress, challenges and successes via cloud technologies. We reserved a folder in the cloud and shared the link with students to submit their reports. The availability of the shared folder from any device with internet access minimized the effort on students’ side for submitting their feedback forms. Feedback forms are designed to mediate students’ self-reflection and self-assessment of their work every week.

Collecting the self-reflection and self-evaluation of students in a design course is contrary to the general workflow of design studios as the evaluation and assessment is generally conducted by tutors or jurors. However, documenting the process for future reference materializes the tacit knowledge learned during the process, and sharing it with peers multiplies the effect.

2 Self-Assessment and Record Keeping in Education

Recent studies in the field of design education report positive outcomes for self-assessment and self-reflection. The Triple Jump Model (Smit & Bijleveld, 2018) requires design students to work in weekly iterations, documenting and evaluating outcomes at the end of each cycle. Juuti et al. (2016) have used learning logs as an assessment method in a second-year product design and development course, in which student groups were asked to answer predefined questions and deliver on a weekly basis (Figure 1). Furthermore, Gulwadi (2009) reports the usage of design journals in a sustainable design studio, categorizing the journals based on reflections, proposed by Hatton and Smith (1995). Design journals in which students record their design rationales and sketches were stated to empower them (Odgers, 2001, as cited in Oh, Ishizaki, Gross & Do, 2013). Moreover, reflective journal writing has a better effect on average students compared to good or struggling students (Cisero, 2006).

<table>
<thead>
<tr>
<th>Group level reflection</th>
<th>week 37</th>
<th>week 38</th>
<th>week 39</th>
</tr>
</thead>
<tbody>
<tr>
<td>on design process progress</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>on perceived challenges</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>on applying tools</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>on learnings</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Personal reflections</th>
<th>on design process progress</th>
</tr>
</thead>
<tbody>
<tr>
<td>on New Product Development skills</td>
<td></td>
</tr>
</tbody>
</table>

*Figure 1. A learning log template used in design education (Juuti et al., 2016).*
Record keeping methods and tools for design education is a developing subject. Existing approaches do not have an emphasis on self-evaluation or setting future goals. Current logs are text based, insufficient to capture visual design progress. Apart from that, these methods do not focus on the deliverable format.

The goal of this paper is to introduce a logging and assessment tool specifically designed for industrial design studio education. The paper will continue with discussion on design studio evaluation. Afterwards project process cards (PPC) will be introduced as a self-evaluation tool for the design studio. In the final part we will present and discuss our findings.

3 Discussion on Design Studio Evaluation

Design studio courses are controlled environments in which students are required to create novel design solutions for a shared design brief. Although there are various frameworks for the design process and methods for design, they all benefit from feedback loops throughout the process. Assessment of student performance and evaluation of design solutions are the key activities that benefit from feedback loops. Throughout the process students receive feedback from multiple instructors in several occasions. However, the assessment of design studio courses is generally done through final presentations, in which students present their work for a particular project brief. The design process is usually overlooked in these presentations and the focus is on the qualities of the final product.

Students present their work to a board of design jurors to receive feedback and the assessment of students’ performance is achieved by the collective grading of the jury board. With collective grading the subjective nature of design evaluation is eliminated, and students receive feedback from jurors with different concerns and an average grade. Although, establishing a jury with various backgrounds seems to solve the subjectivity of grading, it detaches the strong link between the design process and the final product.

The evaluation of learning performance and the design qualities of a final product do not necessarily relate to each other. Design studio courses aim to teach design skills that are transferable to future design problems. As instructors of 3rd and 4th year design studio courses, we believe that the design process should get more emphasis. Hence, we studied the evaluation and assessment of the design process with PPC.

During an industrial design project, students receive critiques several times both from the tutors and from their peers. However, project critiques are most valuable when students present their work as in-progress, narrating their thinking, rather than demonstrating their final products. The final presentations, which are generally referred to as juries, have great weight in the evaluation of students’ performance. Juries are generally formed by studio tutors and external critics who are experts on the subject of the project brief. Industrial design juries provide feedback on the final product from a wide perspective as a group of tutors and experts criticize similar concepts in detail. From the beginning till the end, the jury process might cover an extended array of ideas, products, possibilities and improvements on a given subject. But the process that leads the way to that particular design presentation for each student is overlooked and evaluated partially.

Problems associated with design juries and design studio evaluation in general might be grouped under three headings: every project and every solution proposed to it is unique; evaluation of individuals in a group project is difficult; and evaluating critical thinking requires evaluation of process rather than product.

Every student and every project is unique, hence requiring personal instruction at some point. Students and instructors need to have good communication supported by a variety of media. Communicating design solutions, especially in the early stages of the design process is prone to errors and misunderstandings. Instead of reviewing the works of students, it might be a good approach to empower students and give them the necessary tools and options to communicate their solutions proactively.

Industrial design projects generally involve product and/or service development processes. These complex processes require a multidisciplinary approach and groupwork. However, evaluating individuals especially in creative tasks is very difficult. Asking each individual about their progress and expecting their own evaluation of the collective effort give clues on the group dynamics and individual performances.

Industrial design process is about critical thinking. Students are expected to devise unique solutions to a problem. Industrial design studio should boost critical thinking by all means, evaluation is no exception. Evaluation and assessment should be continuous and in line with the development of the concept into the final product. Students
should learn the iterative nature of the design process to compare their performance to their earlier experiences and evaluate their temporal progress. With self-assessment and evaluation students can reflect on and criticize their performance and improve their design skills.

Evaluating each and every student for their design process creates huge workload for instructors. Instructors prefer to warn students for common mistakes and traps during the design journey, but each student has a different path. Keeping track of each students’ progress and providing feedback on their projects is a considerable workload for lecturers (Smit & Bijleveld, 2018). Leaving the documentation and standardizing the documentation format lays out effective opportunities for the tutors as they create a database of student critiques on the formulation and progress of the industrial design studio course. This database can be utilized further to analyze and improve the course subject.

4 Project Process Cards (PPC): A Self Evaluation Tool for Design Studio

Providing feedback for students’ design solutions is a critical part of design studio instruction. Experienced instructors guide each student to propose creative, novel, successful design solutions based on their problem definition. Feedback in a studio course is generally one way, from instructor(s) to student. Also, students provide feedback to each other and facilitate peer learning, which is an essential component of the studio. Although students collect a plethora of external criticism and feedback for their projects. We, as studio instructors for more than 15 years of experience, believe that criticism for the self and self-assessment or self-evaluation are critical for industrial design instruction. As there is no course book for a specific project, students do not document the studio process and their progress. Hence, students often feel the need for a structured documentation of their progress for future reference.

With project process cards (PPC) we aimed to collect students’ self-reflection during the design process. The gap between students’ self-evaluation of their performance and instructors’ expectations from the students creates confusion in both parties. Creating design solutions with an effective design process has many details that require tacit knowledge and can only be acquired by learning by doing. The process and the resulting design solutions are two major points that need to be assessed for each student in a design course.

Project process cards are weekly self-reports. A digital report template is provided by the teaching staff. Students were encouraged to extend this template as they need. There were two main sections in the report; activities and reflection. The activities section is the main space for reporting weekly activities. Students were asked to include photos of their sketches, mock-ups, mind maps, mood boards, user research preparations, research findings, prototyping process and other design related activities (Figure 2). They were encouraged to report their extracurricular activities (such as exhibition, fair and museum visits) related to their projects as well. Students were expected to explain their activities briefly in short sentences to quickly create a simple and clear structure.

At the end of the report template there was an area allocated for self-reflection. Students were asked to answer three specific questions: 1) What were the strengths of the week? Students were asked to tell their most successful achievements. 2) What were the weaknesses of the week? Students were expected to criticize themselves and express their thoughts on what they could have done better. 3) What is the plan for the upcoming stage of the project? By answering this question, students were encouraged to plan their activities for the following week.

PPC’s were created digitally in Adobe Illustrator and delivered in PDF format based on the provided template. The software was selected due to the following reasons: 1) The software allowed quick editing and annotation while providing enough creative space for students to modify the content (unlike word processors). 2) It exported as editable PDF files for future editing and reduced file size. 3) The software was taught within a must course in previous semesters.

In group projects, each member of a group filled a PPC individually, reporting his/her own work. Each week a group member in charge of the delivery reviewed and compiled all PPC’s of the group and delivered it as a single document. Weekly deadline for the report delivery was deliberately set to a day without studio class activities to provide enough time to document and reflect on their studies.
5 Methodology

During the study we utilized the project process cards in 3rd and 4th year industrial design studio courses with a total of 101 students, and the students prepared 563 cards. In each semester PPC were assigned as a compulsory part of studio course grading. Students were required to submit their PPC weekly to a shared online folder. The folder was intentionally shared by all the students in the course to facilitate peer learning. They were able to view each other’s PPC and have the opportunity to compare their progress with their peers.

In total, PPC was applied in four industrial design courses in two consecutive years (Table 1). Although PPC cards are expected weekly, the number of PPC per student could not reach the number of course weeks (10) in three courses. Only in 2018 spring semester at third year industrial design course, students submitted PPC as expected.

<table>
<thead>
<tr>
<th>Course</th>
<th>Semester/Year</th>
<th>Number of students</th>
<th>Number of cards</th>
<th>Number of cards per student</th>
</tr>
</thead>
<tbody>
<tr>
<td>EUT 322</td>
<td>Fall / 2017</td>
<td>31</td>
<td>173 (66 Group)</td>
<td>5.58</td>
</tr>
<tr>
<td>EUT 321</td>
<td>Spring /2018</td>
<td>20</td>
<td>200</td>
<td>10.00</td>
</tr>
<tr>
<td>EUT 421</td>
<td>Summer/2018</td>
<td>33</td>
<td>89</td>
<td>2.69</td>
</tr>
<tr>
<td>EUT 322</td>
<td>Fall /2018</td>
<td>20</td>
<td>101 (38 Group)</td>
<td>4.80</td>
</tr>
</tbody>
</table>

Table 1. The distribution of items into subtitle categories.

Students are not graded based on the content or quality of PPC, they only needed to submit PPC on time to get credit. Students were free to assess their own progress by self-motivation. They used PPC as a note-to-self tool and as a to-do list for the coming weeks of the project. With PPC the oral nature of design critiques turned into written form and aided students to have a focused and planned design process.

The main use of the PPC for instructors is to document each student’s progress from their perspective and to stay on the same page in terms of the design process. As the cards are stored in the cloud folder, it was convenient to access
documents from any device. Students were asked to name their files in a standard format, where they put their name and semester week number in the file name (name_surname_week), to index the large number of files in the shared folder. With this sorting technique, it was easy to find a particular file for a student.

Analysis of PPC utilization in industrial design courses is an ongoing research at the moment. It was planned to apply content analysis to understand the pitfalls, plans and possibilities during the design process. Content will be evaluated based on the ratio of positive and negative comments. All written comments in the PPC will be categorized as positive, negative or neutral. After this process, the ratio of the positive, negative and neutral comments will be compared on a weekly basis among the students (Tullis & Albert, 2008). Furthermore, comparing the characteristics of the process with the qualities of the final product might shed light on the possible improvements in industrial design studio instruction.

6 Findings and Discussion

Although a thorough content analysis of the cards is still in progress, preliminary reflections and findings of the research are presented in the following sections.

6.1 Reflection on the Utilization of PPC

PPC is designed to aid critique sessions by increasing communication between the student and the instructor. During a design project each student dives into the minute details of their design solution and expects instructors to remember their progress. However, instructors might not have the same detailed understanding of individual students and their project. With the help of PPC, instructors and students share the same understanding of the project process. Having a quick look at the cards of a student before a critique session gave all the necessary details for the student’s progress and made the comments tailored to the needs of the student.

Due to the nature of the studio course, there are time periods of consecutive weeks during which students do not receive explicit instructions on what to do. During these times students were expected to manage their studies and time on their own. However, in conventional studio education, students often fail to make use of such time periods efficiently, leaving important project tasks to the last minute. PPC alleviated this problem by making students think about their next step at the end of each week. It made them more aware of their goals, time constraints and progress, all of which are important to succeed in complex learning situations (Seufert, 2018).

PPC was submitted through a shared cloud folder from where students could see each other’s weekly work. It can be speculated that being aware of each other’s progress has increased the overall motivation of the class and provided an additional platform for peer learning. However, the overall effect of PPC on peer-to-peer learning was not measured and it is a subject for further research.

Project process cards can be improved to be more accessible, allowing tutors to easily annotate on them. Although the current digital format has its benefits, it does not allow quick editing. Furthermore, while PPC provides a useful tool for final review and grading, it becomes hard for the tutors to keep track of them on a weekly basis. All in all, a more suitable format can be found to increase its effectiveness. Also, some students altered the provided template and utilized different techniques like color coding to communicate more clearly.

Students’ acceptance of the PPC was observed to be high. As there is limited amount of time for each student to explain their project during jury assessment, students considered PPC reports as another medium to showcase their work to jury members. In their presentations students focus on the final outcome, and often overlook the design process. They believe that through PPC they can showcase the process as well, leading to a complete understanding of their process and the final product.

In the reflection part of the PPC, we asked for the strengths to encourage students to realize and express what they have been doing right. This question lays the foundation of self-reflection and acts as a warm-up before further self-criticism. In the next part, weaknesses, we expected an honest opinion from the student on what did not work. In the initial implementations of the PPC, students chose to write down their plans for the next steps, rather than actually self-criticizing. Therefore, the third question, asking about their next steps, was added and the expected info for the weaknesses part was communicated to the class more explicitly.
6.2 Benefits of PPC’s to Design Studio Education

PPC was particularly beneficial in assessing group projects. They were referenced in order to distinguish the workload distributed amongst team members in group projects. Delivering each student’s PPC within a single group document meant that students were aware of each other’s activities and they were in consensus about the distribution of the workload. Although the same report format was used for both group and individual work, it was observed that some groups clustered their reflections together in one page, similar to the format presented in Juuti’s (2016) study.

During four semesters, PPC was utilized to solve two critical incidents. Both issues were related to grading and groupwork, for which students did not receive sufficient grades to pass the course at the end of the semester. However, after elaborating on their PPC and requiring evidence on the activities that they did not include in their PPC, tutors were satisfied that the students indeed fulfilled the requirements of the course and settled on a passing grade.

PPC also provided a documentation of project activities for archiving purposes. Students mentioned pros and cons of the project, their performance and the tools utilized during the process. PPC served as a feedback form to report insufficiencies in their design skills and identified opportunities for improvement.

Commonly mentioned strengths include: doing detailed research, learning new design software package, effective note taking, effective working, generating sufficient number of ideas, good team work, fairness in groupwork, and good use of software. In some cases, students used the strengths section as a summary of activities instead of positive reflection. Some of the apparent weaknesses include: detailed work, lack of knowledge, lack of resources, bad time management, difficulty in focusing, inability to follow the plan, working inefficiently, lack of presentation skills, low number of alternatives, and miscommunication amongst team members. Some student quotations from PPC are below.

S1: I did not have a mock-up for this week’s critique. I could not use the benefit of mock-up at this critical time.

S2: We have to revise the project calendar again and again. We need to solve our problems in communication and help each other.

As mentioned in the paper, the effect of PPC on peer learning is a topic for further study. Along with that, students’ opinions and experiences can be measured to improve the tool and have a better grasp on its effectiveness.

Our intention was to develop a self-evaluation mechanism that enables students to learn through their own activities. Triggering students to reflect on their work and plan ahead also allows instructors to focus on the design critiques other than dealing with students’ weak points that are obvious to the student as well. This approach is particularly suitable for classes with a shortage of teaching staff.

To sum up, we applied self-reporting probes, used in user experience research studies to industrial design education for four semesters in two years, to better understand students’ journeys in proposing design solutions to a shared brief. Our aim is to link the final product to the design process and understand the effects of the process on the final product. We received positive feedback and acceptance from the students, as they used the tool for self-reflection. As for the instructors, PPC served as a documentation and communication medium to increase the quality of communication between the students and the instructors.

References


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Using a Self-Reporting Tool to Capture Design Student’s Experience

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Abstract: Considering the continuous design activities that are performed throughout design projects, design students go through several stages of decision making. Sometimes they experience problematic situations in between consecutive supervisory meetings. In order to provide better guidance, it is important for supervisors to understand students' process in between these meetings. There are available tools used in fields like education and healthcare in order to monitor an individual's daily life in relation to the context (e.g. time, place, activity) and personal circumstances (e.g. emotions, feelings, ideas). These tools are developed based on experience sampling method (ESM), a research method focused on collecting self-reported data from participants in order to measure their daily life experiences, especially during a long period of time. Aiming at assisting design students to do regular self-reporting on their experiences, this study presents background research for designing experience sampling tools that would be used by students and supervisors to keep track of students' experiences throughout design projects. In this sense, this study intends to assist students with self-reporting activities, translate the main design requirements of experience sampling tools into the context of design projects, as well as revealing guidelines for the future implications of ESM tools in design education.

Keywords: student experience; experience sampling; design education

1 Background

In design schools, students are trained to discover their skills and values and translate them into their own design visions as future designers. Whilst working on their projects, students perform design activities and discuss their work with their project supervisors or course tutors in regular meetings. During these meetings, supervisors evaluate students' progress and provide feedback on the work presented to them. Students then continue working and respond to the provided feedback.

Sometimes, students may encounter problems (e.g. not knowing what or how to do next) while working on their projects. Students may also find it difficult to recall and explain their step-by-step actions retrospectively since there may be a time gap between the activities followed in between supervisory meetings. Therefore, it is important for
students that their supervisors can identify the cause of a certain problem or a chain of problems leading to a ‘stuck in a moment’ situation.

In design projects, students’ experience of the process and personal evaluations of what they think, or feel about their activities, could be a useful source of information for their supervisors in terms of understanding what is happening in detail, between supervisory meetings. Similarly, providing a platform for design students to regularly report their experiences on their design projects, could help them to express how they feel at certain stages of the project, helping to reveal problematic and positive situations. Gathering these experiences would help supervisors to monitor students’ progress, make interventions if necessary, and provide feedback on what goes wrong or good with the project.

There are tools available which are used in fields such as education and healthcare to monitor an individual’s daily life in relation to the context (e.g. time, place, activity) and personal circumstances (e.g. emotions, feelings, ideas). These tools are developed based on experience sampling method (ESM), a research method focused on collecting self-reported data from participants in order to measure their daily life experiences and observe them during a long period of time. With ESM, participants are able to make evaluations about their experiences at the time they occur; this way, memory biases while re-calling a past activity or a situation is avoided. In this sense, monitoring the student experience in between two supervisory meetings based on student’s self-reporting could be investigated by using an ESM tool throughout the design projects which is specifically developed for the context of a design project.

Based on the explanations above, this study aimed to reveal insights on assisting design students to report their experiences during design projects by using an ESM tool. In this sense, this study focused on creating guidelines for designing an ESM tool which facilitates reporting and monitoring the student experience based on student’s self-reporting.

2 Structure of Study

Firstly, existing studies from the literature related to design education were reviewed with an eye to understanding how a design student’s experience could be defined, and what dimensions this experience consisted of. Additionally, ESM studies in literature were reviewed to understand the affordances and constraints of an ESM tool. Then, explorative studies were conducted to identify the initial insights on how to construct the content, type of questions, and measuring instruments of the tool which was used for the main study.

It was determined that applying the experience sampling method and using an ESM tool for students to report their experiences regularly, would provide in-depth data and enable evaluation of the features of a tool to be used by students during design projects. Therefore, in the main study, an ESM tool was designed and evaluated with 19 students who were taking one of the MSc studio projects in Delft University of Technology (DUT). It was used for 2 weeks and evaluated by follow-up interviews with students. Based on these results, design guidelines were drawn up to give a direction for the educators and researchers who are interested in enhancing the design studio experience.

3 Literature Review

3.1 Dimensions of Design Student’s Experience

One important characteristic of design education is that design is learnt by doing rather than reading or listening to somebody, who is explaining what designing is (Lawson, 2004; Dorst et al., 2004). Cross (2001) describes designing as an unusual problem-solving process and he proposes three main areas within the process of designing: formulating the problem, generating solutions for the problem, and finding strategies for the process. Dorst (1997) explains core design activity as a decision making on the kinds of actions that need to be taken and the content of action. These actions require cognitive abilities, where students think, analyse, synthesise and create ideas.

On the other hand, the design process also involves meta-cognitive abilities, such as reflecting, thinking about the process and decision-making about the strategies (Christiaans, 2011). Schön’s theory of reflective practice describes the need for explicit reflection during the design process that involves continuous actions. This reflection guides the designer to proceed with the next step and eventually the final product is the result of these decisions (Valkenburg, Dorst 1998). Dorst (1997) explains that design students need to learn how to approach design tasks in a subjective way, which focuses on learning to think about design as well as learning design.
The emotional experiences of students have also been investigated in the literature. In educational psychology, the affective experiences are part of measuring student's learning experiences and usually evaluated in relation to motivation and cognition. In his studies, Pekrun (1992, 2002, 2006) clearly points out the academic emotions and explains their interrelation with a student's academic motivations (e.g. achievement, self-regulation, communication). Similarly, studies address the relationship between motivation, cognition and affect in order to measure students' experiences in an educational context (Linnenbrink, 2006).

### 3.2 ESM Tools

ESM aims to monitor the fluctuations of people’s everyday experiences; the link between external and internal coordinates of experiences, hence the relationship between the inner thoughts, ideas and feelings between the physical space, such as the time, location or certain activities (Csiksemihalyi et al., 2007). The main strategies for developing ESM tools involve optimizing the quality of sampling by minimizing the interruption (to avoid frustration while responding the questions in daily life) and by keeping participant’s motivation high (to create the engagement and increase compliance in long-term studies) (Intille, 2003; Scollon, 2009; Vastenburg, 2010). One of the main constraints of self-reporting tools is that a user’s motivation for reporting over the long-term can be a challenge. Long-term motivation is strongly related to the feedback system. People's motivation can be increased by providing regular feedback (Hsieh 2008). Besides use as a tool, in recent years, the quantification of self-movement has led to the use of self-tracking products in daily life (e.g. wearables). Research on self-tracking products also shows that collecting data and giving feedback are considered as two main aspects when designing these products. Privacy should also be considered (Li et al 2011). While self-tracking motivation is personal; the self-reflection can be more collaborative and social. This creates engagement and compliance in long-term (Choe et al. 2014).

### 3.3 Discussion on Literature Review

During the literature review about design education and learning experience, the dimensions of a student's experience were analysed to understand what kind of data an ESM tool needs to collect from a design student. Accordingly, the first dimension is design activities, which indicates cognitive thinking (e.g. analytical, reflective, creative thinking) during a design process. Secondly, student's affective experiences are involved in how he/she experience the design activities. These are emotions, mood or feelings, which helps a student to express the consequences of their activities. Lastly, students have motives, which indicate specific goals or expectations in design projects such as being creative, problem solving, or communication skills. These are usually educational goals, expectations or attitudes about design activities during design projects.

By reviewing existing tools, the main considerations for an ESM tool are defined as engagement, compliance and privacy. Engagement is related to motivation for self-reporting by minimizing the interruption. Compliance refers to long-term motivation. This is usually enhanced by giving meaningful feedback to the user. Privacy is also important for the people since ESM tools are designed to monitor behaviour and people are aware of it while using these tools. In order to explore how dimensions of a design student’s experience (design activity, affective experience, motive) would be captured by an ESM tool and how to apply the main considerations (engagement, compliance, privacy) in the context of design courses, explorative studies were conducted. The results were used to design an ESM tool for the evaluation study.

### 4 Explorative Studies

Explorative studies aimed to answer the following research questions:

1. What should the content of the tool consist of, considering the design activity, affective experiences and motives?
2. What should be the frequency of reporting in relation to students’ work schedule and design activities?
3. What do students consider the benefits of self-reporting during design projects?
4. What are the privacy concerns of students in terms of sharing their experiences with fellow students and supervisors?
5. How might visual instruments help students to indicate positivity and negativity of their experiences?

The exploration stage involved 3 interconnected explorative studies. 15 MSc students from DUT participated in total. These students were from 3 different MSc program of Industrial Design Engineering Faculty: Integrated Product Design (IPD), Strategic Product Design (SPD) and Design for Interaction (DFI). Participants were selected among the students who take design studio and have regular supervisory meetings.
4.1 Study 1

Study 1 aimed to make an initial observation of the relationship between design activities, feelings and motives while a design student is reporting his / her experience. Therefore, individual interview sessions were conducted with students. They were asked to illustrate their design activities and feelings in between 2 supervisory meetings by drawing a journey map with the author (Figure 1).

![Figure 1. Study 1: Journey Mapping for a design student’s experience](image)

4.2 Results of Study 1

4.2.1 Reporting Design Activities, Moods, Reasons

All students clearly explained the connection between their design activities and their moods, and gave explanations about their moods. The explanations showed that the mood that is stated during one activity (e.g. evaluation of meeting) may be influenced by a previous or future activity (e.g. supervisory meeting/workload for next week). Also, mood transitions were not always related to design activities. Close deadlines, workload, giving a break were some examples reported by participants (Figure 2).

![Figure 2. Stages of design activities that are defined by students for the time period between two supervisory meetings](image)
4.3 Study 2
Study 2 aimed to observe design students’ self-reporting for a specific period of time, focusing on design activities, feelings and reasons. Students’ motivations for self-reporting were also observed. A different group of four MSc students was selected for Study 2. A diary was prepared as an online document and shared with the participants. They filled in the documents and sent it back every day for 4 days (Figure 3). At the end of the study, students were interviewed to evaluate their self-reporting experience.

4.4 Results of Study 2
4.4.1 Reporting on Feelings
The statements from online diaries showed that students have many activities during the day, their feelings are constantly changing based on these activities and the changes may not have a direct impact on the overall experience related to the project (Figure 4). Although the participants mentioned diverse feelings in their diaries, they reported on one or two main mood change to summarise their overall experience.
4.4.2 Design Activities and Motives
In general, three main motives that have a major impact on a design students’ experience were identified: “knowing what to do next”, “getting work done in a smooth way”, and “being in contact”. Students also expressed these motives with their own keywords in the diary. Some example statements from the participants are:

e.g., “I want to feel capable tomorrow.”; “I want to feel guided tomorrow.”; “I want to feel satisfied tomorrow.”

4.4.3 Engagement and Privacy
During the interview sessions, the participants mentioned their privacy concerns about sharing their feelings with their supervisors. Some example statements are as follows.

e.g., “This kind of diary would be very straightforward. I could express my emotions by using icons/levels etc.”; “Sharing emotions could be too much, they can change, and they might be irrelevant after a couple of days.”

The participants also stated that they see the benefit of reporting their experiences as a facilitator for their self-reflection during the design projects.

4.5 Study 3
Study 3 was conducted to evaluate the visual instruments to capture the experience. In Study 3, six MSc for Integrated Product Design program students of DUT participated in the study. All participants were selected from the students who were working on the same project in the project course ‘ID4175 Advanced Embodiment Design’. This made it possible to compare students’ self-reporting on similar conditions. Students were asked to carry a booklet diary for 8 days, and they were asked to fill in the diary according to their work schedule.

The diary was used in order to allow students to report their experiences whenever they want during the day. During Study 1 and Study 2, the students described their emotions, mood and feelings by using their own words. In order to enable reporting of the positives and negatives of the affective experiences, two different pre-defined visual scaling instruments were used in the diaries. The first visual instrument was a 10-point Likert scale. Likert Scale is widely used in surveys, or ESM tools, to learn individual’s opinions about a specific phenomenon. In the booklet, Likert scale was used to allow students to rate their satisfaction level (1 being unsatisfied – 10 being satisfied) with their design project, in relation to their design activities. The second one was a cartoon based pictorial instrument for reporting and expressing moods, which was initially developed as part of “PMRI: Development of Pictorial Mood Reporting Instrument” study (Vastenburg et al. 2011). Mood statements included bored, calm, cheerful, excited, irritated, neutral, relaxed, sad, and tense; and they were accompanied by visual representations. Mood statements were identified based on Russel’s model of circumplex affect, involving two main axes: arousal and pleasantness (Figure 5).

![Figure 5. The example page from a booklet diary](image-url)
4.6 Results of Study 3

4.6.1 Visual Instruments
Using measurement tools facilitated monitoring the fluctuations in the students’ experiences. Visual representation of mood characters triggered students to explain more specific characteristics of their experiences; providing answers to what, when, where, who questions.

The reports delivered by the students on the same day showed that they may sometimes have a problem at the beginning of the day, but they may solve it at the end of the day. Therefore, they would be satisfied with the overall performance of the project. In this sense, scale ratings helped students to indicate their ‘overall’ feelings about the project progress.

4.6.2 Moods and Motives
The majority of the negative mood statements indicated being in a rush, stressful because of close deadlines. “Being satisfied” was associated with different aspects such as good results, having a good plan and having a smooth process while performing design activities.

4.6.3 Time of Reporting
The characteristics of the reports also showed differences according to the time of responses. Students evaluated their experiences based on the time that they responded. For example, the reports provided at the end of the day indicated the activities expected to happen in coming days, such as deadlines, user tests, or prototyping. When they responded in the middle of the day, the activities that they perform at that moment were mentioned more.

5 Experience Sampling Tool Evaluation Study
Based on the results explained in explorative studies, an ESM tool was designed. This tool was evaluated during one presentation of an MSc Design Course in DUT. The intent of the experience sampling study, which was named as “Take a Snapshot!”, was to observe the participants’ self-reporting patterns based on the number, frequency and content of responses for a long period of time. In order to gather additional data about self-reporting motivation and privacy concerns, the interview sessions were conducted after the study.

5.1 Procedure of the Study
Participants invited to the experience sampling study were following the Joint Master Project (JMP) project. JMP is a third-semester course in Faculty of Industrial Design Engineering, DUT. Students, who attend JMP course, vary in relation to the three master programs they follow: namely, Strategic Product Design (SPD), Integrated Product Design (IPD) and Design for Interaction (DFI). At the beginning of the JMP course, students from IPD, SPD, and DFI form a group and work on a project in collaboration with companies. Each group of students has their dedicated design studio, where they can work together or individually.

19 students used the self-reporting tool and they received prompting e-mails twice a day. 19 students were members of 6 different project teams in total. To create an easily accessible tool that allows students to do self-reporting at the time they receive notifications, it was decided to use an internet-based tool. The students had access via their computers or mobile devices. The e-mail reminders were sent to the students twice a day during the weekdays (one at the beginning and one at the end of the day: 09:00/17:00). At the weekend, the students received a single reminder, only at the beginning of the day. An online survey tool (www.surveygizmo.com) was used for preparing the questions and the links to launch the questions embedded in reminders. The questions were prepared in the form of an individual survey. Overall, three main media were involved in data collection (see Figure 6): the database, where the students’ responses are collected; the surveys that students fill in; and the e-mail reminders that students receive every day.
5.2 ESM Tool

For the ESM tool, three main categories were used to capture a design student’s experience. i) Content of work: addresses students’ activities in relation their problem-solving process; how students evaluate their work in terms of the quality, creativity, ideas, and workload (e.g. research, analysis, brainstorming, idea generation, modeling, report writing etc.). ii) Planning & Strategies, addresses students’ decision-making process during their activities in order to coordinate better and progress with their work. (e.g. planning, meetings, discussions, scheduling etc.). iii) Communication / Interactions: addresses how the team dynamics, communication with supervisors and other parties work within design projects. Six questions were asked in total for these three categories. The questions were as follows:

1. What is your mood about content of work in your JMP project?
2. What is the reason of your mood?
3. What is your mood about planning/strategies in your JMP project?
4. What is the reason of your mood?
5. What is your mood about communication/interactions in your JMP project?
6. What is the reason of your mood?

For mood reporting, the same pictorial mood reporting instrument in Study 3 was used. To encourage the students for detailed explanations about their mood, the “neutral” state was not included (Figure 7).
5.3 Results of Evaluation Study

5.3.1 Characteristics of Reports
The participants’ answers for “What is the reason of your mood?” were reviewed one by one. These answers were highlighted based on types of information they contain. This highlighted information was then reduced in six main characteristics which were named as activity, outcome, collaboration, progress, workload and time management. These characteristics represented the reasons that influenced the moods of the students during the design process and explained as follows.

- **Activity** indicated process of design activities such as brainstorming, prototyping, to do list, sketching, user testing, as well as planning and group work.
- **Outcome** indicated the results of their design activities such as good ideas, prototypes, models, drawings, as well as coach/company feedback and accomplishment. Outcomes directly influenced students’ mood changes during the projects.
- **Collaboration** indicated the group dynamics such as task division and students’ experience of working as a group (e.g. having fun).
- **Progress** indicated students’ perception of making progress such as completing tasks, getting a good feedback from their supervisor.
- **Workload** indicated when students think that they have too much work to complete. Workload influenced the students’ overall experience negatively.
- **Time management** indicated students’ perception of time pressure. Feeling of time pressure influenced the students’ mood change from positive to negative.

Students reported on different aspects of the same design activities within three main categories in ESM Tool (content of work, planning /strategies, communication/interactions). For example, in content of work, coach meeting was evaluated based on the quality of feedback. However, when the same activity appeared in planning/strategies, the explanation was related to the schedule problems. In communication and interactions category, brainstorming sessions were mentioned by emphasizing the fun they had during the sessions although they were also mentioned in content of work category. Students also reported the moments when they were mentally distant to the project. They used the statements such as “not working on the project today.”

5.3.2 Number of Reports
During the two weeks of study, 19 participants received 437 e-mail reminders in total. Overall, 232 of 437 reminders were responded by participants. The number of responses was higher during the weekdays compared to weekends (Figure 8). Each participant got 22 notifications over 14 days. On average students responded with reports 15 times. The minimum number of responses was 12. The majority of students did not respond to the notifications during the weekends. The mean number of responses per day remained 1.3 for 2 reminders. During the weekend, it stood at 0.4 for 1 reminder per day. The number of responses showed greater intensity during the week; students preferred reporting during the days when they were working on the project. Most of the students mentioned that reporting twice a day was too much as they were busy during the day and were feeling interrupted.
5.3.3 Time of Reporting
Throughout the day, the number of responses in general dispersed evenly. Although students received notifications in the beginning (09:00-09:30) and at the end of the day (17:00-17:30) students’ response times during the day did not match the notification times.

5.3.4 Mood Reporting
Although students were obliged to select at least one mood from mood reporting tool, they also used combinations of different moods. In individual explanations of students, it is observed that when students used more than one mood, the reports involved more than one keywords or two different conditions related to the same activity or outcome. Some examples of using mixed mood states are illustrated below.

e.g., Content of work/calm-bored: “The quality of work is good, yet not innovative enough.” Content of work/calm/tense: “Contact with client went well. Still a bit stressed since we do not have much time left to finish the project.”

5.3.5 Engagement and Privacy
Overall, students mentioned the benefit of self-reporting whilst carrying out design projects. Some example remarks from the students are as follows.

e.g., “Good thing about filling in is that every day I was realizing if I was enjoying the project or not. It changed a lot, it was funny for me to see it, if you don’t think about it you don’t realize or forget.”

“I don’t know if I want to know what others write! It is very nice to do it individually, then you have time to think and reflect on it…”

“Reflection for yourself, trying to improve yourself, and a tool that helps you to do that, it is better... It triggers you to be sincerer, you see the image, and you link it to your feelings, and then you write ‘why’.”

5.4 Conclusions and Guidelines

5.4.1 Assisting A Design Student’s Self-Reporting Activity
Design students’ experience is driven by design activities which are interconnected to each other and performed continuously throughout design projects. Therefore, as illustrated in Figure 9, the pre-set categories function as a starting point to report about student experiences based on cognitive aspects.

The content of the tool should also guide students to report their affective experiences in an unambiguous way. Pictorial mood reporting tool supports self-reporting activity and facilitates students’ reflection on their experiences. As the self-reflection is facilitated, students’ engagement with ESM tool is enhanced accordingly. However, mood reporting and self-reflection activities should remain personal in ESM tool in order to consider the privacy issues. In this sense, privacy for mood reporting and self-reflection enables the engagement.

5.4.2 Monitoring A Design Student’s Experience
Monitoring the moods instantly might mislead supervisors as the moods might change during the day. Mood reporting does not provide extensive feedback about the student experience, at the time when they report; because there are many (past and future) factors that influence students’ evaluation of his/her own experience at the time when they do self-reporting. Therefore an overall mood chart may be more helpful to collect. Also, selecting pre-defined
characteristics may help students indicate different aspects of their experience at the time they do self-reporting (Figure 10 and 11).

![Figure 10. Reporting and monitoring the students' experience](image1)

![Figure 11. Monitoring activity of supervisor](image2)

Accordingly, the characteristics as mentioned in the results of evaluation study (outcome, activity, collaboration, progress, time management, workload) would be defined by supervisors and used in the ESM tool to give a tag for each self-reporting activity. Suggested pre-defined characteristics are illustrated in Figure 12. Based on how many times each characteristic is used in self-reports in each of the three categories (content, strategies, communication), supervisors would have an idea what goes good or wrong with the project. This way, in long-term it would be possible to keep track of experiences according to the specific dates or time periods or number of reports that student provides.

Notifications can also assist different types of self-reports at different times of the day and week. Daily reports provide an overview when they are provided at the end of the day, which are useful to address outcomes or an overall feeling of the student. The same understanding can be applied in the weekly reports, students can be asked to evaluate the week with an extra weekly reminder. There are also moments that students do not have a specific feeling about their work or the moments that they don't want to share their experience. By allowing students freedom for not choosing a specific characteristic, their willingness for reporting can be investigated.
5.4.3 Structure of ESM Tool

According to the presented guidelines related to reporting and monitoring, the structure of an ESM tool can be defined in three steps:

- A medium that provides notifications for students to indicate their reporting activity. This can be in the form of e-mail reminders or any other notification according to the technology that is used.
- A medium that records students’ reports and represents them continuously.
- A medium that allows a supervisor to adjust the notifications or the content of reporting according to the purpose of monitoring.

To conclude, beyond the content and guidelines for reporting and monitoring student experiences reported above, further implications can be explored for specific design project courses.

5.5 Further Research

This study focused on the self-reporting experience of design students during design projects. Applying the guidelines provided above might lead to new research questions. One aspect could be to investigate using new media and technologies to increase the quality of self-reporting. Another point could be to investigate the social aspects of self-reflection: the format of the feedback mechanism could be studied and whether this feedback mechanism has an effect on group dynamics or not. The findings of this study also may lead researchers to focus on the following questions:
• How to design the setup and introduce the tool to students?
• How to customize the content with the given characteristics from the main study?
• How to use the tool to facilitate the supervisor meetings effectively?

All the insights presented in this study aim to give direction for developing new design concepts that facilitate reporting and monitoring student experiences in the context of design education.

References


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**Visualisation Method Toolkit: A Shared Vocabulary to Face Complexity**

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**Abstract:** With companies, universities, individuals or entire departments, promoting open dialogue, constant interdisciplinary collaboration is a challenge that still meets some resistance. Learning to deal with complexity, with the coexistence of different points of view, learning to work in more heterogeneous teams, in relation to know-how combined in new, sometimes original and challenging formulations, brings particular needs. From the importance of language and a shared vocabulary to the ever-increasing need to work on tools and not just applications, from the constant promotion of collaboration and contamination between different backgrounds and disciplines to the guarantee of a continuous training process through laboratory activities and workshop, this contribution - through the Visualisation Method Toolkit project and its experimentation - investigates the potential of data visualization as a medium to bring design closer to a company's core business as well as support students, institutions and other organizations in communication, both in the analysis and/or scenario phase and in support of dissemination actions towards a more informed quantitative/qualitative collective decision making with the aim of enabling new innovative and sustainable good practices.

**Keywords:** data visualisation; workshop; toolkit, communication; sustainability

**1 Introduction**

Delineate and define the meaning of the term big data, means first of all to incorporate a new *forma mentis*. Today, the multifaceted nature of information leads to a real paradigm change: the classic vertical social structures leave room for reticular conformations as well as the birth of ever new relationships with the resulting acceleration of the elaboration and transmission of information (Castells, 2009).

What we are experiencing is a period of “interregnum”, one of those moments in which the ancient ways of acting no longer work, the lifestyles learned/inherited from the past are no longer adequate to the current *conditio humana*,
but still new ways to meet the challenge have not been invented, constructed and implemented (Bauman, 2011). What we are experiencing is a “liquid modernity”, in which the only true constant is the continuous change, and the only true certainty is the uncertainty, the not definitive. However, modern enterprise, as well as the academic world, are still conservative and multidimensional organisational forms, represented by a plurality of actors with often opposed interests and individual positions to defend. In what can be defined as a “solid mentality”, the philosophical focus lies in the determination to control in detail the definition of the future. A closed innovation, which takes a competitive advantage around the issues of control, the hierarchical perspective and competition, declining all those strategies influenced by activities related to the enhancement of human capital, collaboration and sharing. A closed innovation in which the elements remain point-like in a general system if not connected in a broader project that knows how to dialogue with the actions of individuals and the community.

Today, it is widely accepted that innovation is one of the main drivers for companies in order to guarantee sustainable and profitable development over time (Giannopoulou, Yström, Ollila, Fredberg & Elmquist, 2010). On the one hand, the acceleration of the transmission of information carries with it the risk of a non-communication determined by the complexity of the phenomena themselves. On the other hand, if until recently, among the main factors that greatly influenced the processes of innovation there was, for example, the tendency of organisations to deal exclusively with internal results, today this process becomes more and more democratic, enabling new producers of innovation and involving new interlocutors including end users. An increasingly global process, a complex system of relationships between companies, research centres, universities that act locally with a glocal perspective and dimension.

2 The Visualisation Method Toolkit

For design or entrepreneurship, for web or marketing, for creativity or for structuring the right discourse, the use of tangible and analogue cards and tools, especially in recent times, is increasingly gaining ground by becoming an integral part of participatory decision-making processes. Whether they are developed by the individual or by large companies, these tools become a valid aid to trigger and support discussions within heterogeneous teams with a view to continuous design research. However, what happens to language when it meets a medium that supports it and inevitably transforms the relationship with the language itself? (McLuhan, 1963).

State of the art, however, does not adequately respond to the academic and business needs dictated by today's information revolution, revolution that brings with it an exponential growth of raw data coming from the most different sources and with an ever-increasing speed. Data that require adequate processing to become information, and therefore knowledge and wisdom (Masud et al., 2010).

Visual representation has always been a transversal cognitive tool based on the natural ability of the human being to perceive the structures of phenomena by organising them formally. So, it is exactly the effectiveness of this technique that ensures more effective memorisation and storage of information (Meirelles, 2013). The use of maps, diagrams, graphs and tables is not new; this type of representation accompanies the course of human evolution by addressing historical changes in different socio-cultural contexts, spaces and the organisation of knowledge on the basis of models increasingly suited to the way we feed on information. C. J. Minard, W. Darton, J. Snow, F. Nightingale, D.I. Mendeleev, H. Beck, and W. Playfair are just some of the names among the milestones in the history of visualisation. These figures, sometimes scientists, philosophers, sociologists or engineers, show transversality of this medium, starting from various fields. From managers to employees, from professors to students, passing through the individual citizen, everyone is the protagonist of today's evident and silent revolution that is completely changing the relationship with knowledge.

How can we make our ecosystem more communicative and collaborative by aligning all the protagonists towards a common goal? Born in 2018 from a collaboration between the Innovation Design Lab of the Politecnico di Torino and the Digital Society School of the Amsterdam University of Applied Sciences, the Visualization Method Toolkit (Figure 1) is the third of a series that deals with issues that affect the world of design as well as entrepreneurship. For these reasons and with the aim of helping to face the challenges and the contemporary organisational, social and cultural transformations, the project integrates and accommodates the disciplines of data visualisation and graphic design. The aim is also to provide a basic grammar to deal with the understanding and communication of complex and heterogeneous phenomena, contributing to the construction of a shared understanding of the structure and correlations of the investigated system, the factors that influence it, the triggering causes, the futuristic areas of intervention. The Visualization Method Toolkit is born to become a valid aid to enable sharing and understanding during participated sessions, allowing everyone to bring their own experience and their point of view in the planning creating a real collaborative knowledge, supporting a more informed process decision.
The Project

Research, selection, organisation, simplification of information, standardisation and graphic/functional restitution: these are the main phases of the design process that led to the development of the real kit. A kit that consists of a series of cards that recall the typical gestures of playing cards, enclosed in a sleeve designed ad hoc by laser cutting techniques. To maintain the aesthetic/material continuity of the series, the sleeve of this toolkit is made of felt, but in this case, the choice fell on a particular felt obtained by recycling PET bottles.

The Cards

A collection of 55 cards. A collection of 55 visual models categorised through different interpretations. A selection of 55 different ways to analyse, explore and communicate quanti/qualitative information. Specifically, it is possible to divide each card into two main operational functions: select and execute.

The first function, select, corresponds with the front of each card and provides all the tricks useful to discriminate the choice of a visual model rather than another, starting from the dataset in possession; specifically, the information is:

- Name and iconographic representation of the visual model;
- Goals of the visualisation, which in this case for all representations corresponds to communicate;
- Reference category or statistic distribution including Bubble Chart, Chernoff Face and Density plot, relation like Arc Diagram and Parallel Set, comparison such as Streamgraph, Bar Chart and Glyph Chart, mapping as Honeycomb Map and Bubble Map. Treemap, Sunburst Map and Circle Packing instead refer to the category hierarchies, time represented by examples such as the Condegram Spiral Plot and Timeline, process including Flow Chart and Funnel Diagram, to conclude with text analysis as in case of the Word Cloud;
- Estimated time for the realisation of the visualisation, both analogical and in a digital version.

The back side of the card, corresponding with the execute function, aims to accompany the user step by step in the pragmatic realisation of the visualisation, through:

- A brief description of the visual model;
- Task as a systematic description of all the steps useful for the realisation of the visualisation, from the creation of the Cartesian axes to the right positioning of the elements, from the choice of colours as a means of conveying further variables, to the creation of a clear and explanatory legend;
- Notes on: when it is more appropriate to use the visual model, why use it, the elements to pay particular attention to and therefore the most critical steps, the type of output and possible future developments are finally the recommendations to be taken into account during the development of the visual project.

Using single representations methods such as this can be used to code most different types of datasets. However, beyond single representations, the method can open almost endless dissemination and communication possibilities thanks to the original and creative hybridisation between two or more different views, enabling and perfecting what Tufte defines as graphic excellence as the ability to convey complex ideas in a clear, precise and efficient way (Tufte & Graves-Morris, 1983).
3 The Workshop: A Continuous Training Process

Workshops, Summer School, Hackathon and Design Challenge, Training, are just a few names and metamorphoses that in recent years and throughout the world, are representing the broader concept of laboratory as a moment of extemporaneous experiential learning. “If I listen I forget, if I see I remember, if I do I learn”, with these words Confucius identifies in the planning and in the practical realization, the attainment of a higher level of knowledge and learning; mere theoretical awareness finds consolidation in experimentation in the field that becomes the true essence of a concrete and empirical knowledge. The pedagogical, creative, educational and social relevance of the workshop lies in its intrinsic complexity, dynamism and polysemic nature. The presence, as a tutor, of professionals and designers, the active participation, the sharing of ideas and the collective experimentation of new solutions in a short period, are all elements that make the workshops an innovative tool, an educational experience integrating training of employees, managers, students or researchers.

Experiential learning, as defined by John Dewey and Jean Piaget and subsequently deepened thanks to the contribution of the theorist of education David A. Kolb, is a process in which knowledge is created through the transformation of experience. This transformation takes place from concrete experiences, in which learning takes place through the perceptual act and then through the personal interpretation of practical experimentations, or through the understanding of meanings through observation and listening. In a context of experiential learning, students can be asked to visit and organise manual work sessions, experiments in the laboratory, reflect on their experiences, communicate them and share them. By this perspective, learning and teaching are above all a social process, an integral part of daily life, as well as facilitators for the transfer of behaviours, learned in future life and work. Holistic learning, in which the participant learns using all of their learning channels: cognitive, emotional, physical; the more the three are involved in a consistent way, the more the level of experientialness is raised. By integrating this concept with the definition of system, understood as a complex reality whose elements interact with each other, a circular model on the basis of which each element conditions the other and is in turn conditioned, it derives a meaning where each single element it is not to be sought in the element itself but in the system of relations in which it is inserted (Bistagnino, 2009). In this logic, the training system is enriched with new perspectives aimed at creating a logic of interaction, comparison, and constant sharing. The first step to enable conscious design participation with a sustainability perspective is to identify the relationships between the components of the workshop system, ensuring non-hierarchical horizontal communication, flexibility, focus on innovation and personal expression. The enhancement of the quality of relationships is favoured by a horizontal approach with the aim of favouring positive relationships for each participant, integrating where possible expansion of the network of the actors involved with the purpose of strengthening interaction and exchange between the training and social system.

The Visualisation Method Toolkit Workshop

The training, conceived as a continuous cycle between acting, evaluating, conceptualising and applying, as an opportunity to expand the present conversation in an inclusive and collaborative way, becomes not only an innovative and technologically sustainable opportunity, but, above all, a social and cultural one. It is precisely the extemporaneous experience that allows the enhancement of the essential function of the toolkit, which goes from being a deck of cards that can also be consulted individually, to a real tool for the project. An experience that in the specific case underlies a specific approach: the Systemic Design. An approach that investigates the behaviour of a complex system not through the simple sum of its constituent components but through the dependence and the strength of the relationships and interactions between them.

The first experimentations of the toolkit took place within the Innovation Design Laboratory and the second level Master in Design for Arts in the Department of Architecture and Design of the Politecnico di Torino. The Innovation Design laboratory is a multidisciplinary training course within the Master Degree in Systemic Design “Aurelio Peccei”, which educates students to an innovative and sustainable design starting from a careful analysis of the territory and the reference context. A data-driven design, where the collection, analysis and then the visualisation of data becomes a fundamental part of the design process, as well as an aid to the development of the concept and the project itself. Design for Arts is a structured training / professional program that addresses, through a multidisciplinary approach, the strategic/functional and innovative aspects of creativity in the disciplines of design culture and visual art.

Forty-two students in the first case, eleven in the second, took part in these experiments. Experimentation that has seen the definition of a specific format for the development of the workshop, a structure that sees the consequentiality of the following steps:
1. **Contextualisation**. A fully-fledged introductory overview from the historical and applicative/functional point of view of the data visualisation discipline. A compelling presentation in all those contexts unrelated to the world of data processing, graphics and design.

2. **Introduction to the Visualization Method Toolkit**. An illustration of the project in general, but above all a detailed account of its layout and use.

3. **Reading and analysis of the starting context**. Whether it is a particular dataset, a journalistic article of current affairs, scientific research, an extract of a novel or a statistical report, the starting points may be the most original and different. At a pragmatic level, this phase requires a thorough reading of the starting material with the aim of identifying the possible areas and topics of discussion as well as the possible paths to be undertaken starting from the information present.

4. **Finding the reading key**. Closely related to the previous phase, this moment requires the selection of the identified themes and therefore the actual definition of the starting point around which the visual project will be constructed.

5. **Identification of the message**. Once the key has been identified, to capture the reader’s attention it is necessary to identify a message as well as the main narrative and therefore the point of view that will be conveyed by the visualisation (Lupi & Aesch, 2012). This particularly delicate phase will inevitably condition future spatial and chromatic/formal choices as choices that will necessarily have to contribute to the clear transmission of the message.

6. **Data search**. Open data, market research, still newspaper articles or monitoring and observations in the first person. This phase of documentation considers the search for further data useful for the story, of the message previously identified, from the most varied and different sources. To all effects a process of contextualization. A context that becomes an integral and significant part of the main information to be conveyed.

7. **Organization, filtering and creation of the dataset**. This is not a simple list of data. It is precisely at this stage that the assumptions of Systemic Design see an application, both theoretical and practical. All the participants are motivated to see the phenomenon investigated as a complex system of data. A system that sees data as components appropriately selected, organised and filtered on a purely quantitative level as a fundamental input. Input that will find an answer and a value in the visual representation of the system itself and therefore of a qualitative output.

8. **Identification and selection of the visual model**. The choice of the most appropriate form and type of graphic representation to transmit one or more quantities becomes fundamental to bridge the "black hole between data and knowledge" (Wurman, 1989). At this point, the participants begin the actual physical exploration of the toolkit. Organising by category, grouping by the number of variables, comparing by similarity, comparing by diversity, deepening with examples or directly verifying the tasks necessary for implementation are just some of the possible strategies and actions that determine or not the choice of a visual model. The choice must necessarily fall on a form that can visually support the information to be communicated. It is not excluded that there may be more valid forms to fulfil this communicative function, not even the possibility of hybridising two or more visual models. (Figure 2).

9. **Playing with data**. Entered into the heart of the workshop, all the participants begin to organise and code their data set according to the selected visual model, as well as experiment and explore the elements involved, such as the composition of the main architecture, number of elements in play, proportions, positions, etc. (Figure 3).
10. **Playing with shapes, colours and sizes.** Participants are asked to free their creative and original inspiration by looking for the right shapes and the most coherent colours to highlight the internal relationships between the elements. Also, yet to create multiple levels of reading, from general to detail, determining the most appropriate hierarchy in content; continue experimenting by adding all the tangential elements useful for contextualisation as well as supporting numbers and therefore the label, reaching the almost final creation of the actual visualisation. (Figure 4).

11. **Simplify, simplify, SIMPLIFY.** "Ornament is a crime" (Miller, Ward, 2002). At this point, all that remains is to stylize, refine and "clean" the visual model from any purely aesthetic and decorative vein, not useful for communicating the message. The goal is not so much to create an aesthetically beautiful visualisation, but rather a visual model functional to the conveyance of the message (Cairo, 2012). Finally, all that remains is to create a clear legend, to guide the reader in understanding information and finding the right title for storytelling.

Although all the phases of the workshop are consequential, they see the possibility of activating continuous iterative processes, in the re-identification of the reading key, in the re-definition of the message, in the search for new data, and above all in the research and experimentation of the right visual model.

**Results**

In order to evaluate the effectiveness and validity of the tool and the practical experience in its entirety, the 53 participants were asked to fill out an anonymous questionnaire, whose answers allowed to outline the strengths and weaknesses of the project.
Almost all the participants (99%) expressed a positive opinion about the clarity of the contents contained in the cards, qualifying the Visualization Method Toolkit as intuitive and straightforward. The motivations supporting this figure are the most varied: from graphic immediacy to the degree of detail of the procedures to be performed, to the practicality of use and consultation. The negative opinion recorded prefers the use of a manual or more traditional ways to consult the graphic forms proposed.

When asked what could be the possible measures to improve the actual tool, the ideas were varied and interesting. For example, it has been suggested the insertion of practical and illustrative examples and case studies, whether analogue or digital; to predict a specific order a priori; the development of a digital version of the toolkit that offers the possibility on the one hand to consult the instrument on various portable devices and on the other that allows to download the visual models in vector format. Finally, among the future steps, the suggestion to widen the anthology of the visualisations, as well as to implement the project from the linguistic point of view through the multilingual translation of the same, to conclude with the insertion of an ad hoc appendix as an aid to consultation. The same percentages emerged to the question: do you think that the Visualization Method Toolkit is a useful tool for the design process? In particular, the prevailing opinion verifies the potential of the instrument in question as valid support for the communication of data and information, as well as analysis during the whole design process. 46% of the participants responding to the test identified the research phase and scenario like the one that could benefit most, followed by the final communication and presentation of the project to 40%, the concept to 10% and the remaining 4% to the phase of data collection.

The last moment of the survey saw the participants’ suggestion, on the possible contexts and sectors of use that could most benefit from this tool: economy, marketing, design, sociology, statistics, journalism, publishing, education to name a few.

**4 Conclusions**

Starting from the design and then from the development, as well as from the subsequent experiential experimentalations of the Visualization Method Toolkit, this contribution investigates the importance of creating new tools, practices and processes to facilitate and enable a more agile, collaborative and shared participation.

Deepening the so-called "learning outcome", it is interesting to highlight how contamination processes, multidisciplinary approaches and co-planning can be qualified through the creation of a shared vocabulary, to all effects of a basic grammar made of shapes, colours, symbols, positions and dimensions, for the codification and representation of information.

Representation useful for the recognition of the most diverse variables that influence a problem, an event or a phenomenon, yet the possibility to investigate these variables in a holistic way enabling on the one hand new strategies of intervention, on the other the sharing of decisions and choices among all the actors involved in the design process, creating a sense of community and participation aimed at a real "interconnected knowledge" (Celaschi, 2016).

In fact, we are in a phase of total change and transformation. An intrinsically complex, articulated and dynamic reality. A reality characterised by always new perspectives in which the contribution of design renews itself every day, but also and above all the relationship with the world of entrepreneurship, education, communication, becoming synonymous with innovation of processes, services and products, in a specific territory or context of interest. (Yee & All, 2017). Precisely in this scenario, the Visualization Method toolkit is an aid to enable a growing awareness of contemporary complexity, awareness in which design as a cultural catalyst imagines scenarios aimed at greater responsibility, transparency and sustainable innovation.

**References**


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When Rabbits Lead to Ideas: Inspiring Design by Retelling Stories through Metaphors

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Abstract: This paper proposes a method that utilizes expressive narratives to inspire design, especially in the conceptualization process leading to design ideas. In this method, expressive narratives need to be deconstructed by designers through the identification of metaphors. These metaphors are then examined to discover the concepts they embody. While interpreting the metaphors the designers try to find alternative representations referring to the same concepts by creating generative metaphors, which open up new ways of looking at the situation by defining new connections. Eventually, the proposed method assists designers particularly in the development of coherent scenarios, abstraction and re-contextualization of objects, and generation of new meanings in their conceptualization process.

Keywords: design methods; metaphors; idea generation; narrative; retelling

1 Introduction

One of the widely acknowledged definitions of design is that it is about problem solving. This is based on Herbert Simon’s work where he claims that science is primarily concerned with how things are, while design is concerned with how they ought to be. Building on this, Schön (1983) characterizes design as “knowing in action”, describing the design process as an intuitive bringing of experience to problems, which nevertheless are themselves treated as unique (Willis, 2007). As cited by Fischer (2014), further descriptions of design as “argumentative conspiracy” (Rittel, 1984), “dialectical” (Goldschmidt, 1991), “discursive” (Goel, 1995), “dialogue” (Schön, 1983), “conversation” (Jones, 1992, Glanville, 1999; Pask, 1976), and “hermeneutic circle” (Snodgrass & Coyne, 1997) signify that design has something to do with language and a dynamic form of sense making through narration.

Among these definitions, Snodgrass and Coyne (1992) propose that for a better understanding of design, the problem-solving metaphor needs to be replaced with the hermeneutic circle metaphor because “this involves a close examination of the part interpretation plays in the design process; how preconceptions function in the processes of selection and evaluation; how preconceptions lead to pre-figurations of the design product; and how tacit experience and skills enter into the situation.” This approach is based on Gadamer’s (1975) conceptualization of the hermeneutic circle as an iterative process through which a new understanding of a whole can be developed by means of exploring the detail of existence and that “understanding occurs in interpreting”. According to Gadamer (1975), understanding mediates linguistically through conversations with others in which reality is explored and an agreement is reached representing a new understanding.

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The centrality of conversation to the hermeneutic circle is developed by Donald Schön (1983), who also characterizes design as a hermeneutic circle that is developed by means of a conversation with the situation. In the design process, the designer projects the meaning of the whole and works out the implications of this projection by referring it back to the parts. Thus, the design is continually re-determined by an anticipatory movement of the pre-understanding. The designer has an anticipation of the whole, which guides her understanding of the particularities (Snodgrass & Coyne, 1997). Schön (1983) speaks of design as “reflection-in-action”, which is “a reflective conversation with the situation”. Similar to the pre-understanding in hermeneutical terms, the designer begins the design task by shaping the situation in accordance with an initial appreciation. The situation then “talks back” and the designer responds to the situation’s back talk by reflecting-in-action on the construction of the problem (Schön, 1983). The process then develops in a circle (Willis, 2007), as in the hermeneutic circle (Snodgrass & Coyne, 1997).

Jahnke (2012) builds upon the hermeneutic circle metaphor (Gadamer, 1976), and revises it towards a deeper understanding of design by introducing Ricoeur’s (2008) term of the “hermeneutic spiral”. With a critique on Gadamer’s hermeneutic circle, Ricoeur’s hermeneutic spiral consists of “a centering movement of reflection and a decentering movement of communication with others via manifested and poetically rich interpretations (Jahnke, 2012)”. Ricoeur (2008) suggests that at the end of these hermeneutic interpretive processes new meanings can be created, and according to Jahnke (2012), this is the key to where hermeneutics and design intersect.

A brief overview on the various definitions of design reveals that the gist they all have in common is that design is about proposing something new. This process of proposing something new can be inspired by various sources such as objects, images (Cai et al., 2010), narratives (Goldschmidt, 1998), previous designs (Eckert & Stacey, 2000) and other phenomena. Among these, literature and narratives can be mentioned as one of the important but less investigated sources of inspiration to design. Previous research on this subject shows that narratives and other kinds of texts trigger a productive process of imagination, and the interpretative process enables an active involvement of the designer (Goldschmidt, 1998; Bolak Hisarligil, 2012).

In this paper, I investigate design as a hermeneutic-interpretive process by sharing a method in the intersection of narrative and design. To gain insight on this issue, I examine the narrative as a source of inspiration for design relying on the approaches that design is a “hermeneutic spiral” (Jahnke, 2012) and a “reflective conversation with the situation” (Schön, 1983). My focus in this particular context is industrial design students’ work with narratives to generate early design concepts. I propose that conceptualization in the early design process can be improved through embedding expressive narratives if the designer literally “retells a story”. The designer in this sense can take the role of a “narrator-designer” who takes a story (an experience, a feeling, a fiction, a description, etc.) as told by the actors, and “retells” this story from a designerly (Cross, 2001) perspective. This particular “retelling” requires skills and abilities for proposing changes to the world or adding to social constructions of realities (Berger & Luckmann, 1966). Thus, the retelling of the actual story consists of designer’s own pre-conceptions related to the components of the story, her interpretation of the story, and the final product that comes out of the design process. Such an approach can provide designers with an awareness of the connection between their pre-conceptions and interpretations in relation with other possible subjectivities, which improve their imaginative reasoning processes and skills of contextualization of early design ideas.

2 Making Sense of Stories and Metaphors: Exploring the Concept of "Retelling" in Design

Narrative is coterminous with story: a story is a symbolized account of actions of human beings that has a temporal dimension. The story has a beginning, a middle, and an ending. It is held together by recognizable patterns of events called plots. Central to the plot structure are human predicaments and attempted resolutions (Sarbin, 1986). This is how narratives provide a platform where people make sense of their thoughts and actions (Mead, 1967; MacIntyre, 1981). According to Sarbin (1986, p. 9), the narrative is an organizing principle for human action,

"The narrative is a way of organizing episodes, actions, and accounts of actions; (...) The narrative allows for the inclusion of the actors' reasons for their acts, as well as the causes of happening".

Among different types of narratives, expressive narrative forms are quite stimulating but also challenging for students. According to Reiss (1976), an expressive narrative is a "creative composition", where the author uses the aesthetic dimension of language. Poems and plays, for example, are good examples for expressive texts since they are highly expressing the author’s attitude in a form-focused way (Munday, 2001). One of the significant qualities of expressive
narratives is that they embody multi-layered meanings and interpretations through the use and generation of metaphors. As described by Lakoff and Johnson (1980, p. 5), the metaphor is “understanding and experiencing one kind of thing in terms of another” by carrying the original realm of meaning into new realms of usage. Although the concept of metaphor originates from language and literature, metaphors are central to the task of accounting for our perspectives on the world: how we think about things, make sense of reality, and set the problems we later try to solve.

From the perspective of design, and product semantics in particular (Krippendorff & Butter, 1984; Krippendorff, 2006), metaphors are considered as signs to make sense of products. As cited by Cila et al. (2014), metaphors are commonly used as a means to stimulate designers’ creativity in the design process because they help facilitate unconventional thinking by building relationships between distinct domains (Snodgrass and Coyne 1992), identify design problems and frame the problematic design situation by seeing it from a novel standpoint and adopting a working principle associated with that position (Schön, 1979). In this sense, metaphor refers both to a certain kind of product - a perspective or frame, a way of looking at things - and to a certain kind of process - a process by which new perspectives on the world come into existence. These kinds of metaphors are defined as generative metaphors (Schön, 1979). In the process of constructing generative metaphors, we bring to a situation different and conflicting ways of seeing. We can tell a story of our experience of the situation and can do this before we have constructed a new, coordinated description of the situation. Considered as a strategy for representing the situation, our story permits us to convey much of the richness of the situation without being constrained by either of the category-schemes with which we begin. Subsequently, we may construct new models of the situation from the stories they have told (Schön, 1979).

The concept of retelling in design broached in this paper emerges from the intersection of the process where designers generate metaphors by taking certain attributes from one entity and transferring them to a product they are designing (Cila, 2014) and the practice of "constructing new models of the situation from the stories" (Schön, 1979). For developing an understanding of design through retelling, Krippendorff’s (2006) social theory of the meaning of artifacts in language is helpful: this theory deals with how artifacts come to live in the narratives that their stakeholders tell each other and enact, in effect making the artifacts available for or prevented from use. In this context, generative metaphors enable us to notice how artifacts live in our narratives through being told and retold by various subjectivities constructing alternative realities (Berger & Luckmann, 1966).

I facilitated a series of workshops on and off for about four years in the department of product design trying to figure out how generating metaphors and retelling stories through design can be utilized in the design process. Senior undergraduate design students voluntarily participated at these workshops from time to time. We read chapters from the novel Alice’s Adventures under Ground (Carroll, 1886) and interpreted them by discovering and deconstructing metaphors.

As most expressive narratives are, Carroll’s (1886) novel is rich in multi-layered meanings and metaphors. When I asked the students to retell the story through design, the deconstruction of these metaphors eventually led to the construction of generative metaphors. Through these workshops I aimed to gain some insight on my hypothesis regarding the need for and usefulness of the step I eventually described as retelling through design in order to inspire the design process through the generation of metaphors.

Each workshop consisted of two sessions: in the first session, the participants retold Lewis Carroll’s story by defining and interpreting metaphorical contents, such as, "a white rabbit is confrontation", "a sneezing baby is confusion", "a caterpillar on the mushroom is conscience", "a door is acceptance of socio-cultural status", "a hookah is wisdom", "a mushroom is control", "a telescope is the changing point of view while growing up", and "a fading candle light is fear of growing and disappearing" (Figure 1).
In the second session, they retold their own story by constructing a generative metaphor, i.e. “confrontation is a looking glass”, “confusion is a bicycle under water”, “conscience is a pair of shackles”, “time is a never-ending ice cream”, “entrapment is a stairway”, “being stuck is a lack of sky”, and “life is a lawless carnival” (Figure 2).

3 Discussion: Retelling through Generative Metaphors for Design

The most significant part of these workshops was the construction of generative metaphors for and through design: the students tried to make sense of the metaphors in the narratives, and to design relevant objects or concepts in their stories at the same time. Utilizing the concept of retelling in this intersection thus stimulated a deeper literary understanding of the narrative and the generation of a novel design concept. As in Jahnke’s (2012) approach to design as hermeneutical spiral, and in Ricoeur’s (2008) words, new meanings emerged at the end of this spiral, from “a centering movement of reflection and a decentering movement of communication with others via manifested and poetically rich interpretations”. An additional contribution of retelling narratives for design and through design was the manifestation of generative metaphors and how they supported both processes of interpretation and design.
Through the relation of narrative and design, the spiral along "deconstructing metaphors-retelling-constructing generative metaphors" contributes to design students’ imagination processes in aspects such as developing a coherent scenario and related concepts, re-contextualizing objects, and constructing generative metaphors.

My suggestion is that this method can be applied in four main steps:

- A thorough and reflective reading of the narrative.
- Looking for metaphors and metaphorical contents.
- Deconstructing metaphors and further elaborating on possible concepts or meanings they refer to. One efficient and productive way of analyzing metaphorical contents is drawing mind maps through which the connections between interpretations become visible and traceable.
- Retelling a related story by starting with the concepts from the previous step and creating a new context, actors, environment and objects. This is the step where generative metaphors are constructed and abstractions from the previous step start to become new scenarios and alternative materialities. Techniques that are useful at this step can simply be writing down stories, drawing storyboards or making short animated movies, building mock-ups and even preparing theatrical performances. Among all of these techniques, writing down the story is essential because it is where the generative metaphors emerge, although the other techniques can also make meaningful contribution depending on the context.
- Improving design concepts towards final products.

4 Conclusion

Designers may benefit from attending the generative metaphors that underlies the different and conflicting stories about any kind of design situation. One is apt to be puzzled, disturbed, and stimulated to reflection by the telling of several different stories about the same situation, when each story is internally coherent and compelling in its own terms but different from, and perhaps incompatible with, all the others. Such a multiplicity of conflicting stories about the situation makes it dramatically apparent that we are dealing not with reality but with various ways of making sense of a reality (Schön, 1979). This point of view refers to the idea of multiple realities, as in William James’ analysis on our sense of reality (Schutz, 1962). As Schutz (1962) explains in detail, the origin of all reality, according to James, is subjective, that means, whatever excites and stimulates our interest is real standing in relation with our emotional and active life,

"But there are several, probably an infinite number of various orders of realities, each with its own special and separate style of existence. James calls them “sub-universes” and mentions as examples the world of sense or physical things, (…). The popular mind conceives of all these sub-worlds more or less disconnectedly, and when dealing with one of them forgets for the time being its relations to the rest. But every object we think of is at last referred to one of these sub worlds (p. 207)."

Based on the approach that realities are socially constructed through human interaction - habitualization - (Berger & Luckmann, 1966) and symbolic interactions, which embed the interpretation of language as one of the symbols in daily interactions (Mead, 1967), the creation of meaning with every interpretation and interaction is a unique process. The context of multiple realities affirms that meaning is not a quality inherent in certain experiences emerging with our stream of consciousness but the result of an interpretation - or a retelling as described in this paper - of a past experience looked at from the present Now with a reflective attitude (Schutz, 1962). This reflective attitude is accomplished through the hermeneutical spiral model in design. Turning our attention to the stories themselves is a way of exploring how the language and construction of narratives organize and give meaning to an experience (Bruner, 1986; White, 1980; Turner, 1974). To create meaning, design requires introspection; starts with pre-conceptions and subjective experience; and, leads to further generations of meaning. Relying on the definition that design is about proposing something new, the hermeneutical spiral model of design supports the continuous creation of meanings and thus related subjective realities.

In this paper, I investigated how narratives inspire design. My scope was the concept generation phase in the early design process, and my focus was a particular type of narrative form, i.e. expressive narratives. Expressive narratives are rich in metaphors and metonyms providing the reader with a wider perspective while making sense of them. Moreover, undergraduate design students enjoy working with them by discovering multi-layered meanings, deconstructing metaphors, and becoming aware of subjective realities. The problem I defined here was that students were experiencing difficulties when transferring their interpretations from the expressive narrative context to design context and needed a particular auxiliary step, which seemed to be missing at present. As a result, the concept of
retelling emerged along with a hermeneutical spiral of design through retelling. Once the expressive narrative is retold for a re-contextualization in design, the construction of generative metaphors starts, which eventually leads to developing coherent scenarios and related concepts, as well as abstracting and re-contextualizing objects. In this sense, the construction of generative metaphors is both a part and an outcome of the process.

The retelling step is actually where conceptualization of design ideas starts because it is where the narrative and design merge. With the help of this step, the required shift from narrative context to design context is accomplished and the initial conceptualization of design ideas is finalized. This particular method is especially useful when students deal with expressive narratives because it heavily relies on the interpretation of metaphors. However, the study can be extended to explore other types of narratives, such as descriptive texts, diary studies or user narratives so that similar missing steps can be detected and particular ways of embedding these narratives to design process can be developed.

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### About the Author

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Cast Away: A New Way to Read Value of Objects in the Context of a Movie

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Abstract: This paper is the exploration of an assignment given in an industrial design undergraduate course called “Culture and Communication in Design”. The course aims to give an insight about how objects are analysed and evaluated by tools provided by semiotics, products semantics and critiques of commodity culture. In this assignment, the movie “Cast Away” was used in order to make an analysis about the meanings and meaning shifts of artefacts that are placed in different contexts. The assumption is that “reading” movies with a concentration on the artefacts placed in the scenes gives students a different perspective to see, understand and discuss some terms about the changing cultural significance and value systems of design. Cast Away, as an original interpretation of the story of Robinson Crusoe, enriched by the objects carried together with the main actor to an unknown island, provides a very rich ground to see and interpret the cultural changes and dynamics between objects, individuals and society. The significance of the exercise, or such exercises in design education, lies in the motivation of training students not only as mere practitioners and creators of commodities, but also as intellectuals who can reflect on their own profession through a critical lens.

Keywords: movie analysis; design education; use value; exchange value; sign value; symbolic exchange value

1 Introduction

The paper tries to introduce a new perspective used in a theoretical class in the curriculum of an industrial design department. The name of the course is called “Culture and Communication in Design” where the analytical approaches of semiotics, product semantics and critical theories based on consumer and material culture are introduced. In the assignment to be presented in the paper, the topics explored mainly belong to the theories of consumer culture, especially the value systems coined by Marx and Baudrillard, analysed by using the scenes of the movie, Cast Away, as an educational material.

2 About the Movie

The movie Cast Away is described as a story of a FedEx executive called Chuck whose plane crashes to a deserted island, where he is the only survivor and “he washes up on a tiny island with nothing but some flotsam and jetsam from the aircraft’s cargo” (“Plot Summary: Cast Away”, 2018). This work is licensed under a Creative Commons Attribution-NonCommercial-Share Alike 4.0 International License. https://creativecommons.org/licenses/by-nc-sa/4.0/
A short summary of the movie is given like this:

Cast Away tells the story of Chuck Noland (Tom Hanks), a Federal Express engineer who devotes most of his life to his troubleshooting job. His girlfriend Kelly (Helen Hunt) is often neglected by his dedication to work, and his compulsive personality suggests a conflicted man. But on Christmas Eve, Chuck proposes marriage to Kelly right before embarking on a large assignment. On the assignment, a plane crash strands Chuck on a remote island, and his fast-paced life is slowed to a crawl, as he is miles removed from any human contact. Finding solace only in a volley ball that he befriends, Chuck must now learn to endure the emotional and physical stress of his new life, unsure of when he may return to the civilization he knew before (“Cast Away,” 2018).

The movie was analysed and compared by some critiques as an interesting interpretation and re-reading of the classical novel of Daniel Defoe; Robinson Crusoe. One of the critiques is that the story of Robinson and Chuck is found similar in terms of class struggle. We can also trace the idea of “sin” in both narratives, as both Robinson and Chuck were sent to a deserted island because of their mistakes. (Hanks Is No Crusoe, 2000) However, most of the critiques about the movie miss or ignore a very important and distinctive aspect; the artifacts—other than the volleyball—carried together with him to the island and his relationship with them and various other objects during the movie.

In the same article (Hanks Is No Crusoe, 2000) there is only one and a very shallow interpretation about the volleyball again, among the others-, that is: “Significantly, Chuck’s only companion on the island is a volleyball, whom he names ‘Wilson’. It’s his little pet and he talks to it every day. Maybe the moral of Cast Away is that all that men can really trust are ballgames – everything else, work and women, leads to disappointment.”

However, is can obviously be stated that Cast Away’s main distinction from the story of the Robinson Crusoe and the point it wants to stress is the protagonist’s relation to the artifacts placed in the movie. At first glance, we can easily say that this modern interpretation of the story is highlighted with the existence of these artifacts in order to emphasize the time and culture changes between two stories, where we can characterize modern life mainly as surrounded by commodities. However, the juxtaposition of the various objects transferred from modern world into the deserted island is where the whole tension of the movie and the distinction from the main source of the narrative; Robinson Crusoe.

That is also where the original idea of interpreting the movie as an educational material for a class about design critique comes from, because the interaction between people and objects in the whole course of the movie becomes a fruitful ground for analysis of the values and their shifts in the modern consumer culture or civilization. Another motivation to use this movie as a tool for analysis is the above-mentioned lack of existing critiques about it in the literature.

3 Theoretical Background

Marx is the key writer who explores the idea of commodity value as he distinguishes between the use value and the exchange value of the commodity. Use value is connected to “the physical properties of the commodity” (1990, p.126); that is, where the material uses of the object and the concept of “need” is dominant. As the second value which is exchange value, distinguished from use value, “the exchange relation of commodities is characterized precisely by their abstraction from their use values” (1990, p. 127). This moment of abstraction is the birthplace of the concept of money; however, the main critique Marx makes is here, money is the agent that hides the real equivalent which is labour, behind the exchange value.

After decades, added to this theoretical classification, Baudrillard comes about two new terms characterizing modern consumer culture which are the sign value and symbolic exchange value.

Baudrillard (1993) claims commodities are motivated to be bought and displayed for their sign value rather than their use value. That is how new term of sign value has become an essential constituent of the commodity and consumption in the consumer society. “For Baudrillard, the entire society is organized around consumption and display of commodities through which individuals gain prestige, identity, and standing. In this system, the more prestigious one’s commodities (houses, cars, clothes, and so on), the higher one’s standing in the realm of sign value. Thus, just as words take on meaning according to their position in a differential system of language, so sign values take on meaning according to their place in a differential system of prestige and status.” (“Jean Baudrillard”, 2007)

As it comes to symbolic exchange it directs us to a totally different dynamics among other types of value systems:
Building on the French cultural theory of Georges Bataille, Marcel Mauss, and Alfred Jarry; Baudrillard champions *symbolic exchange* which resists capitalist values of utility and monetary profit for cultural values. These cases of *symbolic exchange*, Baudrillard believes, break with the values of production and describe poetic exchange and creative cultural activity that provides alternatives to the capitalist values of production and exchange. ("Jean Baudrillard", 2007)

From the perspective of these value systems, as Marx and Baudrillard put it, a very extensive potential to analyse and scrutinize the people’s interaction with the objects, they want to have, buy, exchange and fetishize. All kinds of interaction with the objects might create unique cases of value assigning as can be traced in some illustrative scenes in the movie.

Interestingly enough the starting point of this analysis was previously made by Marx himself in his early works about Robinson Crusoe; in Capital and in his book called Grundrisse; where he connects his theories with the life of Robinson. In Capital; he mentions Robinson “as an example of the pre-capitalist man creating goods because they are useful and producing only as much as is useful to him and not seeking a profit. (…) Marx also refers to Crusoe in Grundrisse (1973); there he sees in Robinson Crusoe not *a reaction against over sophistication and a return to a misunderstood nature life* but rather *the anticipation of civil society.*”(Grapard, 1995)

Coming to Cast Away; even the artifacts in the movie don’t seem as the core elements in the scenario; they can be interpreted as the supporting characters who take role; especially in the long and extended scenes where Chuck is totally alone as a human trying to survive in the island. We can see this character attributes in the volleyball called Wilson in a very strong way as lots of critiques are centred on him; however, the interactions or confrontations with other artifacts or commodities in their packages as it were, worth to illustrate various value systems.

The character of Wilson is sometimes beyond analysis in the value systems of Marx and Baudrillard, because this *characterization* is taken into an extreme from an object/commodity into a human friend. Connected to that it will not be too much to say there is an analogy between Wilson and Friday; as one of the key figures in the novel Robinson Crusoe. That can be the reason why it was so challenging in the analysis asked from the students of the class. However, it is also an inspirational example in such a study to be held with other objects and circumstances.

**4 The Study**

The study is based on the exploration of an assignment used in an undergraduate course called “Culture and Communication in Design”. The course is a theoretical class which aims to give an analytical background based on the frameworks of semiotics, product semantics and other communication theories. Consumer culture and value systems are one of the important modules that are studied towards the midst of the semester. After studying and discussing the key terms about the issue and the systems given by Marx and Baudrillard, students are asked to watch the movie Cast Away at home, and write a report about it; with a concentration on the above-mentioned value systems. They are told not to make a classical film critique or a mere summary of the scenes, which is a common mistake repeated in different semesters. After they watch and write a report about it, they were invited to fuel a discussion in the classroom where they brainstorm on their reflections on the axis of the movie and the value systems mentioned.

The significance of the exercise, or such exercises in the design education, lies in the motivation of training students not only as mere practitioners of design as creators of commodities but also as intellectuals that can reflect on their own profession in a critical lens.

**5 Reports**

After the theoretical background given and discussed about the issues of value systems in the consumer culture, students were asked to watch the movie at home and write a report explaining their reflections about it. Most of the reports are very rich in terms of different subjects of analysis, because the content of the movie is very fruitful in that sense; i.e. there is a large number and variety of objects and scenes waiting to be analysed. Because of that, only some highlights will be given about some repeating subjects and phenomena in this paper.

Before we start to mention the highlights of the student feedbacks to the assignment, a brief summary of the scenes concerning the subject matter of the course is needed. These are mainly the confrontation of different characters, especially the protagonist Chuck with different objects/artifacts in different circumstances.
As we go along the synopsis of the movie ("Plot Summary: Cast Away", 2018) we can highlight the circumstances where confrontations happen concerning people in connection to the objects. One of the most important scenes is the one about the exchange of Christmas gifts; kitchen items given by Chuck, small ring box and antique watch that belongs to Kelly’s (Chuck’s girlfriend) grandfather given to Chuck by Kelly.

Second important part starts with the scene that the plane Chuck travels going straight down and crashes in the ocean; after that Chuck manages to reach to the shore of a small island together with a series of FedEx parcels carried in the plane. After he decides to open them, he comes up with contents like these: “a pair of ice skates, a leather and lace dress, videotapes and a legal document declaring a divorce, a volley ball that eventually becomes his companion and a parcel decorated with a pair of wings and for unexplained reasons he doesn’t open.”

Third part is the period after he manages to go back to his hometown or “civilization” after he spent four years in the island where he reinterprets his life in a new perspective when he encounters with some of the objects that was once part of his life in the island.

One of the students made an analysis of the movie by first dividing the movie into episodes similar to the ones mentioned above, but by adding the issue of value systems:

The movie can be roughly divided into 3 parts. The first part where Chuck lives in a civilized condition where the products not only have their use values, but also exchange and symbolic exchange values, the second part where he is trying to survive on a deserted island, assigning other use values to the limited products he has and the third part where he goes back home to civilization. (Ayda)

This division is something we started with during the class discussions; where whole signification system for Chuck is reversed and re-transformed.

In the first episode Chuck is a devoted engineer who is strongly connected with the idea of time, the pager he carries is the symbol for that. The job he makes is also part of this emphasis, timely distribution of the parcels by FedEx as the main principle of his job. However, we can trace the change in the concept and significance of time during the movie, by using the connected objects depicting and signifying time. Apart from the pager he always carries with, the beeper he gives to his fiancé in the Christmas; the reciprocal gift given by her, heirloom watch that also took part in the island context. This antique watch is a heritage from her family and she has attached the photo of herself in it. Although Chuck travels a lot between different time zones, he sets the clock according to Memphis, their hometown, and says it will always stay like that. For one of the students “the watch will usually show the wrong time and won’t fulfil its use value but this is not important for Chuck. For him, the watch has a symbolic value rather than a use value. The watch is set to “Kelly time” according to his words and it is a product which will remind him of his girlfriend any time he wants.” (Ayda) Following that, we can understand the significance of the watch from a series of scenes: “during the plane crash, he tries to save not himself, but the watch; he looks at the watch and the picture in it every night he spent in the island.” (Elif)

In the class sessions, the concept of time was also discussed comparatively between modern and traditional life. It was emphasized that Chuck eventually shifts into the cyclic time of nature where sun is the major parameter instead of the calculated time the clocks tell us that the modern life is based on.

This gift exchange ceremony in the airport is also the only scene where the objects take part representing the symbolic exchange value; kitchen items, small ring box and the heirloom watch. Most of the students discovered this connection by emphasizing the symbolic value given to the objects rather than their use or exchange value. While kitchen items that are brought to Kelly by Chuck are both useful and symbolic as they represent the travelled places by him, the ring box has a pure symbolic exchange value as it is the sign of wedding proposal. (Elif, Mustafa, Ayda etc.)

Coming to the island, sign and exchange values of the objects taken in the FedEx packs are converted into pure use value whatever they are originally designed for. Examples from the student reports can be summarized like this:

The video tapes might be carrying some very important information or might be some old memories of a family. Whatever they are, it is easy to say that they are important for either the sender or receiver in terms of use value or symbolic value. But Chuck cannot make any use out of them and therefore they are useless for him. The documents are for a divorce lawsuit and they probably have to be transferred on time to wherever they have to be. But on the island, they have no value rather than pieces of papers. The other products in the boxes also seem
to have no use at first sight. But Chuck manages to use them according to his needs. He uses the steel part of the ice skates as a knife and cuts the things according to his needs. Later on he also uses them as a mirror to see his/his teeth's reflection. He uses the permeable fabric of the dress as fishing net and he fishes with it. (Ayda)

Apart from the objects taken from the FedEx packs, the natural materials like straws, sand, coconuts, crabs and fish etc. are converted into functional items by Chuck, as a revival of the story of Robinson. The details about these materials in the story are also stated by most of the students. “Just coconuts, crabs and some fishes are his non-cooked meals. (…) When he succeeded to light a fire, it became valuable for him, fire has gained a sign value, sign of Chuck’s success.” (Ece)

He used tree skins and video tapes to make ropes, but the interesting one was that he used the rope by which he attempted suicide to make his escape raft. Once he used the object as a tool for his death, then it gained another function. (Sühendan)

After he manages to go back to his homeland, Chuck became aware of the things that he previously did not notice. This part is where the critique of consumer culture is more dominant compared to the other scenes in the movie. Here are some highlights from the students about this period:

When he survived and came back home, many things have changed a lot. Light, fire and any cutter became very important, however a bed was unnecessary to him. (Ece)

After he goes back to home, he still keeps the habit of lying on the ground, not on the bed. That's where we see spring mattress lost its use value. He also lost the values about time and being timely. Cast Away is a nice movie that shows the values that we give to objects, events and people in our lives are changeable (Elif)

To celebrate his homecoming, a party is made and seafood is served. Seafood is known as an expensive treat consumed by wealthy people which carries a lot of sign value. But since Chuck has had seafood for the past 4 years of his life, he feels disgusted and does not eat it. So, the seafood has lost its use and also sign value for Chuck. (Ayda)

The comeback could be considered as a reverse adjustment to life. The system of values on the island has changed him and for that reason it sounds strange to him to have all the comforts. For example, he sleeps on the floor instead of the bed, he stare at the lighter and the food, because on the island he had to adapt other objects to get them. That means that some objects we take for granted could be also understood with different values. He starts to criticize the system that once he was part of… (Leonardo)

Even so, the ending of the movie looks like a tragedy. But we know, he is no longer obsessed by the time and also escape from his limitations. I make an additional remark. Now, he can decide where he wants to venture, not confined to one place, not caught by time, not living a life cast in concrete. (Soyhun)

Coming back to the issue of Wilson, students seem to be puzzled by not to be able to classify or misclassify the role of that volley ball in terms of these value systems, but some classified “him” in one of the value systems: symbolic, use etc. Another hard to classify item in the movie is the unopened pack with a wing illustration printed on.

The most important change of value is about the volleyball. The ball had become his only friend. His need of communication, sharing emotions is shared with the ball. (Ece)

We can understand how much value he attributed to these objects and he needs them to get motivated to live from his decision of taking Wilson, the heirloom watch and the parcel with non-opened wings illustration together with him when he decided to leave the island. We can also understand the extend of the value he has given to Wilson from the scene where he even jeopardizes his life in order to save him. (Elif)

He also found a volley ball in those packages and drew a fire symbol on it with his blood. After numerous failed tryouts, he made a fire at last and thought that the volley ball brought him luck. From that time, he always kept it nearby himself, talked to it as a friend, attributed an important meaning and gave a great value to it. (Metehan)

Wilson was there in order to satisfy the social hunger of Chuck. It was enlivened, value changed and transformed into a part of Chuck’s body. (Mine)
He uses the sharp side of the skates as a knife to broke coconuts and tulles of the dress for fishing and the ball 'Wilson' as an imaginary friend to talk. (Negrican)

The friendship that he struck up with a ball he later calls “Wilson” is a clear example of how a commodity transforms into something intimate. Wilson is not volleyball anymore but a close friend of Chuck, his comrade, a witness and a remembrance of his experiences. (Ezgi)

Another student who wrote a report that concentrates only on the Wilson wrote:

Wilson was created by Chuck who painted a face on a broken volleyball with blood. The audience watches the steady appearance of Wilson and sees how important he is for Chuck's mental health. This fact changes the symbolic value drastically. Even though one should think the symbolic value is the same as the sign value, in this case the symbolic value isn’t. It is less objective. I can especially observe this in the scene where Chuck shouts “I’m sorry Wilson!”. This desperate shouting explains the importance of this imaginary friend. Only when it was nearly too late, he instinctively decides to let the volleyball float away. The face, painted with his own blood floats away. This signifies the viewer that all the pain of his stay on the island is leaving him. (Carlota)

As we can understand from the papers, the phenomenon of Wilson only, as a subject of analysis would be enough for an assignment in such a subject, as it floats around all the value concepts and beyond, from use value as a friend into a metaphysical totem for giving luck; it is also an indication about the potentials of different perspectives for such an educational exercise.

6 Concluding Remarks

This exercise was very helpful for design students in order to be able to criticize their own profession as a value giving practice and rethink about the origins of the values assigned to the built environment, socially and individually. Cast Away is a very successful movie in terms of providing a ground to read these values, whether or not it is the main message of it, (because some of the papers include the critique that it is an extended advertisement of FedEx!). Having examples like Wilson and parcel with a print of wings are symbols or signs that are hard to analyse, that challenges students to classify values in a very strict way.

There are some traps that students fall into like some of them had a tendency to criticize and the read the movie itself rather than the objects in their contexts. That is the reason why they sometimes mixed the elements of symbolism placed in the movie with the symbolic or sign values of the objects.

Also, one importance of the exercise is providing students with different forms of representations and media; that creates a fresh ground in which they feel more confident and eager to share their ideas. In this sense the method used in this exercise is closer to flipped classroom, because the audio-visual material required to be seeing and understanding outside of the class together with a report; however additional discussions and evaluation was made more in the classroom. The use of a movie as an educational material for a distinct area like consumer culture and design critique can also be connected to the similar issue where different media tools are contained within an education environment (Bergman & Sams, 2012).

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References


**About the Author**

Hümanur Bağlı  Graduated as an industrial designer from METU, received her master’s degree from Hacettepe University, Graphic Design and PhD from ITU, Industrial Product Design. Worked as a design researcher with Intel corp., also as a visiting scholar in City Design Center, UIC, Chicago. After her experience as research assistant in METU and as assistant professor in Yeditepe University, she worked in ITU, Department of Industrial Design. Currently working as a design professor in Şehir University, head of Department of Industrial Design. Among her academic interests are basic design, graphic design, semiotics, product semantics, design thinking, sufi culture and design, entrepreneurship.
Abstract: Among other things, translation is defined as “carrying something across”. With this interpretation, derived from the etymological root of the term, translation is not exclusively bound to a linguistic context. Therefore, a comparison between aspects of translation theory and the transfer of meaning in basic design exercises can be justified. Understanding linguistic translation as an act of cultural negotiation, raises the question to what extent basic design exercises reach across cultural constraints in transferring experience between design teachers and students. In other words: are basic design exercises transferring universal design principles or are they culturally determined the way language is? With the close reading of three basic design exercises, we present their diverse goals and intended transfer from teacher to student. (1) Drawing a cube is declared as a schooling of observation and an exercise in representing three-dimensional space in a two-dimensional drawing. (2) The technical aspect of constructing abstract geometric compositions had the declared goal of teaching perfection and craftsmanship. (3) And the graphical exercises followed the declared goal to generate a field of visual variations inferred from a strict set of rules and to learn to navigate within the design process. Based on this archaeology of intended goals described in the course of the three exercises, the paper discusses the implicit cultural constraints of the three exercises.

Keywords: basic design exercises; translation studies; cultural studies; technical drawing; design process

1 Basic Design Exercises and Translation Studies

Basic design exercises are usually conducted at an early stage of design education. In design and, specifically in the context of visual communication, they are regarded as a basis for solving more complex problems at a later stage. They isolate one formal or technical aspect of an applied project such as composition, colour, imagery, or typography. The syllabi of basic design exercises are formulated with clear constraints in order to guide a student through a manageable field of options in due time. The field of visual options is explored by an individual with tools and materials. It is assumed that a student who has managed to develop an aesthetically appealing composition, e.g. with vertical paper stripes, will be able to use this experience also in applied projects such as poster design, publication design, or the design of a man-machine interface. Basic design exercises were understood in the modernist tradition as a tool to teach universal visual principles. This issue will be contested later on in our contribution. Basic design
exercises are conducted with the intent to transfer an experience from a teacher to a student. But what are the experiences which are to be transferred? What is carried across from teacher to student through the exercise?

We can search for a differentiated answer to these questions by a comparison between the transfer of an experience from the teacher to a student with the transfer of meaning in a linguistic translation referring to the field of translation studies.

A straight connection between the transfer from teacher to student and linguistic translation can be drawn by referring to the etymological root of the word translation. According to the dictionary, the Latin term of “translatio” is the participle of “transferre”, which is translated by “to bring something across”, “to carry something across”, “to transfer”, and “to translate” (Langenscheidt, 1967). From the etymology of the term, we can infer that the meaning is not bound to the context of linguistics and, therefore, the attempt to look at the transfer provided by basic design exercises and the field of translation studies is justified (see also Baule/Caratti, 2017 and Renner, 2016).

An early approach to translation studies was proposed by Roman Jakobson, in his article “On Linguistic Aspects of Translation” (Jakobson, 1959). He starts out with a reference to a quote by Bertrand Russel: “no one can understand the word ‘cheese’ unless he has a non-linguistic acquaintance with cheese.” Jakobson argues that no one understands the word “cheese” without a linguistic acquaintance with the word and uses the example of “nectar” and “ambrosia”, which we understand through a linguistic encounter, reading Greek mythology, but without having the experience of tasting, smelling, or drinking the actual beverage. In his continuation of the reflection on translation, Jakobson distinguishes three categories of linguistic translation. He describes (1) intralinguistic translation as the act of rewording within the same language, (2) interlinguistic translation, or translation proper, as the transfer of a text from one language to another language, and (3) intersemiotic translation as the interpretation from verbal signs to signs of non-linguistic systems.

If we try to assess the validity of the three categories proposed by Jakobson for the discussion of the transfer of experiences in basic design exercises, we may have to go back to Bertrand Russel and say that the judgement of the quality of a cheese is only possible if we have experienced a variety of different tasting cheeses. In addition, we can claim that making a tasty cheese can only be learned by exploring how cheese is made. Besides, the creation of a meaningful communication design object can only be achieved by making it. The designer gains experience and constantly learns in every design process – from the first sketch to the perception of the final message by a beholder. Basic exercises help transfer what an experienced designer has learned to students. The language used to formulate the framework of the exercise does not describe the experience itself, but is used as a tool. Since the transfer of experience is the core of basic design exercises, the three linguistic categories do not apply here. Basic design exercises provide neither an intralinguistic, nor an interlinguistic or an intersemiotic translation. In conclusion, we can infer the need for a fourth category in addition to the linguistic perspective of Jakobson’s three categories: the translation from an original experience to its re-enactment in a condensed form – this is what is supposed to happen in a basic design exercise.

With this critical discussion of Jakobson’s famous differentiation of translation, we could give up the comparability of the transfer in basic design exercises and linguistic translation altogether. But this might be too incomplete a conclusion and miss finding an answer to the inquiry of what gets transferred in basic design exercises. If we turn back to the discourse of translation studies, one of the central topics of the discourse focusses on whether there is a core content or not which is possible or impossible to transfer from the source language to the target language. According to Walter Benjamin, information can be transferred, but not the essence of a literary text (Benjamin, 2000, p. 15). He uses the German word “Brot” in comparison to the French word “pain” to demonstrate that both terms point to the same object but are part of a different cultural context which is crucial for the meaning of the word (Benjamin 2000, p. 18, see also Richter, 2010, p. XV).

Continuing this line of thought, Lawrence Venuti contests the idea that there is an invariant which crosses different languages and would make translation easy. He claims that there is more than communication in the act of linguistic translation (Venuti, 2000, p. 470) and that the act of translation is primarily a cultural negotiation. A language is shaped by the collective memory of a society and this is the reason why a text cannot be translated literally.

“Translating is always ideological because it releases a domestic remainder, an inscription of values, beliefs, and representations linked to historical moments and social positions in the domestic culture. In serving domestic interests, a translation provides an ideological resolution for the linguistic and cultural differences of the foreign text.” (Venuti, 2000)
With this observation in mind, we can go back to the transfer basic design exercises provide and ask if there is also a cultural aspect which is transferred by basic design exercises. In opposition to the above-mentioned positions, questioning the existence of an invariant crossing different languages, Jacques Derrida’s understanding of the term translation can be employed to argue for an invariant meaning (Davis, 2001, p. 18). For Derrida there is no philosophy without translation.

“What does philosophy say? Let’s imagine that it’s possible to ask such a question: What does philosophy say? What does the philosopher say when he is being a philosopher? He says: What matters is truth or meaning, and since meaning is before or beyond language, it follows that it is translatable. Meaning has the commanding role, and consequently one must be able to fix its univocality or, in any case, to master its plurivocality. If this plurivocality can be mastered, then translation, understood as the transport of a semantic content into another signifying form, is possible. There is no philosophy unless translation in this latter sense is possible. Therefore the thesis of philosophy is translatability in this common sense, that is, as the transfer of a meaning or a truth from one language to another without any essential harm being done [...] The origin of philosophy is translation or the thesis of translatability, so that wherever translation in this sense has failed, it is nothing less than philosophy that finds itself defeated.” (Jacques Derrida, 1982/1985, p. 120)

The idea that meaning is “before and beyond language” claims that there is something before language which can be translated into a different culturally determined linguistic system. For the discussion of basic design exercises and their translational aspect, it is plausible that there is meaning before and beyond language. But before we draw any conclusions, a close reading of basic design exercises will help us to challenge the ideas of translation studies described above as a field of cultural inquiry.

2 The Transfer in Basic Design Exercises

2.1 Analytical Drawing: The Cube

Drawing was, and still is, considered one of the most basic processes to develop visual ideas. As we can see in the archived student portfolios of the Basel School of Design¹, drawing was the major focus in the education of graphic designers in the middle of the 20th century. Landscape drawing, figure drawing, nude drawing, portrait drawing, drawing of animals, drawing from memory, light and shadow drawing, etc., all these diverse areas of drawing occupied a major part of the schedule and were based on object drawing taught over two semesters in the preparatory year (Maier, 1977; Bollin, 1995).

The introductory class of Object Drawing followed a canonical sequence of drawing man-made objects. The students had to represent these objects with soft pencils (3B to 6B) in a linear manner on large sheets of paper (42 x 59.4 cm) mounted on the board of an easel. Starting point of the class was the representation of a physical cube with a 15cm-long edge, which was placed close to the drawing board on a stand. The transfer of the students’ observations was achieved by large freehand gestures on paper. The first challenge consisted in the transfer of the lines describing the square the cube was resting on (Figure 1). As soon as the two visible angles of the square and the relationship of the two sides of the cube facing the drawer were determined, the square was completed as the basis of the drawing (Bollin, 1995, pp. 6-7). The dissection of this basic square into quarters and the addition of the two diagonal lines connecting the corners, was executed in a second step. To confirm the correctness of the drawing, an ellipse was drawn into the square in a third step. If the drawing was correct, the ellipse inscribed in the square was precisely in a horizontal position. In other words: the largest extension of the ellipse had to be parallel to the horizontal edge of the paper (Bollin, 1995, p. 14). If it was not, the representation of the square had to be reconsidered and revised. Once the ellipse was fitting the square in a horizontal position, the drawing was continued. The vertical lines in the corners of the basic square were drawn as parallel lines to construct the cube (Maier, 1977, Vol. 1, p. 13). The top square of the cube was developed by observing the angles and the foreshortening of the four visible edges. In the final stage of the drawing, the important and visible lines were worked out. The lines follow a spatial logic. Visible lines and lines close to the beholder should be darker, lines towards the background lighter. Imagined lines are faded but follow the same spatial logic as the visible lines. After mastering the representation of the cube, additional basic geometric solids such as the cylinder, the cone, or the sphere were drawn into the cube (Figure 2, left). With the ability to draw these solids, more complex objects were drawn by dissecting them into basic solids. The representation of bottles composed

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¹ Archive of the FHNW Academy of Art and Design, e.g. student portfolios Peter von Arx, Georg Staehelin, Rudi Meier.
of cylinders, ring cylinders, and spheres was an intermediate step (Figure 2, middle) towards drawing objects with more complex shapes such as pliers, wrenches, scissors, etc. (Figure 2, right).


Figure 2. Three drawings from three different students, Object Drawing Class taught by Mario Bollin, the cylinder developed from the cube (left), the bottle (middle) and the pincers (right), preparatory year Basel School of Design, published in: Bollin, Maria (1995): Zeichnen; Grundlagen im Vorkurs Schule für Gestaltung Basel, Basel: Schule für Gestaltung, pp. 24/30/85 (left to right).

In the preparatory year, parallel to object drawing, a drawing class focusing on the representation of sculptural objects was conducted in front of plaster casts from gothic cathedrals (Maier, 1977, pp. 42-71). The spatial representation experienced in the object-drawing class was applied in a third drawing class focusing on nature studies (Maier 1977, pp. 72-104).

If we ask what the learning result of the object-drawing class was, we can describe three major issues:
• The drawing of the cube transfers the experience of a method to negotiate the representation of three-dimensional space in the European cultural context.
• The drawing method, based on large gestures, shows that precision in a drawing can be developed through the iterative approximation to a final result.
• Even though the method of representation and the evaluation of the correctness of the observation are rational and follow the aim to objectify the representation of space, the quality of the traces developed by each student in the analytical drawing is individual.

In contrast to the described approximation of a result, the following basic exercises were transferring a different experience to the students.

2.2 Technical Exercises as Aesthetic Training
An early example of basic design exercises was conducted at the Kunstgewerbe- und Handwerkerschule Magdeburg in Germany around 1930. One subject was called “elementare Gestaltungübungen” (elementary design exercises) taught by Franz Fiebiger, but most likely developed by Walter Dexel and Director Wilhelm Deffke. In this subject, the students drew nothing but lines. They drew those lines on large-format paper or cardboard with ink and the help of tools such as pens, brushes, rulers, and compasses. The approximately 90 examples of student work archived in Magdeburg, present the drawing course as undertaken in a purely constructive and abstract manner, excluding freehand methods or depiction as such. The works show multiple lines, either straight or circular, in consistent, increasing, decreasing, or variable thicknesses, mostly black and white, also addressing positive-negative inversion.

In the estate of Walter Dexel, we can find 42 written assignments (see Vitt, 1980, pp. 164-165). Some descriptions in those assignments match the student works. On closer review of the assignments it is noticeable, that these indications could not serve as assignments alone. They only cover certain aspects of the drawing, leaving others out. It is questionable whether they were really formulated beforehand or rather in retrospect of the exercises as descriptions. Nevertheless, it is evident that the student works and those “assignments” belong together as Figure 3 shows.

Figure 3 (left). L. Link (student), ink on cardboard, 46 × 63.5 cm, Magdeburg, July 14th, 1932. Matches with Basic Design Exercise “17. Different line width, same spaces, slope downwards to the right with imaginary joint, slope upwards to the right in a row”. (middle). Anonymous, lithography, 64.2 × 50 cm, Magdeburg, without date. Matches with Basic Design Exercise “24. Compass exercise, same line width, same space, one half positive, one half negative”. (right). J. Kalinke (student), ink on cardboard, 64 × 45.7 cm, Magdeburg, October 26th, 1933. Matches with Basic Design Exercise “26. Wave line, different line width, different spaces”.

2 17. Ungleiche Linienstärke, gleiche Abstände, schräg rechts abwärts in imaginärer Gehrung, schräg rechts aufwärts in Reihung
3 24. Zirkelübung, gleiche Linie, gleicher Abstand, halb positiv, halb negativ
4 26. Wellenlinie ungleiche Linienstärke, ungleiche Abstände
While the assignments are formulated in a technical language, the student works are executed with a high level of precision. There are no imperfections or corrections visible. This lets us assume, that the students – in case of mistakes – must have repeated the same exercise several times. On the final sheet there were no corrections allowed. To master the tools and the material must have been the declared goal of the exercise.

For Wilhelm Deffke, the Director of the school – a member of Deutscher Werkbund – precision was associated with machines, which he appreciated:

“Far from any idealization of traditional craftsmanship, as it has shaped the early Bauhaus, Wilhelm Deffke understood the machine not only as a ‘miracle of the human mind’, but above all as a means of educating people to precision, both in planned design thinking and in production itself.”5 (Eisold, 2016, p. 88)

Several works, such as in Figure 3 middle, were executed as lithographs in the printing workshop. It is not clear, whether the basic design exercises were followed by a lithography printing class reproducing the same visuals, or whether those prints were the templates based on which the exercises were executed. The language used in the assignments suggests a purely technical exercise, but their execution and results also imply experiences on an aesthetical level. The large number of works involving optical effects can be associated with Wilhelm Deffkes aesthetic preferences and his special interest in visual perception: “The aim of the education was the training of visual perception, a strengthening of visual thinking as a counterpart of linguistic thinking, a thinking, a thoughtful eye [...]”6 (Eisold, 2016, p. 91). This analogy to language is also the starting point of a research project conducted but never completed by Deffke: His “Grammatik der Formensprache (Bildsprache)” (grammar of visual language) in which he planned to inquire into “the basic elements of the point, the line, the plane, the symbol or sign, the alphabet, heraldry, the figure, and space” (Deffke, 1948).

Outside of the narrow framework of the assignments, there are additional student works which cannot be attributed to any precise assignment. While the ones connected to the assignments visually focus on the aesthetics of specific visual effects and decisive compositions, the non-attributable ones appear more tentative. Some of them fall behind in their visual quality, e.g. a circular spiral of which the stroke ending in the centre appears unsolved (Figure 4).

From the starting point of given assignments, the students were most likely free to apply or develop their own line-based compositions. If this is true, the experience that the teacher wanted to transmit must have been not only a technical, but also a visual or even a creative one. The freedom here lies in the still tight frame of what has been experienced so far and its free combination or rearrangement. But the gap between the consistent sheets of instructed exercises and the tentative, more individual solutions appears quite large.

5 “Fern jeder Verklärung traditioneller handwerklicher Arbeit, wie sie das frühe Bauhaus noch geprägt hatte, begriff Wilhelm Deffke die Maschine nicht nur als ‘Wunderwerk menschlichen Geistes’, sondern vor allem als Mittel der Erziehung zur Präzision, sowohl im planenden entwerferischen Denken als auch in der Produktion selbst.”
6 “Ziel des Unterrichts war das Training der visuellen Wahrnehmung, eine Stärkung des bildlichen Denkens als Pendant des Begrifflichen, ein denkendes, ein nach-denkendes Auge [...]”
The learning result of these exercises can be described as follows:

- The ability to create a neat and technically precise large-format ink drawing, suppressing the slightest human touch or expression.
- The visual vocabulary of shapes and line compositions limited to construction and visual effects provides the student with an understanding of modernist aesthetics.

### 2.3 Creativity or Planning

One exercise, which has been continued for several generations, is what Manfred Maier and his colleagues developed for the course “grafische Übungen” (graphical exercises) at the Basel School of Design. Maier taught there from 1965 till 2000 at the Vorkurs (preparatory course) and the Fachklasse für Grafik (Graphic Design Class).

In contrast to the previous example, focusing on technical precision, technical challenges were reduced to a minimum in this exercise. In an early version of the exercise, the students were asked to start from a black and a white paper square, of which the first was cut into four equal bars. In a first step, the students arranged the four black bars in different ways on a white square. A specific set of interventions was allowed: tearing, folding, shifting, and cutting (see Figure 5). Despite these interventions, the formal character of the four equal bars should have remained visible. The more solutions the students could find, the better. Solutions with pictorial character in any sense (including abstract basic shapes such as a cross, circle, triangle, etc.) were rejected (Maier, 1977, Vol. 4, pp. 42-72).


The second step was to choose one solution as a theme and to develop more variations of it. The resulting variety of solutions were, in a third step, analysed and organized according to appropriate, but self-defined, graphic qualities such as dark and bright, vivid and calm, full and empty. Maier describes these qualities as “qualitative criteria” (Maier, 1977, Vol. 4, p. 42). With their own set of criteria, the students developed their individual criteria matrix, a chart with two axes, which allowed them to place each solution within it (see Figure 6).
In the last step, gaps in the matrix were filled in with more variations. According to Maier, the goal of the exercise was the variety itself – a quantitative criterion – and the awareness the student gained of the design process. In his publication on the preliminary course, Maier also discussed less successful student works. He emphasized how difficult the seemingly simple exercise is and describes failure as part of the design process.

In a later version of the exercise used in the preparatory year of the Basel School of Design in the 1980s, the criteria of evaluating the compositions became mathematical in order to minimize the aesthetic judgement. Here, the black square of 8 by 8 centimetres was not cut into four bars, but remained a square. The black square had to be transformed by a sequence of actions of ripping, cutting, or folding. After the actions were executed, the black square had to be placed within the format of 8 by 8 centimetres. The parts of the square extending over the format had to be eliminated. The solutions of this exercise were only valid, when it could be visually proven that the black shape originated from a square after the actions were executed. A combination of conditions such as original right-angled corners, edges in original length or the original relationship between the edges of the square had to be visible in order to explain how the sequence of actions led from the original square to the final composition. Part of the exercise was to define a set of conditions that guarantee the conclusion to the square: “A solution is clearly legible if the square appears in the original format with at least two full side lengths or its angles or different combinations of both elements.”

(Quote from the documentation of the exercise, Figure 7. Archive of the FHNW Academy of Art and Design.)

7 "Eine Lösung ist klar lesbar, wenn das Quadrat mit mindestens zwei Seitenlängen oder seinen Winkeln oder verschiedenen Kombinationen aus beiden Elementen im Ausgangsformat erscheint."
Once again returning to the question of what the learning result of this exercise has been, we can define the following points:

- The method proposed in this exercise helps students to conduct a design process from the first sketch through a productive and goal-oriented practice, developing both intuitive and analytical skills. The variations are generated in the first phase with an experimental exploration. In the second phase, the variations are created systematically.
- The students learn on an abstract example to define criteria in order to a) create and b) evaluate variations of solutions to a design problem. The criteria are not based on an aesthetic judgement but on the consideration of the constraints given in the description of the exercise.

3 Conclusion

In consideration of the above described exercises, we can go back to the question of linguistic translatability and the transfer of the debate to the translational aspects of basic design exercises. Despite the above-mentioned difference between linguistic translation and the transfer of experience in basic design exercises, we can find a surprising parallel in the cultural constraint of a language and the cultural constraint underlying a basic design exercise.

The cube exercise trains the eye and the ability to observe, but in the transfer to the two-dimensional drawing, cultural conventions of the representation of space are becoming apparent. The depiction of the vertical lines describing the vertical edges of the cube as parallel lines is a convention which is underlying the representation of space ever since the Renaissance masters and their understanding of perspective. In this sense, the exercise transfers more than the training in observation from teacher to student. The cultural constraints are the underlying schema of the pronounced goals of the cube-drawing exercise.

Also, in the basic exercises conducted at the Kunstgewerbe- und Handwerkerschule Magdeburg in Germany around 1930 presented above, a cultural component is transmitted. Next to the training of the hand in the precise use of the tools and the training of the creation of visual effects derived from an open description of the exercise, the underlying message is the ideal of a mechanical production in the machine age. The designer has to be able to develop results which could be done by a machine as the quote of Wilhelm Deffke emphasizes.

In the third exercise on the design process, we once again encounter an underlying cultural schema. The systematic approach to the design process and the development of a field of visual variations based on rational criteria implies that the development of a creative result is plannable and inferable from rational criteria. With a critical analysis, the suggested plannability is transferring a biased conception of the design process: to strictly follow established structures in varying solutions excludes the development of a surprising, intriguing, or shocking visual message.

In conclusion, we can claim that, as language is determined by the cultural context it is used and transformed in, basic exercises carry clear constraints which are culturally determined in the transfer from teachers to students. As to the existence of an invariant meaning reaching across languages, the exercises described above suggest that a basic experience can be transmitted across cultural contexts. With other words: the cube drawing can also be taught in a cultural context outside the Western hemisphere, but the perception of analytical drawings in a non-Western
culture carries an inherent notion of domestication. It is a specific interpretation of the world which is not shared globally but to a wider extent than a specific language.

Derrida’s claim that there is meaning before and after language, is key to understanding basic design exercises as a translational act. As mentioned before, the linguistic description of the basic design exercise is not describing the experience which has to be transferred, but the framework in which the experiences are most likely to be re-experienced by the student. In this sense, language is a tool to transfer meaning experienced by a teacher to the re-experiencing of meaning by a student’s exploration. Since experiences can only be guided intentionally to a certain degree, basic design exercises as language also depend on the individual interpretation of the respective student or reader. Both of them are bound to their cultural context apparent in the constraints of visual schemata or the structure of language.

References


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Upside Down: A *Flipped* Design Thinking Course

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**Abstract:** In constructivist learning, learners are responsible for their own learning process in order to acquire specific professional and personal skills. Constructivist learning methods based on prior knowledge of the learner and learning objects (LOs) of the constructivist approach are the conductors and activators of learners’ insider knowledge. In such a learning approach, the planning of effective learning needs to be questioned and restructured. The use of LOs in learning planning is of great importance in encouraging learners to be self-learners. This paper presents a case study conducted in an interdisciplinary Design Thinking course conducted with 16 students, one instructor, and one researcher in a Department of Industrial Design. The case study aims to explore the efficiency of flipped classroom in course planning, information transfer, process management, and student motivation and participation. This explorative case study included three projects during the semester, focusing on the use of LOs in alternative ways depending on the learning process. Three different models were experimented with for the delivery and usage of LOs. These models were compared and evaluated by facilitators’ observation and reflection, as well as students’ reflection and feedback.

**Keywords:** design thinking; learning objects; flipped classroom

1 Introduction

This paper focuses on the pedagogic application of a Design Thinking mindset and the flipped classroom model as a set of pedagogical approaches. Education has been going through a transition in order to catch up with developments and shifts, as well as to fulfil the future needs, in the professions. Education, in that sense, can be framed both as a game changer and as a tool that has to adapt itself to social, economic, environmental, and technological developments. Within this perspective, a Design Thinking mindset, which is based on problem solving and creation process of creative industries, is of great potential when integrated into different educational approaches (Wringley, 2015), since this mindset has already been used in diverse contexts due to its comprehensive approach.

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From a constructivist point-of-view, learning is an active process, in which students are responsible for their learning, constructing knowledge built on their past and existing knowledge and experiences, with no didactic transmission of knowledge (Piaget, 1970; Olssen, 1996). The flipped classroom model, as one of the constructivist educational models, suggests an inverted class structure for the delivery and usage of LOs, compared to traditional teaching, as well as the use of technology. In this paper, the literature on Design Thinking pedagogy and the flipped classroom model is presented in order to create a theoretical framework for the case study conducted in a Design Thinking course.

2 Theoretical Framework

2.1 Design Thinking Pedagogy

Education models are changing from the teacher-led approach to learner-based approaches (Biggs & Tang, 2007). Design thinking education can be accepted as a model for enhancing creativity, endurance, engagement and innovation (Dolak, 2013). It aims to act as a model for design-led change in the world by solving daily life problems through interdisciplinary learning processes (Rauth, Köppen, Jobst & Meinel, 2010). Group work is essential in these processes and aim to increase students’ motivation to learn from one another by enabling collaborative working and engaging in constructive dialogues (Luka, 2014). In order to facilitate Design Thinking learning processes, learning tools are developed with the aim of enabling participants to develop solution proposals to untraditional innovative tasks and develop their problem-solving abilities. The Institute of Design at Stanford has created teaching/learning aids and designed LOs for different activities developing design thinking skills (Plattner, 2009; Plattner, 2010). The tools are in compliance with the seven principles that design thinking follows: (1) focus on human values; (2) showing not telling; (3) creating clarity from complexity; (4) getting experimental and experiential; (5) being mindful of processes; (6) bias towards action; (7) collaborating across boundaries (Plattner, 2009). Design Thinking education focuses on the process, and students experience all Design Thinking phases as Understand - Observe - Define (POV: Point-of-View) - Ideate - Prototype - Test throughout their learning journeys. The instructor makes some emphases on the learning goals, individual needs, and content of the project, as well as acting as a facilitator, giving support and guidance to students. The learning process is designed in the frame of the constructivist learning approach, which focuses on the individual learning journey. The Design Thinking learning journey at Stanford encourages using design principles in learning activities: (1) inviting multiple audiences; (2) extending nature of classes; (3) diversifying learning opportunities; (4) encouraging diversity of students; (5) extending contact beyond physical walls (Plattner, 2010).

Design thinking education is based on constructivist learning. Scheer, Noweski and Meinel (2012, p. 11) describe three fundamental steps to realize in Design Thinking teaching methodology in their dissertation Transforming Constructivist Learning into Action Design Thinking:

- challenges situated in a real-life environment of the learner;
- action – the interaction of thinking and action plus interaction and sharing of knowledge between learner and teacher;
- application – solving the problem and applying the insights, reflecting and understanding through applying ideas.

Learning is an active process, which is highly related to making meaning individually, socially, and continuously in order to construct knowledge instead of an accumulation of knowledge (Piaget, 1970; Olssen, 1996). A constructivist view in education does not focus on behaviours or skills, but rather on cognitive development and deep understanding that is in the centre of the learning and teaching processes (Fosnot & Perry, 1996). From this point-of-view, learning is an “interpretable, recursive and non-linear” process accomplished by active learners (Fosnot & Perry, 1996). In that sense, there is no passive transmission of knowledge from the instructor to the learner, but rather the learner’s insider knowledge is valued and built upon. Individuals construct their existing knowledge by interacting with others socially and are responsible for their learning processes. Reflecting on these interactions enables the individual to make sense of them and accomplish the individual (private) aspect of construction (Henriques, 1997). Considering Design Thinking pedagogy, reflection is a fundamental part of design education as well. Schön describes two critical notions: reflection-in-action, implying to thinking on feet, and reflection-on-action, implying to thinking on previous actions. Therefore, whereas the first notion signifies considering experiences, feelings, and theories in use, the second notion requires revisiting one’s actions and practices later (Schön, 1982; 1984). Reflection is also essential in assessing the individual learning process by incorporating reflective tools/objects, either digital or non-digital, in learning environments (Coombs & Smith, 1998).

A learner’s engagement with learning and reflection play a significant role in contextualizing learning (Banks, 2001), which requires learning objects (LO) to be designed accordingly. LOs are the artefacts that are shaped by learning objectives, learning goals, and learning methodology. They are a collection of content items, practice items, and
assessment items that are combined, based on a single learning objective (Cisco System, 2013). In the constructivist approach, the learning objectives depend on the context of learning, so must be definable in the context of use of the learning object (Banks, 2001). The deliverables have to be described and planned while planning the learning journey. Ritland (2000) describes three types of LOs used in Constructivist learning approach: micro-level LOs (fundamental LOs), combined information objects (generative-instructional LOs), and macro-level scaffolding (frameworks). In a full object-based learning environment, such objects might be embedded in an appropriate sequence with information objects, assessment objects, etc. (Banks, 2001, p. 9). Banks (2001) explains that the user interacts with LOs as following: evaluating the LO in practice within the scope of expectations from LOs, meeting the essential prerequisites or necessities to use the LO, adapting to the sequence of the learning journey.

There are different educational models, adopting the constructivist point-of-view, which propose different classroom structures. With the introduction of technology in education, digital tools and environments have started to be used. Considering the integration of technology and the sequence and delivery of LOs, the flipped classroom model was experimented with in this study.

2.2 Flipped Classroom Model

The flipped (inverted) classroom methodology is a learner-centred, constructivist teaching approach, facilitating students’ active engagement in learning through delivering learning materials outside the class and using class hours for collaborative and interactive learning activities related to those materials with a focus on what students actively do (Baker, 2000; Lage, Platt, & Treglia, 2000; Butt, 2014). It is a form of active learning, requiring students to engage in meaningful learning activities as they think and make sense of what they are doing (Prince, 2004). In the flipped classroom model, active and collaborative learning activities (case studies, problem-solving, deepening and advancing concepts, etc.) are conducted during class hours and the passive learning activities that focus on information transmission (reading, watching instructional videos, etc.) outside the classroom, unlike traditional didactic teaching, and students are required to complete pre- and/or post-class activities to benefit from the in-class work (Butt, 2014; Abeysekera & Dawson, 2015). Therefore, a flipped classroom is not very different from a traditional classroom in terms of the syllabus and LOs used, but the form of delivering and accessing them is different from providing a less structured and inquiry-based learning environment (Hmelo-Silver, 2004; cited in Butt, 2014).

The flipped classroom model suggests the use of a variety of technologies for preparing and sharing the course content and materials (Roehl, Reddy, & Shannon, 2013). It allows the delivery of information and learning objects prior to class and to make use of class hours for students to engage in interactive activities with an intention “to create a more collaborative learning environment where students are focused on working through problems with both the guidance of their instructors and the support of their peers” (Findlay-Thompson & Mombourquette, 2014, p. 64). Therefore, students are provided with the opportunity to explore the content on their own and to prepare for individual and/or collaborative activities focusing on skill development in the class (Roehl et al., 2013). This allows focusing on individual learning paths, skill levels, and needs in the class during peer-to-peer and/or instructor-student interaction or collaborative activities. Similarly, the use of multiple media enables instructors to meet the individual needs of students with diverse learning styles and provide them the relevant guidance and support (Bryant & Hunton, 2000). Instructional videos are considered an essential part of the flipped classroom model, especially for lecture-based courses. However, using instructional videos or another form of computer-aided instruction is not enough for a practical application of the flipped classroom model. How the classroom is restructured and how well the technology is integrated within the overall approach through regular and systematic use are the key to making the model active and successful (Strayer, 2012; Tucker, 2012).

The inverted structure of a flipped classroom enables students to interact with the course content and LOs as needed, according to their learning styles, and become more aware of their learning process. Students are responsible for gaining a basic understanding of the course content before the class in order to be able to engage in in-class activities and the challenging interactive experiences and comments, insights, and feedback from the instructor complement, facilitate, and guide their learning (McLaughlin et al., 2014). In order to make sense of what has been learned, reflection is an integral part of the learning process. Therefore, the instructor is responsible for planning a component for the course for student reflection to be commented on by the instructor, which is crucial for assessing students’ learning (Roehl et al., 2013). In summary, in order to provide a compelling experience, a flipped classroom needs to involve highly-structured pre-class assignments to introduce new theoretical concepts, means of accountability to ensure that students complete pre-class assignments and out-of-class works, well-designed in-class activities for students to make sense of activities, and open lines of communication for free student-instructor interaction (Talbert, 2014; cited in Canina & Bruno, 2018).
Considering the effects of the flipped classroom model on student learning and despite the limited studies providing quantitative results on the effectiveness of flipped classroom, the findings from the research conducted in various disciplines reveal that the students’ perception towards the flipped classroom and its effects on learning is positive in general (Bishop & Verleger, 2013; Butt, 2014; Findlay-Thompson & Mombourquette, 2014; Canina & Bruno, 2018). Although some studies show that a traditional approach is more preferred, it is stated that the students showed increased collaborative skills and tendency towards cooperation and innovation as the semester progressed (Strayer, 2012). Disciplines that predominantly require lectures, readings, etc. seem to be more suitable for applying the flipped classroom model, considering course contents, ways of delivering information and developing skills. However, it “could be easily adapted to multiple disciplines such as textile design, apparel design and construction, interior design, and nutrition” (Roehl et al., 2013, p. 46) that utilize lectures for providing instruction as well. In that sense, the flipped classroom model could also be beneficial in design education, including all design fields, which are practice-based by nature. In terms of the feedback cycle and inquiry-based learning environment of a flipped classroom, there is already a similar educational approach with design education. Within this perspective, the flipped classroom model is applicable in Design Thinking courses, in which a variety of LOs are used. Canina and Bruno (2018) report the findings of their experimental study on “Design Thinking via flipped classroom,” comparing traditional and flipped Design Thinking teaching, and point out the potentials of the model:

1. Pre-class activities are beneficial for providing an overview of the Design Thinking phases and allow an in-depth understanding and awareness.
2. Giving more responsibilities to students for their learning through well-structured guidance to facilitate the interaction among students in the development of a design project.
3. Technological tools help following and to assess students’ process and progress.

Reviewing the literature, a “flipped” Design Thinking course experimented with the aim of exploring the potentials of the flipped classroom model in a practice-based course.

3 Application Background

In this case study, it was intended to reconsider the teaching and learning process and the delivery and usage of LOs in Design Thinking courses and to discuss the results of the application of the flipped classroom model by comparing three experimented models in three consecutive projects. The Design Thinking Course, Roles of Actors (instructor, researcher, and students), LOs/Technologies and Data Collection methods used within the scope of this study are explained in this section.

It is also important to note that this study was planned and approached as a part of the researcher’s Ph.D. dissertation and aimed at making use of the results in his research.

3.1 Design Thinking Course at the University

The Design Thinking course, which has been in the curriculum since 2016, conducted in the 2017-2018 spring semester at the University, has been chosen for the experiment. The course is a one-semester elective course, which is open for 3rd and 4th year students from all departments at the University. This interdisciplinary practice-based course is 4 hours a week and consists of three projects, durations of which are 3, 4, and 8 weeks.

The learning process of this course was planned in the perspective of the Constructivist Approach, that instructors are responsible for the action and reflection process of students, who are responsible for their learning (Schön, 1982; 1984). The learner-centred approach based on knowledge and application includes theories, methods, philosophies and also practices that students can construct knowledge by applying the knowledge in practice while solving daily life problems. Students are able to use or apply knowledge, put theory into practice, use knowledge in response to real circumstances, reflection, ideation, design process, design history, defining design, creative thinking (idea generation), group dynamics, wicked problems, design contexts, visualisation, experimentation, prototyping, and short collaborative design thinking projects. The applications of the course are workshops, lectures, tutorials, field study, individual and group challenges (Wrigley & Straker, 2015).

The learning outcome of a student at the end of the Design Thinking course is to experience the process and gain a Design Thinking mindset so that the student can infer and recall the Design Thinking process, plan, and co-lead the process, and organize the tools.
3.2 Roles of Actors
Three main actors - instructor, researcher, and students - were present within the course and their roles are described below.

**Instructor**
The instructor was responsible for leading the learning journey of the course in terms of the learning planning, giving direction to action and reflection processes of students, and controlling their learning. As suggested in the literature, the primary responsibilities of the instructor were guiding students to handle complex design problems, adapt insider knowledge to action and establish a dialogue, and focus on their making experience (Schön, 1982; cited in Waks, 2001).

**Researcher**
The researcher in this study was responsible for reporting the research process, archiving the reflection and feedback of the instructor, giving direction to application and co-planning of the course content, based on the research planning, through structured meetings with the instructor.

**Students**
16 3rd year students (13 female, 3 male) enrolled in the course. The students were from five different departments: Visual Communication Design (6), Computer Engineering (3), Interior Architecture and Environmental Design (5), Industrial Design (1), and Architecture (1). The students were responsible for realizing the action which is described by the instructor, preparing course submission before their deadlines, and attending the courses to participate in individual or group-based projects.

3.3 Learning Objects and Technologies
Google Classroom was used for communication throughout the course for sharing learning materials, making announcements, and collecting project submissions. The researcher followed the course flow and submissions via this application.

The LOs used in the course are the course syllabus, project briefs, and templates. Project presentations and project documentation can also be accepted as LOs for reflection. Within this context, the Templates are accepted as Micro LO, the Syllabus and Project Briefs as Combined LO, and the Documentation tools as Macro LO.

The LOs were the same in each project, only with small revisions that had been found necessary based on the reflections and depending on the project content. Among the various LOs, this study is mainly focused on the various usage of templates and their effects on learning, since they are essential educational tools for facilitating and keeping track of students’ learning and enabling students to focus on the relative phases and tasks within allocated time periods in Design Thinking courses.

3.4 Data Collection
Structured and semi-structured reflection forms were used for data collection. Structured reflection forms were designed based on the reflective writing methodology (Table 1). The reflections (Figure 1) among the actors are described below:

**Instructure/Researcher**
The researcher received the instructor’s reflections on the course (Affection, Cognition and Metacognition levels) after each class through interviews and in written formats and then archived them. The researcher and the instructor planned the following class depending on the research and learning plan after the course reflections.

**Students/Instructor**
The instructor asked the students to reflect on their action process during the course and project at the beginning and end of the course verbally. The instructor forwarded these reflections to the researcher. In addition to these reflections, the students’ reflections on the semester were collected in written format at the end of the semester. In Project 03, written reflections were also collected online each week. These reflections were used both for assessment and as written material for the research.
Table 1. Templates for the teacher and the student in the structured reflective diaries (Gelmez, 2016).

<table>
<thead>
<tr>
<th>General thoughts and emotions (Affection and cognition)</th>
<th>What are my feelings and thoughts about today’s class?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reflections on curriculum content and pedagogy (Cognition)</td>
<td>What did I learn today? How did today’s class contribute to my learning process? What couldn’t I understand in today’s class? Why not?</td>
</tr>
<tr>
<td>Reflections on the learning process (Metacognition)</td>
<td>How have my ideas changed? What is the link between the things that I have learned in today’s class and the things that I have learned previously? What would I want to change if today’s class was repeated? Why?</td>
</tr>
</tbody>
</table>

Figure 1. Reflection Structure

4 Test and Analysis

Within the scope of the study, three projects were conducted with the application of three different models with the test structure presented in Figure 2. The experimented models are described below in detail, in terms of the course flow as well as the application and evaluation of the models, with a particular focus on the delivery and usage of templates within the projects.

4.1 Case 01

Project 01_3-week individual work

“The project aims to develop social responsibility project ideas in order to make a difference about the subjects of disability, women rights, abandoned children, and elderly people, bring some solutions, and create social sensitivity.”

In Project 01, the brief was delivered to the students in the class (Figure 3). Each week, the templates to be used for the relevant phases of the Design Thinking process were presented in the class. The purpose of using these templates
and how they are used were explained in detail by the instructor. Then, each template was filled out together with the class as an example. After the class, the templates were shared online (Google Classroom), and the students were asked to fill them out as homework before the next class. This homework aimed at enabling students to practice what they had learned in the class and complete the previous class’ tasks in order to be prepared for presenting their ideas and move onto the next phases in the next class following the introduction of the new templates. At the end of the project, each student presented their work in the class.

Figure 3. Case 01 Course Flow

Working with the templates allowed students to progress; however, they remained in a passive role during class hours, despite the expectation of creative project outcomes through a creative process. Moreover, moving onto the next phases with new templates each week made it difficult for them to make sense of what they were doing and why they were doing it, even though each template was explained in detail and practiced by the instructor in the class and the students completed the necessary tasks for the project at the end. It was observed that they only completed the tasks as homework, not for developing an understanding of the content and context for deep learning.

Based on the students’ and the instructor’s reflections, the course flow was revised for Project 02, in terms of the design, delivery, and usage of templates.

4.2 Case 02
Project 02_4-week individual work

“How might we enhance the university experience of students at the University they belong to by identifying their needs and the problems they face with and generate feasible, realistic solutions using Design Thinking methods?”

Similar to Project 01, the brief and the templates were delivered to the students in the class (Figure 4). The templates had the same content as the previous ones, so the students were familiar with them. Differently, they included short explanations as guidance. Unlike the previous project, the students worked on the templates in groups of four with a focus on their works. This cooperative exercise allowed them to support each of their learning and clarify each other’s uncertainties and questions relevant to the templates through peer interaction in small groups. The students were also allowed to make field research (in the campus) during the class hours, which provided them the opportunity to cross-check their ideas, thoughts, and opinions on the tasks by visiting places, interviewing university authorities and students, etc. The instructor visited each group for desk critiques, and each student presented his/her work via their templates-in-progress. The students revised their templates, if they needed to, as homework. At the end of the project, each student made a presentation to the whole class with the participation of university authorities.
The revision in the course flow helped the students show more progress and develop a deeper understanding of the project since it allowed them to take the initiative and interact with peers more. Even though the templates served as a catalyst in the process and the students engaged with them by themselves, spending more time on figuring out the role and contribution of the templates in the project and particularly in the learning process, the usage of the templates were not engaging and effective enough in terms of facilitating an independent learning process, in which the students took the responsibility of the process.

Based on the students’ and the instructor’s reflections, both the course flow and templates were revised for Project 03, and the flipped classroom model was chosen as a model for the application.

### 4.3 Case 03

**Project 03_8-week group work**

“The project aims to design an event for migrant children between the ages of 3-13 from different countries, using different languages and with diverse cultural backgrounds in İzmir. The main purpose of this event is to create meaningful memories via diverse experiences and a reminder of good memories. The physical, operational, and obligational constraints and opportunities, multicultural aspects and needs, and age issues have to be considered.”

In Project 03, an expert was invited to the class, and the brief was given to the students, following by a Q&A session and sharing of experiences related to the project content (Figure 5). Then, the groups were formed. In contrast to the previous experiments, there was no delivery of templates during class hours. The templates, which were revised after the previous project with the additions of more detailed explanations and examples, were shared online and filled out as homework individually beforehand. In the class, the group members shared and discussed their works via their completed templates in order to find a middle ground as a group. The group discussions involved the clarification of misunderstandings, etc., if needed, and collaborative decision-making about the project phases and tasks. Following the re-completion of the templates of each group, the works were presented to the instructor. Different from the previous projects, the students led the discussions with the instructor, who acted as an activator, asking questions to provoke further thinking on the tasks and the project as well as answering questions if the groups had any. Then, the groups revised their works. There were also classes, in which the groups shared their works-in-progress to other groups for class discussion. Before the presentation to the expert, each group prepared a presentation to practice in class and asked for feedback for improvement.
Each student and the instructor completed an online reflection form prepared by the researcher both for self-assessment and course-assessment. Both the observations during the project and the reflections indicated that the flipped classroom model, in terms of the delivery and usage of the templates, helped the students engage in a more interactive process of learning during the project, independent of the instructor’s dominance, and take the responsibility of their learning processes as well as that of their peers. Moreover, even though the students reflected on themselves and the projects verbally during the previous projects, the online and written reflections helped assess each student’s progress and the course as well. The increased interaction in the course flow via the flipped usage of templates was also encouraging for the students to reveal insider knowledge and be more enthusiastic, willing, and open for participation and reflection freely and confidently. This was apparent in the end-of-semester reflections and project outcomes. The reflections contributed to the improvement of the course for the next semester (2017-2018 fall semester).

5 Conclusion

The literature on the Design Thinking pedagogy and the flipped classroom model as a constructivist teaching approach points out the potential of the model to be used in Design Thinking teaching, which is based heavily on practice. The study presented in this paper show that there is a high potential of using templates in projects with a flipped approach since it allows students to develop a deeper understanding and awareness of their insider knowledge and learning journeys and make sense of what they are doing while doing. They are also enabled to take the initiative and responsibility throughout the process through increased peer interaction and collaboration due to the usage of templates as a facilitating LO within groups. The use of technology eases the assessment of students’ performances and reflections in the process and serves as an artefact for instructors to assess each student’s learning process.
Moreover, the flipped approach in using templates in the course enables students to be prepared for interactive and collaborative in-class activities by exploring and working on tasks beforehand and conceptualizing the subject and tasks in question. Therefore, immediate action is taken in the class with a focus on learning activities and project content, rather than the template only as a LO to be filled out. This enhances the use of time in class hours and allows students to spare more time to understanding and active learning.

Even though none of the students had taken a Design Thinking course before, they were familiar with the design thinking process to a certain extent, since most of them were from design-related departments. Therefore, further work is needed to test how effective the flipped approach is in a Design Thinking course with a larger group of students, who are from a variety of departments that are not design-related and taking the course for the first time. The flipped course flow provided the most satisfactory results among the experimented models. However, qualitative research methods were used in this study. Using quantitative methods as complementary to measure learning might provide more comprehensive results. Despite these limitations, this study indicates the positive implications of the flipped classroom model in practice-based courses, particularly Design Thinking courses in this case. Hopefully, it will open up a new discussion on alternative approaches in this field and inspire researchers to explore future possibilities.

References


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Repurposing Online Videos for Exploratory Design Research

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Abstract: This paper presents the development of a generative toolkit which utilizes user-generated online videos (UGVs) as found data and repurposes them for exploratory design research and idea generation. The toolkit aims at supporting design students to browse, select and analyse UGVs for generating design insights and ideas for unfamiliar problem domains and hard-to-access user groups. The toolkit development process started with a retrospective analysis of a selection of industrial design studio projects followed by interviews with the students and the tutors involved. An initial model was developed and used in a 5-week design studio project taken by 75 senior year industrial design students at Anadolu University. Based upon the findings of these studies, the revised toolkit was implemented in a half-day crash workshop involving a small number of participants. During the workshop, the participants were provided with a concise literature review regarding a specific design project topic, a YouTube playlist of related videos, the video analysis board samples from previous studies, and the video analysis board templates for different analysis modes. Since the toolkit puts a special emphasis on unfamiliar domains and challenging user groups, the workshop involved the assistance of an external expert during the video analysis process. Through the UGVs the participants were able to immerse themselves into the subject and get familiar with the problem domain rapidly. The components of the toolkit such as video analysis samples and templates were also used as guidelines to interpret UGVs. The expert was directly involved in the video analysis process, and made clarifications and remarks concerning the participants’ questions and comments for gaining insights. The paper reports the outcome and findings of this half-day workshop and discusses the key insights for further developing the toolkit.

Keywords: exploratory design research; idea generation; user-generated videos; unfamiliar problem domains; design education

1 Introduction

During the early phases of design process, designers need to explore the problem domain in order to form a sufficient background about it. It is easier for designers to empathize when they are familiar with users and the use context. When designing for user groups or use environments that they are not familiar with, designers could face various
challenges including users’ health conditions or disabilities (Newell et al., 2011), risky or unsafe use environments involving occupational groups such as miners or firefighters, projects involving remote areas or cultures such as promoting healthcare in a remote area (Rodriguez et. al., 2006), and time constraints (McQuaid et al., 2003). These challenges limit designers’ direct access to users or use environments and make it difficult for them to benefit from the methods or approaches requiring stakeholders’ direct involvement. In cases where designers do not have direct access to users for design exploration, other sources such as user-generated online videos (UGVs) may provide rich data for design research and support designers in gaining design insights for idea generation.

User-generated content (UGC) is the content made publicly available by the end-users over the internet, which reflects a certain amount of creative effort, is created outside of professional routines and practices, and puts an emphasis on the potentials user-generated media offer (Vincent & Vickery, 2007, p. 4). UGC provides descriptive representations of real users’ experiences through visual materials. Many anonymous user-generated contents may enable empathic inferences without meeting the users directly. Various types of UGC such as personal diaries, professional portfolios or travel journals may be utilized as rich data sources for research. As a free and expanding source, UGC platforms like YouTube have the potential for design exploration for the designers with limited professional experience and resources (Mura, 2014) and promise a fruitful environment for research and learning.

There are several free video sharing sites to watch and upload videos such as YouTube, Blip, Dailymotion, Vimeo, Vine and Metacafe. Among them YouTube is the leading video sharing site (Netpaths, 2018; eBizMBA, 2018). The domain name “YouTube.com” was activated in 2005. Currently, it can be navigated in a total of 76 different languages which cover 95% of the internet population. According to YouTube usage statistics, YouTube is the world’s second largest search engine and third most visited site; 400 hours of video are uploaded to YouTube every minute and over one billion hours of YouTube video a day are watched. On average, there are one billion mobile video views per day (Brandwatch, 2018). Although other video sharing platforms such as Vimeo may be gaining popularity, YouTube is dominating the online video sharing platforms because of its keeping itself up-to-date with the technology and playing a pioneering role in introducing new video formats to the online community such as enabling uploads of high resolution videos unless they violate copyright laws (Rival IQ, 2018). The type and length of the video content on YouTube varies (Figure 1): the average video length is the shortest for “Trailers” and the longest for “Movies”; “People & Blogs” is the category with the highest volume of uploads, 41% of all videos uploaded to YouTube; the “Gaming” category follows it by 14 %. While YouTube is famous for music videos, they constitute only 5% of all videos, which is a rather small percentage.

Today, online video content sharing is a prominent resource of information and many people engage in constructing knowledge or seeking information from online content sharing destinations, particularly from YouTube (Oum & Han, 2011). User-generated online video content has become a topic of discussion and inquiry within the scholarly literature with a focus on its potentials and pitfalls in teaching and learning (Snelson, 2009; 2011). Although perceived as a medium for entertainment rather than as an educational tool by many, YouTube can be used as an innovative and efficient learning medium (Lee & Lehto, 2011). A study conducted to obtain a consensus from experts about research priorities in video content sharing technology shows that the second highest priority is the investigation of its impact...
on transforming education such as classroom use in various educational settings (Snelson et al., 2012). There are many scholarly examples of usage of YouTube videos in nursing, clinical skills, surgical education, etc. (Duncan et al., 2012; May et al., 2013; Basch et al., 2017). Lee and Lehto (2012) conducted a study for identifying the reasons of people’s using YouTube for learning; according to them, acceptance of, and intention to use YouTube as a learning source depends on the ease of use and usefulness of it. As an easy-to-use information source, it is perceived as useful; this satisfies users, and in turn, positively affects the intention of using it for learning. Usefulness of YouTube is related to the preferred way of learning such as visual learners’ preferring visual media as well as its providing fresh and diverse content that corresponds to users’ information needs, its being a sensorially rich environment, and people’s beliefs in their own ability to utilize YouTube for learning.

The use of videos as source of data for design research has a considerable history including design ethnography and usability studies (Yrilisku & Buur, 2007); yet, the use of UGVs for design research purposes remains a relatively less explored area. There are several considerations which make the use of UGVs challenging, and a researcher needs to approach them cautiously. All UGVs might not be suitable to be utilized as research material. In the literature we came across discussions about technical and ethical issues regarding the use of UGVs as research material. First, UGVs need to satisfy some criteria as research material. A video that can be used for research is required to capture the essence of an event, to provide the viewer with the feeling of being there, to make the events and actions understandable, and to show the sequence of events in order to clarify the intent of the person recording the video (Goldman, 2007, pp. 30-32). Furthermore, the use of videos for research purposes necessitates the researcher being aware of the purpose of the video recording, the background, the context and how these are reflected in the video (Jewitt, 2012, p. 3). There are a number of additional issues including respecting privacy (Bakardjieva & Feenberg, 2001; Berry, 2004), confirming the accuracy of the content for the reliability of the information provided in the video, confirming the expertise of the content creator from reliable sources (Tseng & Fogg, 1999), and taking into consideration the fact that there are groups of users such as low-income groups or elderly who have little representation on these platforms (Mura, 2014).

2 Developing an Exploratory Design Research Toolkit: UGVs as Found Data

This paper presents the development of a generative toolkit based on a series of studies aimed at exploring UGVs provided by the end-users over the internet as found data and repurposing them in exploratory design research and idea generation. The overall aim of the study is to identify alternative ways of interpreting UGVs and to develop strategies for utilizing them in a reliable and structured way for various types of design projects. The toolkit enables the designers to explore alternative ways of browsing, selecting and analysing UGVs for generating design insights and ideas. The toolkit was developed based on several educational projects that involved diverse topics. The following sections present the development of the toolkit based on these studies with a special emphasis on the findings and insights drawn from a half-day workshop conducted for further developing the toolkit.

The toolkit development process started with an analysis of a selection of industrial design studio projects followed by interviews with the students and the tutors involved. The study was based on illustrative case studies where the senior year industrial design students at Anadolu University employed new media tools together with empathic tools; the tutors encouraged the students to utilize online videos to explore an unfamiliar problem domain and to enlarge their knowledge base for problem restructuring. The key insight drawn from this study was that the new media tools coupled with role-playing would be a strategic approach for exploratory design research for unfamiliar problem domains (Eren & Korkut, 2017a). The initial version of the process model and the toolkit was developed and tested in a 5-week educational project involving 75 senior year industrial design students working in groups of five. The project aimed at developing a paediatric examination table and its environment (Eren & Korkut, 2017b). Based upon the findings of these studies, the toolkit was revised and implemented in a half-day crash workshop involving a small number of participants.

2.1 A Taxonomy of Video Analysis Modes and Coding Techniques

A taxonomy of the modes of analysis and coding techniques employed by the students in various educational projects (Eren & Korkut, 2017c) are presented in Table 1. Typically, the video analysis boards prepared by the students were observed to be a compilation of screenshots from the videos or a sequential organisation of them. There were also rare cases where students attempted a more quantified approach and visualized the data quantified by themselves. The analysis boards were also supported by labels, captions, marks, pictograms, comments, and citations from the videos and from the literature search conducted prior to the video analysis. The major modes of analysis identified were thematic collage making, quoting, storyboarding, and quantifying; these modes showed some variations within
themselves. The coding techniques identified were diverse and rich, and included labelling, marking, figure outlining, commenting, diagramming, etc.

Table 1. The modes of analysis and coding techniques employed by the students across various educational projects

<table>
<thead>
<tr>
<th>Mode of Analysis</th>
<th>Coding Technique</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thematic collage making</td>
<td><strong>Labelling</strong></td>
<td>(In the example, the video frames showing the ways in which firefighters handle the hose were brought together, categorized, labelled, and described.)</td>
</tr>
<tr>
<td></td>
<td><strong>Figure outlining</strong></td>
<td>(In the example, the video frames showing various body postures of miners were brought together and outlined, and the outlined figures were isolated for further analysis.)</td>
</tr>
<tr>
<td>Quoting</td>
<td><strong>Marking, Commenting</strong></td>
<td>(In the example, several sequential video frames were quoted to comment on a design insight.)</td>
</tr>
<tr>
<td>Storyboarding</td>
<td><strong>Documenting time-coded observation notes</strong></td>
<td>(In the example, observation notes were provided in relation to the time-coded sequential frames.)</td>
</tr>
<tr>
<td></td>
<td><strong>Marking, Labelling</strong></td>
<td>(In the example, specific regions on the sequential frames were marked and labelled.)</td>
</tr>
<tr>
<td></td>
<td><strong>Documenting observation notes, Zooming in</strong></td>
<td>(In the example, observation notes were given in relation to sequential frames, and a specific part of a frame was shown as a close-up.)</td>
</tr>
</tbody>
</table>
Narrating, Labelling with pictograms
(In the example, several sequential video frames were brought together around a narration. Each narration was categorized and labelled with a pictogram.)

Storyboarding

Marking
(In the example, the whole video was summarized with video frames ordered sequentially. The frames which included specific elements were marked with color-coded circles.)

Storyboarding

Diagramming, Visualizing quantified data
(In the example, various actions of two separate users were quantified and visualized comparatively.)

Quantifying

Thematic Collage Making

Bringing similar or related images from separate videos together is an analysis mode which may help the designer to explore variations or diversity concerning a specific issue such as body posture while carrying out a specific task. Figure 2 shows the video analysis board sample from the toolkit illustrating thematic collage making; the student, who was designing boots for firemen for her graduation project stated that she used YouTube videos to get familiar with the problem domain and the user group. Through the videos she watched on the internet, she was able to explore some extreme cases such as traffic accidents or wild land fires difficult to observe in real life. She prepared a collage from the screenshots from various videos documenting different ways of handling the hose in different contexts. The student had prior knowledge from the literature search on fireman buddy system for hose carrying and handling. She stated that she tried to explore the body postures in detail while carrying the hose and directing its tip to the fire, and the contact areas of the boots to the suit and to the ground.

Quoting the Video Content

Another mode of analysis is video quotation. In the example provided in Figure 3, the student “quoted” a video section where a design contribution would make sense by taking screenshots from the video and making a video line with specific key frames. She marked the key areas and elements to analyse the event.

Storyboarding the Video Content

By taking screenshots from the video, organizing them into a storyboard with sequential key frames, and writing down the observations by indicating the time it took place in the video, the video content can be presented in the form of a storyboard. Figure 4 shows the video analysis board sample from the toolkit illustrating storyboarding the video content. Concerning the project, the student reported that she reframed her design problem as “feeding babies in restaurants, creating a hygienic surface on feeding chairs, and letting the baby feed himself/herself.” She watched YouTube videos and documented important issues that might help generate design ideas. She took screenshots from the videos that she found relevant and significant, wrote captions and annotations under them, and used color-coded
marks on them. She stated that she tried to document hand functions in relation to the actions of the caretaker and the baby, while considering the range of baby’s reach on the feeding chair.

Quantifying the Video Content
One of the approaches developed by the students was quantifying and visualizing the quantified data. In the example given in Figure 5, the student intended to measure the frequency of activities and sub-activities to understand how many times these actions were performed and how effective a particular action was in the process. She adopted a comparative approach and made comparisons between two separate videos concerning two children with similar levels of cerebral palsy to reveal the commonalities and the variations in their conditions. For this purpose, she used a time-line diagram showing when and for how long an activity or sub-activity took place. She color-coded them in the diagram according to the child observed in the video to show the differences specific to each child and the commonalities between them. Understanding similarities and differences helped the student to observe common problems and individual needs, the variations concerning the walking support needs of people with cerebral palsy, and to explore which actions needed care.

Figure 2. The video analysis board sample from the toolkit illustrating thematic collage making

Figure 3. The video analysis board sample from the toolkit illustrating video quotation. The example is from “walking support for people with cerebral palsy” project.
2.2 Implementing the Revised Toolkit Through a Workshop

As mentioned earlier, based upon the findings of the studies conducted, the toolkit was revised and implemented in a half-day crash workshop involving a small number of participants. During the workshop, the participants were provided with a concise literature review regarding the specific project topic given – paediatric examination table and its surroundings, a YouTube playlist of relevant videos, the video analysis board samples compiled from the previous studies, and the video analysis board templates for different modes of analysis. The participants were also informed that the literature review findings drew attention to the examination position, the equipment used, the frequency of an observed problem, the attitude and behaviour of the medical personnel, and the examination environment. The
participants were free to use the proposed video analysis modes and coding techniques or approaches of their own choice to explore the project topic. Since the toolkit puts a special emphasis on unfamiliar domains and challenging user groups, the workshop also involved the assistance of an external expert during the video reviewing and analysis phase.

In the previous study (Eren & Korkut, 2017b) the student teams had watched and analysed the videos, prepared their video analysis boards, and then discussed their analyses and insights with an expert. Considering the time limitations and the small number of participants involved, we adopted a different approach for the workshop; the videos were viewed by the participants and the expert together, which allowed the direct involvement of the expert in the video analysis process (Fig. 7). Thus, the observations, questions or insights voiced by the participants were commented on by the expert during the video viewing and analysis. It was observed that when the participants focused on a subject and searched for an insight, the expert provided specific and just-in-time feedback on the subject verbally or by acting out bodily. For example, while viewing a video content the participants noticed that the butterfly figures on the wall were not actually decorative; the expert commented on it and drew their attention to guiding the child indirectly during the examination, and the discussion led to design insights related to the paediatric examination table and its surroundings.

The participants were able to conduct the video analysis quickly and benefit from the video analysis board templates. While watching the videos, they used these documents as guidelines rather than templates to fill in. The direct involvement of the expert accelerated the process significantly. While it might be difficult to involve an expert directly in such a process for large groups, it was observed to be beneficial for a small group. The final stage of the workshop was idea generation and it was concluded with a concept map (Fig. 8). The idea of building a concept map emerged in response to the time limitation and the participants were observed to favour a format that allowed a more open-ended group work. The concept map was suitable both for documenting the observations and interpretations from the videos and for relating them to the emerging design ideas as a complex set of interconnected propositions. The design ideas were expressed in the form of product requirements and descriptions.

The participants prepared the concept map and linked the color-coded areas with arrows (Fig. 8). As explained by the participants, the issues circled in pink focused on the physical space such as the general atmosphere of the examination room. The subjects circled in orange referred to accessibility, safety, ergonomics and circulation such as circulation patterns around the examination table. The issues circled in green referred to the interaction with the stakeholders and the distribution of tasks during the examination process such as the location of the attendant. The issues circled in red referred to the proposed interaction between doctor, patient and attendant such as keeping the stakeholders within the child’s visual field and at his/her eye level. The design ideas that emerged as a result of the concept map study implied gamified experiences: a thematic path in relation to the stages of the examination, and an examination mascot in relation to the child’s mood. The participants proposed several thematic paths including adventure island, forest and space. An examination mascot which would accompany the child throughout the process was considered useful to reduce the feeling of uncertainty.
Figure 8. The concept map prepared by the participants collectively during the workshop

3 Conclusion

Although dealing with diverse and unfamiliar problem domains help design students develop new knowledge and skills, coping with challenging user groups or use environments in educational projects involves serious difficulties for design educators and students. Despite causing a number of ethical and scientific concerns, user-generated online video content has been becoming a noticeable teaching, learning and research medium for various professions and practices; UGC is convenient, accessible and in massive quantity. Utilising this medium to empower design students and tutors for exploring unfamiliar or challenging problem domains in the early phases of design process requires the development of novel approaches and methods tuned to the qualities of the medium and to the needs of the stakeholders involved.

A previous study we conducted (Eren & Korkut, 2017a) indicated that utilising UGVs together with role-playing would be a promising approach for exploratory design research for unfamiliar problem domains; this approach brings together three actors – students, tutors and experts, and utilises literature search, UGV analysis and role-playing. The expert is the key actor, a live support agent, who can provide help for interpreting the specific literature, discussing and providing feedback about the credibility of the UGVs, sorting out the priorities, and may facilitate personalized and first-hand experience through role-playing. This paper focuses on user-generated online videos only and discusses the development stages of a toolkit which aims at supporting design students to browse, select and analyse UGVs for generating insights and ideas for unfamiliar problem domains. A workshop was conducted with a small number of participants to test and develop the latest version of the toolkit. During the workshop, UGVs were viewed and interpreted together with an expert, and it was observed that the templates provided were not used directly but only as guidelines; the participants discussed and diagrammatically visualized their findings, design insights and ideas in the form of a concept map. The workshop results drew our attention to the impact of the expert’s presence in the UGV analysis process. In our previous studies the video analysis boards prepared by the students had served to document and visualize the findings and insights from the UGVs in detail and facilitated a thorough discussion of these with the experts and the tutors. In a condensed and small-group study where the participants were accompanied by an expert during the analysis, on the other hand, a format which enabled quick note taking turned out to be a more practical alternative. An important outcome of the workshop is the need to diversify the tools provided to the participants for UGV analysis in accordance with the mode of analysis and the level of expertise available. The workshop results also indicated that the toolkit needs to address UGV analysis at different resolutions such as pre-screening or in-depth analysis.
References


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An *In-between* Ludic Approach for UX Research: A Case Study

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**Abstract:** UX research is a still under-defined topic, in which a definite sense for both researchers and practitioners is to be found. In this context, we propose a UX approach to be introduced as an integrative educational method, useful to translate user studies results into indications for the future experience that users will have in relation to the designed product, service or installation. Our approach is based on an early and direct involvement of the user, the scope of which is about letting the designer get inspiration throughout the ideation process. It is imagined to stand in-between the explorational and generative phases of the design process, putting itself in an interstitial space between quantitative or qualitative research, ethnography and co-design, detached analysis and proactive cooperation. In this way, we are trying to go beyond the concepts of human-centred design, towards a design-driven research that makes UX methods and tools meaningful for the designer. The approach is described through a hands-on experience of a student’s thesis work and is purposed to set the beginning of a conversation for future developments.

**Keywords:** UX research; design-driven research; beyond HCD approach; user involvement; UX in education

1 Introduction

The purpose of the contribution is to propose an integrative approach to UX. It is presented through a hands-on experience that refers to a design thesis project developed in 2017 (Sciannamè, 2017), at Politecnico di Milano, and set in Bagatti Valsecchi’s House Museum: a fascinating historic house in downtown Milan, populated by its owners with original and fake Renaissance artworks and furnishing, and pointed by Orhan Pamuk as the main inspiration for its masterpiece *The Museum of Innocence*. The project lays in the fields of interior and interaction design, as it aims to improve spaces through a meaningful experience of them, provided by contemporary digital technologies that need to be unobtrusively embedded in the space itself.
It can be stated that this context of user experience (UX) research perfectly reflects Hassenzahl’s (2011) new millennium Experience Society, where people are no longer interested in material goods, preferring meaningful and memorable engagement and where, therefore, design has to transcend the object-centred – or, in this case, exhibition-centred – attitude, in favour of an experience-centred approach. According to the wide-ranging tendency in design research today, experience and interaction design are inevitably intertwined with digital technologies (Dourish, 2001; Kaptelinin & Nardi, 2009, p. 253; Hassenzahl, 2011; Rasmussen, 2013, p. 2), hence UX has to deal with issues related to human-computer interaction (HCI), but extendable to design in general: the meaning of UX is not to be found in the instrumental values of a product or service, yet in a more vast set of variables regarding the user’s sensations and perceptions towards a positive contribute to his/her quality of life (Hassenzahl & Tractinsky, 2006).

In the light of these premises, the paper intends to highlight the current principles and practices that guide UX research to propose an integrative approach: a methodology which stands in-between ethnography and prototype testing, collecting quantitative data and qualitative impressions, context analysis and co-design. The approach is then described through its application in a hands-on experience, specifying the methods that brought to its definition and the reported results. Ultimately, the valuable contribution as well as the limits the approach presents, both in the design process and in the academic context, are discussed in order to start a conversation towards future developments.

2 Theoretical Setting

The attempt to reach a definition of UX necessarily leads to a holistic focus on the user (Hassenzahl & Tractinsky, 2006; Väänänen-Vainio-Mattila, Roto & Hassenzahl, 2008; Hassenzahl, 2008; 2011). This does not imply an elemental vs Gestalt approach (Blythe, Hassenzahl, Law & Vermeeren, 2007, p. 1), nor a deconstructive attitude excluding the situatedness and uniqueness of the experience (Law, Vermeeren, Hassenzahl & Blythe, 2007). The holistic approach is here intended just as the opposite of reductiveness (Blythe et al., 2007, p. 1), it is the overcoming of utility and usability in favour of the broader and more human definition of UX deriving from encountering systems (Roto, Law, Vermeeren & Hoonhout, 2011, p. 6), thus encompassing active and passive interactions as well as a wide range of artefacts. As both Forlizzi and Battarbee (2004) and Hassenzahl and Tractinsky (2006) suggested, UX needs to shift attention to the pragmatic aspects of an interaction – such as physical, sensual and cognitive qualities – as well as to more subjective ones – like aesthetic, hedonic stimulation, identification, evocation, emotion and affection – to really comprehend an experience (here intended in Forlizzi and Battarbee’s definition, as something that remains unique and with a sense of completion in one’s memory, and which may inspire emotional and behavioural changes). Even if UX is influenced by the characteristics of the designed system and by the context where it takes place, it is evident that a major part is played by the users’ internal states (Hassenzahl & Tractinsky, 2006; Roto et al., 2011) and, thus, a user-centred design approach is inevitable.

Through experience we give meaning to the world (Wenger, 1998, p. 51; Dourish, 2001, p. 129) so, from the designer’s point of view, UX needs to be about the meaning involved in the interaction between the user and the outcome of the design process (Forlizzi, 1997, p. 12; Ciolfi, 2004, p. 27). By the way, there is no common acceptance about the meaning of UX in design practices, it is not clear what UX mainly represents and which is its aim. Instead, there are studies about design-inclusive UX research, in which design is considered part of and contributing to UX research, and the modalities of this relationship are investigated (Vermeeren, Roto & Väänänen, 2016).

In human-centred research and design, even the involvement of the user is not univocally pursued. It can be requested in different moments and with different purposes throughout the design process. Furthermore, the users to whom the designer addresses his/her work may change, considering past, present or future users. As Zhang and Dong (2016) explain, user studies can be synthesized in three different approaches: (i) empirical studies, based on the analysis of past experiences; (ii) experimental studies, in which designers learn from the present situation; and (iii) scenario-based studies, focused on an expected future. Additionally, the methods of enquiry differ on the basis of the UX researcher’s attitude: they can be mainly qualitative, corresponding the requirements of a creative process; but also strictly quantitative and replicable, following rigorous protocols gathered from science (Hanington, 2010). From this primary distinction, where both are valid and valuable paths, the involvement of users is again differentiated according to the activity of the engagement the researcher requires. As stated by Zhang and Dong (2016) in their four-modelled framework, user studies can be conducted through an indirect involvement, by designers representing users – after an ethnographical investigation, for instance – or, increasingly augmenting users’ participation, by designers consulting users – we can think about questionnaires, focus groups, structured interviews, etc. –, by users participating in the design process or even by users as designers – as utmost result of co-design practices. Eventually, UX can inform different phases of the research and design processes depending on its attended contribution and
motivations: it can be introduced preliminary in the process, during the exploratory phase, when the researcher/designer needs to discover information about the people he/she is targeting, their context and their habits; during the generative phase, both in a projective or constructive way; or, after the product or prototype is completed, during the evaluative phase, to test the solution in an iterative process (Hanington, 2010).

As Hanington (2010) asserts, human-centred designers and researchers need a balance between the multitude of existing methodologies for UX inquiries. This is not just about the quality or quantity of data, nor the activities conceived to collect them: a key factor also regards the role users have to play in the design process.

In this context, we propose an approach that stands in-between qualitative and quantitative methods, ethno-graphy and co-design, detached analysis and proactive cooperation, something that is currently foreseen but not sufficiently deepened: an early involvement of the user to guide and shape the design process (Jordan, 2000; Forlizzi & Battarbee, 2004; Yargin, Süner & Günay, 2018).

The reason for that can be outlined from Hassenzahl’s (2011) definition of experience design. If user experience can be summarized by answering the questions what, how and why – hence tracing the functions, the modalities and the reasons for the interaction with a product or service – the designer aiming to design for experience (Kolko, 2011) firstly has to identify why he/she is doing that, which are the needs and the emotions involved and, most importantly, what is the meaning in people’s interactions (Forlizzi & Battarbee, 2004) and, therefore, in his/her own work. A clarification in the scopes of UX research and design is fundamental and primary for the designer approaching the discipline. Maybe figuring the user as the unique and pivotal centre of the design process embeds the risk to remain stuck in present paradigms, while “[…] the research must be directed toward new interpretations of what could be meaningful to people” (Norman & Verganti, 2014, p. 96; Forlizzi, 2018). In this scenario the designer gains a central role by changing the meaning of UX. Placing itself in an interstitial space between ethnography and testing, UX research becomes design-driven. A renewed importance is given to the designer’s personal interpretational process. (S)he can bring inspiration from user studies and technologies through a personal interpretation of the results of his/her inquiries, finding the balance between the validity of qualitative and quantitative methods (Hanington, 2010), both because the designer defines the tools to involve users, already applying a personal lens, and because qualitative data is open to interpretation.

In this context of the user’s early involvement as an inspirational process for the designer, exploratory design games are an interesting solution to undertake. In fact, games and play have been assessed as tools for research (Habakken, & Gross, 1987), as well as design (Ehn, Sjögren, Greenbaum & Kyng, 1992) and educational tools (Buur & Iversen, 2002). Focusing on their research employment, they can be means for both collaborative inquiry into existing practices and participatory visualisation of possible futures (Brandt, 2006), covering a wide range of design issues to investigate the uncertainty of reality and therefore envisioning strategies to cope with its complexity (Brandt, Kjærgård, Schou & Vallin, 2011, p. 12). They have a few peculiarities that identify them as perfect instruments for involving users. First of all, exploratory design games are intrinsically engaging and enjoyable for people to take part in (Brandt, 2006, p. 65), especially if they are designed according to an embedded approach (Kaufman & Flanagan, 2015), so that the real purpose of the game is concealed to the player. Then, they are able to make the users feel at ease, creating an informal atmosphere and even fictional game worlds for them to empathise with, figuring scenarios. In fact, abstraction and stylization allow people to eliminate functional knowledge and experiences (Brandt, 2006, p. 58), freeing their creativity. Fundamental components of exploratory games are their materials that work as boundary objects (Star & Griesemer, 1989). At the same time, they are shared by the participants but still they leave space for different interpretations (Brandt, 2006, p. 63). Especially if they are contextualized, they facilitate people’s remembering of experiences and help setting a discussion, also, in a very brief amount of time (Brandt et al., 2011, p. 10). Due to their characteristics, design exploratory games can be used for different purposes, such as to conceptualize design, exchange perspective, orientate negotiation and work-flow, or scenario (Brandt, 2006), but there cannot be a further specification of their traits as they are essentially flexible, varying upon context, purposes, application areas (Vaajakallio & Mattelmäki, 2014) and even user’s typology.

Thus, our proposal comes with a shift of meaning in UX research. Acknowledging the current tendencies, which are still under definition, we propose a different way to exploit user studies into the design process, considering them as sources of inspiration for the designer’s personal process of concept development and using games as triggers of UX research. In the next section a hands-on experience of the approach here discussed is described as an example.
3 Methods

3.1 Exploratory Research

Proposing an approach for UX research does not imply the crossing out of any other. The contribution aims to suggest a method that can be complementary and not substitutionary to current practices. In fact, in the reported case, the research starts with a primary quantitative collection of data and an ethnographical enquiry (Stake, 1995).

The Bagatti Valsecchi’s Museum has been selected for a well-established relationship with Politecnico di Milano and for its richness in stories to be unveiled to visitors. In order to get acquaintance of the museum, the location for which an interactive installation had to be designed to enrich its spaces, and convey additional cultural contents, an investigation of the users targeted by the project has been conducted.

Firstly, quantitative data about the visitors of the previous semester were collected through the statistic system of the museum, inferring their geographical provenance (Italy/other countries), an approximation of their age and of their cultural interest (whether or not they were possessors of museums or cultural heritage associations memberships). Secondly, to get a little closer to the users of the museum and to comprehend its dynamics, an ethnographical enquiry based on unobtrusive shadowing has been undertaken. That seemed to be the better solution to get impartial information about visitors’ experience inside the museum, as their direct involvement in this exploratory phase could have vitiated the results. A sample of one hundred people or groups have been followed through their entire permanence in the museum spaces to understand their behaviour and attitude towards the rooms and exhibited goods. They were warned at the beginning of the visit that an ethnographic study was in progress and, frequently, the same visitors were also involved in the activities described in the following. In the meantime, a structured form was being filled in to take notes about the visitors’ profiles (age range and spoken language); their social condition (alone, in couple, in group); the tools used (audio guide, informational sheets, Silent Book, app, guided tour or no tool); the path followed; the stay times for each room; the objects that caught their attention; their general attitude; and any particular behaviour they manifested in the different places. This system had the limit to be based just on the researcher’s observation in a time span of about a month, that is why a complementary qualitative research has been undertaken. Taking advantage of their long experience at Bagatti Valsecchi’s, the museum personnel has been directly involved in the research through semi-structured interviews. Fourteen volunteers answered questions aimed at completing the information about the visitors (in the first part of the interview) and their relation with the museum (in the second part), adding multiple and more expert points of view to the exploratory research. They were asked about visitors’ profiles (approximative age, provenance and cultural background); the most appealing rooms or goods; frequent questions and comments; visit modalities (tools and social configuration); the efficacy of the communication tools; eventual missing information; and – more subjectively – their opinion about the reasons for people to visit the museum and what could be improved.

Although, despite the gained familiarity with the place and its users, none of the collected information provided a hint on the meaning for the intervention to be designed, which we previously stated has to be the purpose of UX research.

3.2 In-between Approach

In the generative phase of research (Hanington, 2010), which stands in-between the deepening of users’ exploration and the beginning of the creative process, an active involvement of the visitors seemed to be the best way to guide and shape the design process.

Through a direct confrontation with the possible users, a complexity of unquantifiable factors could be acknowledged, enriching the quantitative research with impressions coming from a personal contact. To get to the required results, the research took inspiration from co-design modalities (Methods: Co-Design Resources for Cultural Heritage Professionals, n.d.; Design Kit, n.d.; Service Design Tools, n.d. to give some examples) and design exploratory games, where active participation is encouraged. Here is to note that the peculiarity of the proposed approach does not stand in its methodology yet in its scope. As a matter of fact, co-design practices and ludic activities inform the generative research in a constructive way (Hanington, 2010), enhancing a positive dialogue that lets users participate in the design process or even act as designers (Zhang & Dong, 2016). Conversely, here the inquest had a projective aim, to provide inspiration for the designer’s creative development.

In particular, simple physical games have been chosen as instruments of inquiry due to different reasons. First of all, they are participatory, they guarantee a common ground for conversation (Brandt, 2011) as game is instilled in human society since its origins (Huizinga, 1938). Moreover, games respond to the necessity of acquiring spontaneous and
unvitiated reactions since, when people enter the parallel dimension of a game, no matter how basic it is, they feel freed from social and cultural expectations (Csikszentmihalyi, 1990). Ludic materials look much less inquisitorial than questionnaires, letting people feel more at ease throughout the investigational activities. Indeed, tangible items encourage users’ engagement, especially in a museum context (Dudley, 2009), acting as boundary objects (Star & Griesemer, 1989; Spallazzo & Mariani, 2017): the tools have different meanings for the visitors (who primarily perceive their ludic value) and for the researcher.

Following, the two UX research-oriented games are described. Both were to be proposed at the end of the visitors’ tour of the museum, just before leaving. Visitors could choose whether to participate to the research by playing one or both games, or to decline. Ultimately one hundred samples per each activity were collected.

As a common practice, the games were introduced by some ice breaking questions, aimed at profiling people. The information requested were the same as the ethnographical inquiry (range of age and provenance) with the addition of their profession (to understand if there were relations between that and their cultural interests) and if it was the first time for them visiting the Bagatti Valsecchi’s Museum.

### 3.2.1 Play Your Cards
The first activity was intended to investigate visitors’ reflections, preferences and emotional connections with the different rooms of the museum.

It was composed of 18 cards, representing each room of the museum, and a dice with six different questions, initially undisclosed to the visitor (Figure 1). Firstly, players had to freely choose three cards, providing a reason for each choice, then they threw the dice and answered the question with one of the cards previously selected and a motivation. Whether none of them reflected the players’ opinion, they were free to give their actual answer, as the goal of the game was to originate a conversation to collect the greatest amount of information (for the same reason, a very short list of optional questions completed the form related to the activity). As the initial pick was completely undetermined by the rules of the game, in order to gather any kind of feedback and thought from the users, questions about negative feelings have been avoided in the dice to favour the most predictable attitude. Nevertheless, they were also not too obvious so that a deeper reflection was stimulated. Some examples are: *Which room would you like to have in your own house? or of which room would you send a postcard? To whom?*

![Figure 1. Cards and dice of the “Play Your Cards” game (Sciannamè, 2017).](image)

### 3.2.2 The Secret Inventory of the Bagatti Valsecchi Brothers
For the second game, the visitors had to be more detached from their real experience, to feel free to explore their purest desires. The activity was, in fact, designed to understand what visitors would like to discover, experience and perform inside the museum, but such a request would have overwhelmed the users. That is why, according to a design embedded approach (Kaufman & Flanagan, 2015), the real aim of the game was concealed by an alternative narrative.

The players were presented a fictional ancient-looking secret inventory of the Bagatti Valsecchi brothers (Figure 2), in which were catalogued a series of mysterious magical artefacts. Each of them had a particular power and represented a different kind of experience that could be achieved with the support of digital technologies. In this case, the players...
had to read the inventory (all the materials were provided in Italian, English and French), choose their favourite object and state where in the museum and how they would have used it. Here the choice was deliberately wide-ranged to offer the most complete overview with different kind of stimuli. There are ten different artefacts in the inventory: the Past-time Pocket Watch that suggests an immersive yet passive experience, possible, for instance, through video mapping; X-ray Glasses, also through image – or any other kind of – overlay, they add content to the space; the Metamorphosis Waistcoat, to make people protagonists of the experience though a direct interaction with multimedia contents, and favouring their entrance in Csikszentmihalyi’s flow (Csikszentmihalyi, 1990); the Thought Bowler, offering a more intimate set of contents with an interaction limited to the choice of people to interrogate; the Invisibility Cloak allowing often prohibited behaviours through tangible Interaction; the Shadows Candle that fosters an environmental experience; the Fine Nose, to activate an unusual perspective on senses stimulation; the Life Quill which involves a very active involvement of users and gives space to their fantasy through digital implementation; the Mirror on the Beyond differing from other artefacts by basing the experience on dialogue and, therefore, recalling AI; and Carte Blanche, to give expression to visitors’ imagination and comprehend any kind of experience that could have been omitted.

Figure 2. Secret Inventories in the three languages proposed (Sciannamè, 2017).

4 Results

As they have little use for the dissertation, the data resulting from the ethnographical research will not be largely discussed. With 236 profiled people (mostly Italian adults – ranging from 31 to 70 – from different cultural backgrounds) and 100 samples coming from the Follow Through observation, it became clear that objective data had scarce practical utility in the design process. However, they informed the researcher about the context for her intervention, that proved to be greatly appealing and highly engaging for almost anyone, as the medium stay time, the observation of behaviours and the collection of opinions clearly demonstrated. It was particularly useful to assess people’s reactions and attitudes towards the space. They even happened to come unexpectedly in relation to the context, e.g. people tried to actively interact with the museum’s artefacts because of their familiarity. This intrigued and affected the researcher so much that the behaviours and emotions manifested by the visitors deeply inspired the development of the games and even the final project, which tries to trigger those spontaneous yet not allowed behaviours.

4.1 Play Your Cards

This activity attracted the preferences of the visitors both because it had the most recognizable game materials (dice and cards) and because it was presented as the fastest.

As expected, it was easy and immediate for the players to understand, no one considered the lack of indications about which cards to pick as a problem, and most of them chose the preferred ones. In addition, the photographic references of the rooms turned out to be fundamental as the visitors especially remembered the sensations that they felt in each of them but not their names, though a visual stimulation was able to recall the experience of the places. As a weakness point, despite the explanations, picking the cards and throwing the dice were frequently perceived as unrelated actions, so, people tended to freely answer the questions choosing among all the cards.
The game intended to collect information about visitors’ preferences and reflections about the museum and, regarding that, it can be pointed out that due to the wide number of possible choices (18) no great percentage manifested a preference (Figure 3): 42 over 100 people selected Fausto’s Bathroom (one of the most iconic rooms of the house). In respect of the answers to the dice, instead, it can be outlined that they were mostly creative and thoughtful, providing interesting points of view. In conclusion, besides the countable data that resulted from the activity, Play Your Cards was mainly conceived to be a trigger for conversation. By the way, only 23 over 100 people agreed to answer the additional questions while the great majority preferred to play also the second game, which is significant as they were not forced to play both games.

In conclusion, besides the countable data that resulted from the activity, Play Your Cards was mainly conceived to be a trigger for conversation. By the way, only 23 over 100 people agreed to answer the additional questions while the great majority preferred to play also the second game, which is significant as they were not forced to play both games.

4.2 The Secret Inventory of the Bagatti Valsecchi Brothers

Inevitably, this activity was the most demanding in terms of personal effort and it was much more dependent on the language. Yet, it could also be a collective activity, letting multiple people simultaneously participate and drawing others to do the same. Positively, many appreciated the idea and the quality of the material but, on the other hand, once immersed in the engaging selection of the preferred artefact, they completely forgot the connection with the museum rooms, overcome by their limitless imagination.

As the Past-time Pocket Watch was the most voted artefact (30 over 100 preferences) (Figure 4), the strong will that visitors had to deepen their acquaintance of the house emerged most intimate and familiar aspects, and that was underlined also by their explanations and selection of the rooms they wanted to better discover. In fact, the most cited rooms: the Grand Salon, the Red Room (where the kids’ objects are kept) and a general everywhere were evocatively connected to the social and domestic life in the house. By the way, even if visitors wanted to feel closer to Bagatti Valsecchi’s family, the experience they portrayed was rather passive, as secret observers.

4.3 How the Results of the In-between Approach Informed the Design Process

Clearly the designer may transfer the quantitative data collected directly into his/her project, as if the users involved had determined some of its traits. However, even if one might decide to do so, it would not be in opposition to the
principles of the approach. Unlike in co-design practices, where the users are specifically called to have an active role in the design process, in this case, they are not (and must not be) aware of the actual purpose of their involvement in the research. Furthermore, in the described example, no one even seemed to care about it, as nobody asked about how the data was supposed to be used after the experience.

Specifically, in the case presented, some meaningful data was kept as guidance in the design process, for instance: a familiar perspective and a not-too-challenging experience were raised to become objectives of the project. In general, this kind of UX research surely gave a privileged insight on the visitors’ repressed expectations (to a direct question, everything about the museum was perfect and nothing had to be changed, while transporting them to a most-likely impossible scenario they revealed their concealed thoughts). In that sense, the most valuable result proved to be the visitors’ attitude towards the ludic activities that were proposed to them. It was as much unexpected as positive and proactive: many people favourably agreed to take part in the games and even the more reluctant ones seemed to enjoy the brief playful experience. Some of them even claimed they had fun. Users’ involvement through games has given proof of its efficacy, as it was demonstrated by the fact that most of times the preliminary profiling questions were not needed as ice breaking facilitators: the game itself covered that function. Ultimately, this unquantifiable information certainly overcame any other datum in the attempt to understand and define the meaning for the designed outcome. Users of the Bagatti Valsecchi’s Museum were eager to be involved in some activity, and this was a meaningful realization in the perspective of the designing for an interactive experience.

5 Discussion

As it has been made evident from the described example, the application of an in-between, design-oriented UX approach, conducted through gaming-modalities as direct, physical and active interaction with the users can inform the design process by guiding the designer’s personal interpretations and decisions towards the setting of a meaning. The novelty, indeed, relies in its being an activity to be set between the exploratory phase, frequently carried out through mixed methods – quantitative and qualitative – and the generative one. The approach here discussed is configured as a support for designers in the delicate and time demanding phase that translates data from user studies into a design concept able of coupling answers to explicit and implicit users’ desires together with fascinating and original design solutions.

A matter of discussion is how to implement it in UX education, in combination with other traditional methods, in the attempt to make the aim of UX itself clearer for students and practitioners, as it is presented as a source of inspiration for the development of the design process. The in-between approach here discussed has not been included in undergraduate or graduate program so far; nevertheless, a critical reflection on limitations and opportunities of such approach has been conducted in order to inform its introduction in UX curricula.

As we outline in the following, a clear limitation of this approach is its specificity that may hinder its generalization within a formal educational activity. Nevertheless, we think that some defining traits may be of guidance for the inclusion of such an in-between approach within a UX education curriculum in a higher education context. First of all, (i) it needs to be carried out in-between the exploratory and generative phases, informing both of them and setting itself among the projective activities (Hanington, 2010). Secondly, (ii) it requires the direct involvement of designer with users, since we feel this direct relationship may be highly beneficial in better envisioning the extant UX – in terms of perceptions, needs and desires – with a deeper perspective. Furthermore, our results suggest that (iii) the employment of elements taken from the game design field may facilitate the direct involvement of users and more fruitful contributions in respect to traditional methods such as the interviews. In particular, the creation of a fictional world with its own rules and tools/objects, and the use of game mechanics resulted extremely useful in, respectively, detaching users from the “here and now” and involving them utterly even if for the short time of the game experience. Moreover, following (iv) the embedded design approach proposed by Kaufman and Flanagan (2015), so concealing the real aim of the experience, resulted in a more relaxed participation of users in what can be actually considered a meta-design activity.

The general traits outlined above only define the skeleton of the in-between tool here discussed but leave wide margins to define the specific characteristics of the tools that have to be tailored on the variable requests of the designer/researcher. An aspect that can be considered a strong limitation, since it sets this in-between approach far from being a comprehensive method, in the same way as cultural probes, personas, focus groups and other tools. It is indeed difficult to outline a univocal way to define its development, as it needs to strictly adapt to the context and purposes of each situation. At the same time, its vagueness may be interpreted as a richness in an educational context since it can be, on the one hand, a stimulus for students to anticipate a creative elaboration of the raw materials.
collected through traditional research methods. At the same time, it can be an opportunity for educators to better explore with students that delicate phase that blurs research with its translation into a concept. Actually, going beyond HCD (Forlizzi, 2018; Norman & Verganti, 2014) is a very ambitious programme, as the threshold between getting inspiration from UX research and remaining stuck in the users’ point of view (therefore producing no real change) is extremely thin.

In conclusion, this contribution aims to be a starting point for a wider conversation about a novel, meaningful approach towards UX: originating from a long-foreseen early involvement of the user in the design process and culminating in a significant reinterpretation of the discipline itself.

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References


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Rapid Development of Materials Experience through Active Learning

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Abstract: In recent years, initiatives have been made to transition materials and design teaching from a predominantly lecture-based and engineering-dominated subject to one that is more practical and nurturing of experiential knowledge. These initiatives have been sparked by the ever-growing body of research into materials experience and the characterization of materials as an influencer of user experiences. This paper contributes to the dissemination of tools and techniques that can bring teaching and learning of materials experience alive within a design curriculum. It presents the rationale and description of a structured activity entitled Material Love-Hate, specifically developed as a means for students to rapidly develop their materials experience in a classroom or design studio environment. The activity requires students to probe classmates’ appraisals of two owned products: one with product materials that they love and one with product materials that they hate. Quantitative and qualitative data are generated and analysed through the activity. On completion of Material Love-Hate, students demonstrate the expansion of their materials experience by preparing a coursework assignment that relates the appraisal of their two products to sensorial-affective and interpretative categories of materials experience. The paper focuses on activity development and reflection of instructor and student didactic experiences, not on the material appraisal datasets that were generated.

Keywords: materials; user experience; product design; interaction; active learning

1 Introduction

For the profession of industrial design, the effect of material choices on people’s experiences of products has always been a subject of high importance. Only in relatively recent times, however, has research effort been put into building an evidence base to support designers’ evaluation and adoption of materials based on experiential specifications (e.g. pioneering work by Ashby & Johnson, 2002; Karana, 2009; van Kesteren, 2008; Pedgley, 1999; Rognoli, 2004). In the intervening years, the term materials experience has entered the vocabulary of design researchers in the field (Karana, Pedgley & Rognoli, 2014). The term encompasses two interconnected concepts:

- the individual experiences that people have with, and through, the materials of a particular design;
- the cumulative experiences that people possess through their interactions with the material world (for designers, facilitating good material-related design decisions; for users and consumers, facilitating material critiques and preferences).
Materials experience has emerged alongside the huge expansion in recent years of research centred on people’s experiences of products generally, across initial, short-term and long-term usage and ownership. For designers, increased awareness and understanding of other people’s materials experience—so-called “second-order understanding” (Krippendorff, 2006)—fuels a greater breadth and depth of one’s own materials experience. With the emergence of materials experience, we may say that user-centred materials and design activities are starting to be supported by operational knowledge that is both distinct and complementary to that of engineering disciplines.

Fundamental to studies into materials experience is the notion of user-material-product relationships and the way materials are implicated in user experiences. The design researcher’s concern in this regard is to understand how the properties of materials can be influential on the total experience of a product, by satisfying people’s pragmatic and hedonic needs (Hassenzahl, 2010). Thus, beyond knowing about material properties such as hardness, glossiness, recyclability and cost, materials experience is essentially about knowing and understanding how people feel, feel about, and respond to material properties. Industrial design students and practitioners are known to be more comfortable to begin materials investigations from such a perspective of experiential characterization, rather than commencing with technical requirements.

In structuring materials experience studies, researchers typically adopt a framework of user experience or a set of psychological constructs that help explain how materials can act as a modulator of product experience. One framework that has found particularly widespread use is the framework of product experience developed by Desmet and Hekkert (2007). This has been comprehensively interpreted for use in the domain of materials and design by Karana, Pedgley and Rognoli (2015) and Karana et al. (2014). The published versions comprise three differentiated components of user experience (aesthetics, emotions, meanings), to which a fourth (actions-behaviours) component has recently been appended (Giaccardi & Karana, 2015). Within the current state-of-the-art, materials experience is evaluated against criteria contained in Table 1.

<table>
<thead>
<tr>
<th>Appraisal Category</th>
<th>Component of UX</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensorial-Affective</td>
<td>Aesthetics</td>
<td>How the properties or characteristics of materials are sensed and liked (or not) by people (e.g. high glossiness, low hardness, bad smell).</td>
</tr>
<tr>
<td></td>
<td>Emotions</td>
<td>How materials can be attributable to changes in people’s core affect (e.g. a source of surprise - ooh!, disgust - urgh!, joy - wow!).</td>
</tr>
<tr>
<td>Interpretable</td>
<td>Meanings</td>
<td>How people judge, evaluate and otherwise construct meaning from materials (e.g. labelling a material as being traditional, looking cosy, seemingly toy-like).</td>
</tr>
<tr>
<td>Actions-Behaviours</td>
<td></td>
<td>How materials influence people’s instrumental and non-instrumental interaction behaviour (e.g. carrying out tasks, achieving goals, avoiding contact).</td>
</tr>
</tbody>
</table>

Much more recently, independent international initiatives have started to develop materials experience as a formal subject of study for university design students (Karana, 2011; Pedgley, Rognoli & Karana, 2015). This is still very much a work-in-progress: the literature currently lacks examples of structured activities for teaching and learning that are directed at enhancing students’ materials experience.

It was from this perspective that the work reported in this paper was developed, intending to contribute to the dissemination of tools and techniques that can bring teaching and learning of materials experience alive within a design curriculum. The paper presents an account of the rationale, methods and results of an active learning exercise called Material Love-Hate, involving students rapidly evaluating the materials of everyday products owned by their classmates, in order to develop their personal materials experience.

2 Sensory Sensitivity

For user-oriented design such as industrial design, material requirements and constraints are formulated heavily on the designer’s (or the designer’s expectations for users’) sensory sensitivity. This implies that a designer has command of the spectrum of material sensorial qualities and is able to relate those qualities to the experiences gained through viewing and interacting with products. In this regard, sensory sensitivity may be considered a foundation for acquiring and extending materials experience. More often than not, material appraisals are linked to people’s (dis-)satisfaction with one or more material properties. The materials experience logic for a designer is therefore, for example: knowing...
that there is a term *glossiness*; being aware of the relative glossiness of different kinds of materials; perceiving particular material-component combinations as having degrees of glossiness; understanding that one’s own perception of glossiness can (will) differ from the perception of other people; and finally taking a position on what degree of glossiness is appropriate or preferred in a particular product and context (and why).

### 3 Research Aims and Objectives

The research on which this paper is based had educational (E) as well as materials experience (MX) aims and objectives, as stated in Table 2. Only the aims and objectives related to education are taken forward in this paper. The working principle from the educational perspective was that a student with elevated materials experience will be equipped to make more creative and effective connections between materials and design during their design projects.

<table>
<thead>
<tr>
<th>Objective</th>
<th>Education (E)</th>
<th>Materials Experience (MX)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective 1</td>
<td>To define and implement an active learning exercise through which students can rapidly expand their materials experience.</td>
<td>To generate datasets that can be analysed to reveal shared, isolated and polarized experiences of product materials.</td>
</tr>
<tr>
<td>Objective 2</td>
<td>To expose students first-hand to a variety of material and product combinations.</td>
<td>To determine any general patterns between a product owner’s materials experience and the materials experience of a participant sample group.</td>
</tr>
<tr>
<td>Objective 3</td>
<td>To increase students’ awareness that sensorial qualities and/or material properties are not universally loved/really liked or hated/really disliked.</td>
<td>To identify sensorial qualities and/or material properties that commonly cause people to love/really like or hate/really dislike certain product-material combinations.</td>
</tr>
<tr>
<td>Objective 3</td>
<td>To familiarize students with vocabulary typically used to describe and convey materials experience.</td>
<td>To reveal any common positive or negative appraisals amongst a participant sample group for certain materials, material families, or product-material combinations.</td>
</tr>
</tbody>
</table>

### 4 Material Love-Hate

Material Love-Hate was conceived as an *active learning* product appraisal activity, intended to increase awareness amongst design students of material-product combinations and in so doing enrich their materials experience. Active learning occurs in educational situations where students are required to carry out and reflect upon practical task-based activities linked to predefined learning objectives (Felder & Brent, 2009). For materials and design, the adoption of active learning over lecture-based teaching reflects a transitioning from a culture of imparting knowledge about materials to a culture of generating experience with materials (Pedgley et al., 2015).

The starting point for Material Love-Hate is a set of products whose owners have expressed an emotional experience (love/hate) attributable to the product materials, possibly also accompanied by supplementary finishes and/or shaping processes. The activity exposes students to a wide spectrum of what may be termed *good* through to *bad* material-product combinations. It results in a rich pool of appraisal data to explore how materials are experienced differently by different people. Such appraisals are said to be made of “contextualised material” (Karana & Hekkert, 2010), in the sense that the material has been given form to fit to a particular product and that the material properties make sense because of the usage scenarios envisaged for the product (Howes & Laughlin, 2012; Dent & Sherr, 2014; Lefteri, 2014).

Strategically, asking for loved/hated, rather than liked/disliked material-product combinations, was intended to provoke participants to identify extremities of their materials experience. Although Material Love-Hate launches from an emotional response to product materials, this emotion is likely to be present (or strongly present) only for the product owner. For other people evaluating the product materials—especially for the first time—their experiences represent a short point-in-time appraisal that is more likely to be centred on aesthetics, meanings or behaviours than emotions. Accordingly, we knew that the backdrop storylines leading to the product owner’s love or hate would also inevitably involve aesthetics, meanings and/or behaviour.
Running Material Love-Hate requires two groups of participants: (i) individuals who are highly familiar with a materially loved and materially hated product that they own, and (ii) a pool of people who in all likelihood will be coming into contact with the individuals’ products for the first time. The activity design as presented in this paper is such that students in a single class can fulfil both roles.

Material Love-Hate was initially developed through two small-scale pilot studies at Middle East Technical University, each involving approximately ten graduate students enrolled on the author’s elective course ID725 Materials Experience. The set-up, running, and analysis of the sessions was refined through the pilot studies and a preferred activity design was reached. The pilot studies were particularly helpful in drawing attention to the necessity to ask product owners what part or location on the product was to be evaluated. For example, the appraisals often related to material, finish, texture, or joining of a single component on a product. Only on rare occasions were appraisals directed towards the whole product – usually because the product comprised just a single component.

Having refined the exercise through the pilot studies, a series of main studies was conducted as described in Table 3, at various educational institutions and with different student cohorts. The implementation of Material Love-Hate involves four distinct phases of work: preparation, appraisal session and data processing, quantitative data analysis, and qualitative data analysis. Each phase is now described.

Table 3. Material Love-Hate main studies.

<table>
<thead>
<tr>
<th>Study</th>
<th>Year</th>
<th>Institution</th>
<th>Level</th>
<th>Course</th>
<th>ECTS</th>
<th>Participants</th>
<th>Appraisals</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>2017</td>
<td>University of Liverpool / XJTLU</td>
<td>UG</td>
<td>Product Form and Materials (ENGG226)</td>
<td>3.75</td>
<td>45</td>
<td>4050</td>
</tr>
<tr>
<td>3</td>
<td>2016</td>
<td>University of Liverpool / XJTLU</td>
<td>UG</td>
<td>Product Form and Materials (ENGG226)</td>
<td>3.75</td>
<td>26</td>
<td>1352</td>
</tr>
<tr>
<td>2</td>
<td>2014</td>
<td>Middle East Technical University</td>
<td>PG</td>
<td>Materials Experience (ID725)</td>
<td>8</td>
<td>13</td>
<td>338</td>
</tr>
<tr>
<td>1</td>
<td>2012</td>
<td>Politecnico di Milano</td>
<td>UG</td>
<td>Expressive-Sensorial Dimension of Materials (095036)</td>
<td>5</td>
<td>32</td>
<td>2048</td>
</tr>
</tbody>
</table>

4.1 Preparation

Every student in the class was asked to identify two products that they own: one with a material that they love (or really like) and one with a material that they hate (or really dislike). Product ownership was important, because a love/hate experience is more likely to develop over an extended period of time and use. For each product, students were requested to provide the following information a week in advance of the appraisal session: (i) student name, (ii) product type/description, (iii) brand/manufacturer, (iv) model number/name, (v) component/material part evaluated, (vi) material/finish, (vii) loved or hated, and (viii) high resolution photograph of the product on a white or otherwise plain background. Where possible, the information was gathered through the online learning environments of the institutions in Table 3. The information was collated into a master inventory, with each student randomly assigned a user number (Un) and each product randomly assigned a product number (Pn). In this way, loved and hated products become purposefully mixed in the numbering system, eliminating the possibility that students might decipher which product is which type.

Having gained all the necessary information from students, the second part of the preparation was to create a product information sheet for each product. The sheets contained the following information: product number, product name, product photograph, and description and location of component/material to be evaluated. Each sheet was colour printed at A4 size, ready for the appraisal session (Figure 1).
4.2 Appraisal Session and Data Processing

On the day of the appraisal session, students were required to bring their two products to class. A large open room was arranged with rows of tables, onto which the product information sheets were placed. On arrival to the room, students placed their product alongside the correct information sheet, in readiness for appraisals. Each student was distributed a questionnaire pre-prepared with their name and user number. The questionnaire was used to appraise all of the class’s products (Figure 2). The questionnaire was divided into two sections: (i) a Likert scale, and (ii) free text area requesting a brief reason/justification for each Likert scale score given. The Likert scale ranged from really like to really dislike but purposefully did not include ordinals for love and hate since these would not be relevant to the majority of people freshly acquainted with the products.

Figure 1. Two example product information sheets.

Figure 2. Example questionnaire containing Likert scale grading and free text area.
A short (ten-minute) briefing was provided to students to explain the purpose of the session and to provide the rules for the rapid appraisal process, as below.

- Only one minute is available per product appraisal; when a countdown timer visible to all students reaches zero seconds, a buzzer will sound indicating the need to move on to the next product. Do not dwell on the product appraisal: state only first impressions.
- Give attention to multisensory experiences when appraising products – do not fixate on or be dominated by the visual appearance.
- Complete both sections of the questionnaire: the Likert scale score (of liking/disliking) and free text area to give a brief reason/justification for each Likert scale score given. The free text can contain a few keywords or a very short sentence.

At the commencement of appraisals, each student was distributed randomly to one of the products located on the tables. Course instructors managed the process by indicating the end of each one-minute period of appraisal and instructing all students to move on to the next adjacent product (Figure 3). This process was repeated until all students had appraised all products. The longest duration was study 4, involving 90 products and therefore 90+ minutes to complete the session. At the close of the session, students handed their questionnaires to the course instructors and collected their products. Students were informed that they would see the results of the material evaluations in three weeks’ time (after the instructors had analysed the data).

![Figure 3. Typical appraisal session for Material Love-Hate.](image)

4.3 Quantitative Data Analysis and Example Results

Data were first verified that product owners did indeed grade their loved/hated products appropriately on the Likert scales (i.e. really like and really dislike). Then, the Likert scale data were numerically encoded according to rules defined in Table 4. Average (mean) grades for each product were calculated, which were then plotted onto charts to visually reveal the diversity of product-material evaluations (Figure 4). The quantitative analysis gives fascinating results into preferred and less preferred material–product combinations, across a wide portfolio of products. It also establishes to what extent there are shared views on these matters.

The charts were used in-class to discuss the kinds of products that were evaluated as most-liked and least-liked, with the product owners asked to provide the storyline behind their materials experience. Occasionally, the class was in disagreement with the product owner about the likeability of the material-product combination: these cases made
especially fruitful discussions on the polarization of materials experience. The discussions also revealed deeper arguments and explanations that lay beneath the product owner’s and participant evaluators’ Likert scale grades and brief free text. Classmates were encouraged to reflect on these storylines and compare them against their own appraisals.

Table 4. Rules for processing Likert scale data.

<table>
<thead>
<tr>
<th>Qualitative Judgement</th>
<th>Owner Mark-Up</th>
<th>Likert Scale Numerical Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>really like</td>
<td>++</td>
<td>+10</td>
</tr>
<tr>
<td>like</td>
<td>+</td>
<td>+5</td>
</tr>
<tr>
<td>indifferent</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>dislike</td>
<td>-</td>
<td>-5</td>
</tr>
<tr>
<td>really dislike</td>
<td>- -</td>
<td>-10</td>
</tr>
</tbody>
</table>

Figure 4. Example results from quantitative analysis.

4.4 Qualitative Data Analysis and Example Results

Scans of all the completed questionnaires were made available to the class via the online learning environment. Product owners were then given the task – as part of a broader assessed piece of coursework on materials experience – to extract all the free text comments related to their own loved and hated product. To assist in this process, a preformatted worksheet was provided to students, containing a materials experience valence matrix to collate all the free text comments linked to the Likert scale ordinals (Figure 5).

Classmates’ appraisal statements were used as the basis for probing more deeply into why people admire or abhor certain material-product combinations. It is known, for example, that the valence and strength of feeling about material-product combinations is tied strongly to people’s personal values (Trimingham, 2008). Stronger and more visceral responses can be expected in instances where material usage resonates with personal, social, cultural, ethical, economic and environmental issues. The worksheet matrices provided students with opportunities for multiple levels and rounds of qualitative data analysis, for example studying vocabulary/terms, categorization according to material experience components, frequency counts, etc. (Figure 6). The free text comments related to combinations of the underlying material, its finish, applied textures/forms, or component joining. From an educational perspective, by generating the analyses themselves, students became immersed in the materials experience data and were obliged to consider how other people experience their own products.
5 Discussion

Involvement in Material Love-Hate engaged students in learning about materials experience through three key stages: (i) at home, looking through products they own from the perspective of materials use and deciding which products to offer for appraisals; (ii) during the material appraisal session, through rapid exposure to the materials of classmates’ products; and (iii) after the appraisal session, through exposure and quantitative/qualitative analysis of the materials experience dataset of their own and classmates’ products.

Students found Material Love-Hate to be a valuable activity and appreciated the way that the dataset was interwoven into subsequent classes of the course. Once they got accustomed to it, students clearly enjoyed the rapid one-minute appraisal of products. There was much smiling and a buzz around the sessions, probably because the evaluated products belonged to classmates and thus there was some intrigue about which products belonged to who. Making students blind as to which were loved/hated products added to their curiosity.
One of the most obvious outcomes from students’ qualitative analysis of the free text data was their gradual understanding of the interplay between sensorial-affective and interpretative components of materials experience. Whilst most students were able to successfully categorize free text comments according to these components – and thus learn materials experience terminology – the value of such atomistic analysis to help explain material-product appraisals was less clear to students. Many felt that the compartmentalization of experience in this way was somewhat artificial and constraining. The most able students chose to piece together headlines or themes within each experiential component into a well-argued holistic characterization of materials experience. They linked the available evidence on material aesthetics, meanings, emotions and behaviours for a given product into a gestalt narrative.

The four main studies using Material Love-Hate were conducted in English because the language of instruction at the host institutions was English. However, for the majority of students (many Turkish, Italian and Chinese nationals) English was not their first language. Therefore, the vocabulary used for the free text comments may not have been as rich, varied or accurate compared with a study made with native English speakers (or a study made in the students’ native language). Equally, students’ qualitative analysis of the dataset will have had some restrictions because of language comprehension. None of the linguistic limitations mentioned was felt to be large and certainly not a barrier to extending students’ materials experience. For the coursework that was submitted following completion of Material Love-Hate, course instructors provided students with feedback on their qualitative analyses and corrected any obvious mistakes or misunderstandings. One opportunity of running Material Love-Hate in multiple countries is the possibility for cross-cultural analyses. In some cases, students brought cultural or country-specific products. Deeper analysis of the full Material Love-Hate dataset can probe these cultural considerations.

6 Conclusion

The aim of the educational research presented in this paper – to define and implement an active learning exercise through which students can rapidly expand their materials experience – has been achieved through careful structuring and delivery of a new Material Love-Hate activity. The activity requires students to engage in material experience appraisals in four consecutive stages: at home, when selecting materially loved and hated products to act as samples; in-class as a solo effort, during first-person practical handling and appraisal of classmates’ product samples (satisfying Table 2, Objective 1); in-class as a group effort, when discussing and explaining the results of Likert scale quantitative analyses (satisfying Table 2, Objectives 2 and 3); and finally solo again, when qualitatively analysing free text materials experience comments that are written-up as part of a coursework assignment (satisfying Table 2, Objectives 2 and 3).

The product samples volunteered by students were varied in materials, types, sizes, uses, age, etc. Students cited not just visual material properties, but sensorial information from other sensory modalities as reasons for their loving or hating product samples. Thus, as an educational resource, Material Love-Hate generates a rich pool of materials experience data suited for students to analyse how material choices can influence user experiences across sensorial-affective and interpretative categories.

Acknowledgements: Many thanks are extended to Sevcan Yardım Şener for her assistance during the preparations and running of the appraisal sessions at the University of Liverpool. The support of Valentina Rognoli for running Material Love-Hate at the School of Design, Politecnico di Milano, under the Erasmus Staff Mobility grant programme, is gratefully acknowledged.

References


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Abstract: Materials selection phase plays a pivotal role in product development, which is driven by consumers’ needs and manufacturers’ requirements. Hence, material research is decisive in achieving competitiveness and success in the products market. Moreover, advances in contemporary technologies have a paramount influence on how new materials are invented and developed. New trends, lifestyles, living expectations, amended with legal requirements imposed by the government—in particular, environmental concerns of products usage and their disposal—additionally complement this process. Therefore, environmentally friendly materials are getting more attention in substituting common materials in markets that are a threat to humanity and the environment. The aim of this paper is to develop an assistive classification method that comprehends product requirements and accordingly, offers the designers substantial suggestions regarding environmentally friendly materials. The complexity of the stated problem, deriving from the conflicting requirements of the designer, consumer and manufacturer, is addressed by utilizing multi-attribute analysis. The herein proposed solution is tailored more towards industrial designers, who in principle are less familiar with material attributes, which in turn complicates the material selection process when designing for the environment.

Keywords: industrial design; product attributes; material attributes; design for environment; material information platform
1 Introduction

Throughout time, concordant to the industrial evolution, many definitions of industrial design (ID) have emerged. The reason for this variety of definitions lies in the fact that ID is actually a type of process, involving various methods. ICSID (now World Design Organization, 2015) (Freddi & Salmon, 2018, p. 6) has ratified ID with the following definition

**Industrial Design** is a strategic problem-solving process that drives innovation, builds business success, and leads to a better quality of life through innovative products, systems, services, and experiences. Industrial Design bridges the gap between what is and what’s possible. It is a trans-disciplinary profession that harnesses creativity to resolve problems and co-create solutions with the intent of making a product, system, service, experience or a business, better. … . It links innovation, technology, research, business, and customers to provide new value and competitive advantage across economic, social, and environmental spheres.

In accordance with this definition, the ID process might be primarily perceived as product/service oriented, meaning that products/services are in the focus, while all other elements serve towards generating a more utilizable product. However, it must be notified that a group of designers (Karana, Barati, Rognoli & Laan, 2015) perceive the ID process as materially-driven. The latter is especially beneficial when novel/innovative materials with unique/specific attributes are an inspiration for developing new products. What actually might be the most suitable explanation of the ID process is that the designer holds the pivotal role (Figure 1), steering the design process in line with the requirements of the product conceived in the imagination of the designer. The designer creates the product by balancing consumers’ needs with manufacturers’ requirements, whereby selecting the most suitable material for that particular product is an inherent task of this process.

Taking the hypothesis for a product/service driven ID process, various authors attempted to define and structure the phases of product development. Adapted both for educational purposes, and to provide efficient guidelines, Table 1 aggregates highlights of several ID methods, organized and combined to accommodate the scheme developed by Pei (2009; cited in Whitehead, 2015, p. 23, rows 1-5) along with strategies for product design (Cross, 2000), the Double Diamond model (UK Design Council, 2005), the Design Thinking Process by Hasso Plattner Institute (2009) and the Verlinden (2015) thematic paper on the experiences and expertise of a selected group of Flandrian designers. It demonstrates the variety of interpretations among authors which, in spite of certain differences, can be classified in three to five phases, whereby problem definition (design specification) is always primer, while the solution (detailed design or similar) is the final task. After querying for information, the designer defines and develops possible ideas and concepts, followed by evaluation of the proposed design, based on feedback, previously completed research and experience.

One of the most challenging tasks the designer faces throughout each phase of the ID process is the selection of the most suitable material for a certain designated product while taking in account its usability/functionality. Namely, the importance of proper material selection is the focus of many researchers because it can attract consumers by giving a specific meaning and certain purpose to a product, while additionally it could fulfill the manufacturer's requirements via contributing towards a more energy efficient, environmentally friendly and cost-effective manufacturing process. The ascent of this trend began concordantly with the rising need to replace traditional materials with new ones. For example, Karana (2009, p. 20) pointed out that the porcelain used for traditional dinnerware could not compete with the cost-effectiveness and light weight of the plastic material. On the other hand, today plastic is considered ‘cheap’
and ‘unfriendly’ for the environment. Examples like these reveal that every material has various meanings, perceptions and associations in terms of technical and aesthetic attributes.

Table 1. Overview of ID methods defining and structuring the product development process (Pei, 2009, adapted by Selim et al., 2018).

<table>
<thead>
<tr>
<th>Authors</th>
<th>Phase 1</th>
<th>Phase 2</th>
<th>Phase 3</th>
<th>Phase 4</th>
<th>Phase 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Archer (1965)</td>
<td>Data collection and analysis</td>
<td>Synthesis</td>
<td>Development</td>
<td>Communication</td>
<td>Solution</td>
</tr>
<tr>
<td>French (1985)</td>
<td>Problem definition</td>
<td>Formulating solutions</td>
<td>Developing solutions</td>
<td>Presenting</td>
<td>solutions</td>
</tr>
<tr>
<td>Pugh (1991)</td>
<td>Design specifications</td>
<td>Concept design</td>
<td></td>
<td>Detail design</td>
<td></td>
</tr>
<tr>
<td>Jones (1992)</td>
<td>Analysis</td>
<td>Synthesis</td>
<td></td>
<td>Evaluate</td>
<td></td>
</tr>
<tr>
<td>Pahl &amp; Beitz (1996)</td>
<td>Clarification of design task</td>
<td>Conceptual design</td>
<td></td>
<td>Embodiments</td>
<td>Design</td>
</tr>
<tr>
<td>Design Council (2005)</td>
<td>Discover</td>
<td>Define</td>
<td>Develop</td>
<td>Deliver</td>
<td></td>
</tr>
<tr>
<td>Hasso Plattner Institute (2009)</td>
<td>Empathize</td>
<td>Define</td>
<td>Ideate</td>
<td>Prototype</td>
<td>Test</td>
</tr>
<tr>
<td>Verlinden (2015)</td>
<td>Front-end</td>
<td>Valorisation</td>
<td>The future</td>
<td>Methodology</td>
<td>research</td>
</tr>
</tbody>
</table>

Having the afore mentioned points in perspective, two questions arise when analysing the separate phases of the already defined and well-structured product-driven ID process, i.e.

1. what is the role of the material selection therein, and
2. whether it is possible and beneficial to develop an analogously structured procedure/concept to select the most appropriate material for a designated product, simultaneously fulfilling consumers’ needs and manufacturing requirements.

Thus, this paper sets out to provide an answer to these two questions, while bearing in mind that each selected material conveys its attributes to the product made with that material, i.e. the attributes which define the selected material are inherited by the product that’s been subject to the ID process. Identifying the phases and components of a procedure for selecting the most suitable material, while pertaining the requirements of the product-driven ID process, is an open task, and involves identifying relevant attributes of the product, mapped as criteria for proper/optimal material selection.

2 Methodology

2.1 Review of the Existing Approaches for Material Selection

2.1.1 Online Models for Material Selection

Nowadays, there are many contemporary tools assisting designers in the material selection process by defining the technical and aesthetical attributes of the materials. The literature review performed by Karana, Hekkert and Kandachar (2007) includes the Ashby and Johnson (2002) method for classifying materials according to their technical and aesthetical attributes, which later, in collaboration with Granta design (2010), resulted in the development of the database model Cambridge Engineering Selector (CES) for identifying materials and manufacturing processes. Other online resources that use the technical and aesthetical categorization approach are Material Connexion (1997) as materials-driven design platform, Material District (1998) as match-making platform for innovative materials, Dupont Polymer Advisor (2015) as online advisor tool, the IDEMAT-Sustainably inspired material selection dataset (Meursing, 2015), Matmatch (2018) as materials search platform, etc. Another way to choose materials is via relevant information aggregated, categorized and classified in handbooks, magazines, catalogues and material suppliers. In particular, Karana et al. (2007) concur that main information sources for material selection are catalogues and practical expertise of the material suppliers, whereby from a convenience, easiness and reliability point of view, designers prefer suppliers’ catalogues over online material libraries, because those are more tactile, sensorial, comprehensive and inspirational. Recently, bearing this challenging complexity in mind, Karana et al. (2015) developed the Material Driven Design (MDD) method which is focused on revealing the material’s user perception considering both “technical properties and experiential qualities”. Furthermore, it must be emphasised that continuous and rapid developments in the artificial intelligence (AI) tilt the scale towards advantages offered by open-source, flexible, online material information platforms, resources and libraries, with simultaneously promoting proper and correct material perception with an improved and more sensorial specification of the pool of materials offered in the resource library.
Ultimately, the designer has the responsibility of choosing the most appropriate material based on the product requirements. As technological development contributes to the invention of new materials, designers have difficulties in keeping up with new information about their technical and aesthetical attributes. Therefore, this paper focuses on developing a concept for a material information platform (MIP) that shall assist material selection by defining its attributes, mapped onto product attributes, in accordance to the product requirements. In order to integrate this concept into an automated self-learning tool, methods such as machine learning will have to be reviewed in the future.

2.1.2 Applicability Prospect of MIP in Product Design

Bearing in mind the challenging complexity of the ID process on one side, and the powerful advantages offered by information platforms on the other, this work proposes a conceptual approach that aggregates these two aspects, whereby the material selection process resembles the human decision-making. Underlined is the fact that such an information platform needs to follow the same stages and strategies the designer performs in the material selection process.

The progressing technologies provide various information platforms through which access to information, rules and co-relations in the fields of education, research and everyday use of products/services increases accuracy, while reducing the delivery time of products/services. For example, Dr. Watson (IBM Watson Health, 2011), developed by IBM, accumulates information about the patient and based on profiling and data classification, gives a sufficiently accurate diagnosis. A further example of utilizing AI is the machine learning system applied to the lamp named Skip, which can adjust its light intensity and position according to the “feedback from the user to certain states of its environment” (Hawkins & Dubinsky, 2016; cited in Sivertsen, Haegens, Rietmeijer & Amorim, 2016, p. 2). As per the definition of machine learning, “a computer program is said to learn from experience E with respect to some class of tasks T and performance measure P if its performance at tasks in T, as measured by P, improves with experience E” (Mitchell, 1997; cited in Sivertsen et al., 2016, p. 2).

The focal point of this paper is the attributes of environmentally friendly materials and their relations with the consumer, manufacturer and designer requirements because on one side, the usage of these materials is rising while experience with them in industrial products is insufficient, and on the other, the information platforms have the potential to accumulate knowledge and experience based on human requirements into a system in order to give more accurate results. Therefore, the focal point of this paper is on the attributes of those materials and their relations with the consumer, manufacturer and designer requirements. In that sense, the next sub-section provides a brief explanation of the environmental strategies in classifying the needed material attributes, considering the complexity of the problem: the information derived from the combination of technical and scientific data is amended with social-human values.

2.1.3 Materials in Design for Environment (DFE)

Whether it’s because of environmental consciousness or implied government regulations, companies today have started to focus on the so-called Design for Environment (DFE) strategies developed through collaboration between researchers and academic communities in order to produce environmentally friendly products. The terminologies such as design for environment (DFE), eco design, sustainable design, design for x (assembly, disassembly, reuse, etc.) (DFX) denote studies focused on implementing environmental strategies as early as possible in the design phase. Considering the emphasis of this paper on utilizing environmentally friendly materials, DFE strategy seemed the most suitable concept to be considered. Giudice et al. (2006, p. 27) explain this strategy in terms of product life-cycle where the “energy consumption, use of materials, component duration, reuse of components, and recycling of materials” are aspects to be considered. Moreover, they define the basic set of environmental attributes related to the material selection process. Apart from the technical and aesthetical attributes, Ashby and Johnson (2002) are also focused on defining environmental attributes of the materials based on “function, objectives, constraints and control variables.” Additional knowledge and experience is required to determine energy costs and emissions involved in a material and in the manufacturing, distribution and end-of-life treatment of the product made with that material. For example, although timber is a renewable material, when used without strategic planning, it can lead to deforestation, as it simultaneously depends on “extraction, frequency and growing speed” (Karana, Pedgley & Rognoli, 2014, p. 113). Problems such as transportation planning or durability of degradable materials are aspects that additionally complicate the decision-making process. Moreover, considering biodegradable materials can be beneficial for degradability of short-term products, but might pose a problem for products that need to be durable (Karana et al., 2014, p. 113). These examples draw a clear picture of the extended knowledge and experience necessary when designing for the environment.
2.2 Multi-Attribute Analysis

Figure 2 describes an attribute classification method utilized for product material specification adapted from the Ashby and Johnson (2002) methodology, where four dominant attribute groups - general, technical, environmental and aesthetical - are defined as relevant for the material selection process. As aesthetical attributes are thereby included, this method serves both engineers and designers. On the other hand, according to Pedgley (2010, p. 346), scientists and engineers prefer numerical communication which often results in developing a technical language of materials, leading to a more precise determination of material attributes.

![Figure 2. Material attribute classification chart based on Ashby and Johnson (2002).](image)

In the ID process, the product specification phase is primary and it triggers the structure of the product design process in which the designer defines the flow of the upcoming phases based on his/her findings, knowledge and experiences. However, there are not any strictly defined rules or patterns on the adaptation methodology of the material selection process in the proposed phases of product development. As per Karana (2009) and Pedgley (2010), a broad mixture of relational and non-relational factors, too devoid of pattern, are influencing the materials experience of the designer, the manufacturer and finally the consumer. This represents a significant drawback due to the considerable uncertainty as to whether theory and decision-making aids can be appropriately and confidently built and thus systematically utilised.

Having the afore mentioned points in perspective, the process of delivering a decision as to what should be the most appropriate/suitable material when designing a certain product, positions the designer exactly in the role of a pivot point on the design seesaw (Figure 1) where he/she finally makes the decision on the material attributes that are transposed into criteria for material selection. Defined as such, this problem belongs to the class of multi-attribute decision making problems (Keeney & Raiffa, 1975; Keeney, 1982; Bohanec & Rajković, 1990; Yoe, 2002; Hwang & Yoon, 2012), whereby the considered attributes are determined according to the objective requirements and limitations of the problem to be accommodated (herein, the production and the product driven design) and the subjective preferences deriving from the customer needs, manufacturer requirements and designers’ creativity. As a starting point, based on the given task (e.g. single-use water bottle, biodegradable salad packaging etc.) and for the purpose of determining relevant selection criteria, a list of product requirements needs to be identified.

Figure 3 elaborates the 5-steps procedure in which firstly the product attributes are defined by designer, manufacturer and consumer requirements. The matching attributes are then transposed onto product criteria, further transposed into fixed and alternate material criteria, and finally mapped onto a set of suitable/matching materials with corresponding attributes. The designer, finally, is offered a set of most suitable materials to select from, in accordance to his/her preferences, but without neglecting the customers’ and manufacturers’ requirements.
Figure 3. Structure of material selection methodology

Based on the feedback from the designer, manufacturer and consumer, the process can be developed further or being reverted back to any of the previous phases.

Figure 4 depicts a list of basic product requirements identified by the designer with his/her pivotal role and preferences, cross-relating to the requirements deriving from the consumer and manufacturer. It must be noted that aside from the designer’s preferences, some of the product attributes (e.g. functional, cost-effective etc.) are mutually required both by the consumer and manufacturer (as cross-sectional requirements) and as such are denoted as fixed product criteria, which later are transposed into fixed material criteria. Contrarily, as alternate product criteria and alternate material criteria are denoted those that do not fall in the mutual cross-section of the designers’, manufacturers’ and customers’ requirements (see Figure 4, e.g. manufacturable, shapable, etc.). The noted overlapping among certain (groups of) requirements reveals that the proposed classification system characterizes with flexibility and is open for defining additional requirements as a function of e.g. product functionality, aestheticism, sensibility, design for environment etc.

Figure 4. Product requirements as a function of designers’, consumers’ and manufacturers’ preferences influencing material attributes and transposing into material criteria.

3 Case Study

The context of giving attributes to products and materials was firstly defined by Ashby and Johnson (2002, p. 73) as properties generating a product personality. The authors explain that technical requirements of the product have an effect on its shape but at the same time they can trigger its “expressing quality, or humor, or delicacy, or sophistication” (Ashby & Johnson, 2002, p. 94). Later, when investigating materials’ meanings, Karana (2009, p. 48) explained this as the associative description concept. For example, based on previous experiences, a polyurethane foam is described as “colourful, transparent, resilient plastic [associated] with childhood jellybeans” (Karana, 2009, p. 48). Relating to this concept a new question proceeds: Can the associative description concept be used to reveal material attributes based on product requirements?
In order to answer this question, a project task was determined. Being aware of its negative effects on the environment, in this paper, a single-use water bottle is used as a product example. Based on the product requirements listed in Figure 3, an associative descriptive concept is used to identify relevant material attributes, which are transposed into decisive material criteria. Table 2 illustrates the process of first mapping product requirements onto material attributes (phase 2, in Figure 3), which in the next step are categorized as either fixed or alternate material criteria (column 4 in Table 2, and Figure 5). As an example, the product requirement denoted as ‘Functional’ is stipulated simultaneously by the designer, the consumer and the manufacturer, thus it is transposed/associated with the material attributes denoted as ‘Food related’ and therefore, further transposed into a fixed material criterion.

Table 2. Attributes describing product requirements and specific material attributes for single-use water bottle (utilizing eco-friendly material) based on US plastic corp. (2000); Vladic, Kasikovic, Avramovic & Milic (2004); Koeijer, Wever & Henseler (2016)

<table>
<thead>
<tr>
<th>Consumer product requirements</th>
<th>Designer product requirements</th>
<th>Manufacturer product requirements</th>
<th>Material Attributes (example)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>Shapable/Manufacturable/Modifiable</td>
<td>Shapable/Manufacturable/Modifiable</td>
<td>Plastic shaping Availability</td>
</tr>
<tr>
<td>-</td>
<td>Resistant to: pressure, temperature, impact, etc.</td>
<td>Resistant to: pressure, temperature, impact, etc.</td>
<td>Chemical, temperature, UV, brittle and scratch resistance</td>
</tr>
<tr>
<td>Functional</td>
<td>Functional</td>
<td>Functional</td>
<td>Food related</td>
</tr>
<tr>
<td>Cost-effective</td>
<td>Cost-effective</td>
<td>Cost-effective</td>
<td>Cost-effective</td>
</tr>
<tr>
<td>Durable</td>
<td>Durable</td>
<td>Durable</td>
<td>Duraibility</td>
</tr>
<tr>
<td>Environmentally friendly</td>
<td>Environmentally friendly</td>
<td>Environmentally friendly</td>
<td>Renewable, recyclable, compostable, short degradation time</td>
</tr>
<tr>
<td>Ergonomic</td>
<td>Ergonomic</td>
<td>-</td>
<td>Weight, elasticity, stiffness, smoothness,</td>
</tr>
<tr>
<td>Aesthetical</td>
<td>Aesthetical</td>
<td>-</td>
<td>Transparency, glossiness, reflectiveness, odour, taste, colour</td>
</tr>
</tbody>
</table>

Using this model for defining relevant material attributes associated to a specific product can be a helpful guide in developing a system that recognizes product requirements and accordingly proposes a suitable material.

4 Results and Discussion
As elaborated in section 3, the design process extracts fixed and alternate material criteria simultaneously based on designers’, consumers’ and manufactures’ requirements and preferences. Considering the previously selected single-use water bottle product, the identified fixed material criteria are: food related, cost-effective, durability, renewable, recyclable, compostable, short degradation time and etc. On the other hand, the alternate material criteria are: plastic shaping, availability, chemical, temperature, UV, brittle and scratch resistance, fluid barrier, weight, elasticity, stiffness, smoothness, transparency, glossiness, reflectiveness, odour, taste, colour absorption and etc. Thus, Figure 5 portrays the result of mapping material attributes into fixed and alternate material criteria based on designers’, manufacturers’ and consumers’ requirements (Table 2). Accordingly, to phase 4 (Figure 3), a set of four material alternatives (polyhydroxy alkanoates (PHA), polylactic acid (PLA), polyethylene furanoate (PEF), polyhydroxy butyrate (PHB), gathered from different on-line resources (material district, 1998; material connexion, 1997) are identified as a closest match in accordance to the fixed and alternate material criteria.
The presented concept works similarly to the designer’s flow of ideas during the first stage of the ID process (Table 1), where defining material criteria is the main strategy in design specification and clarification of design task.

As part of phase 4 and based on feedback obtained in phase 5, each of the identified four matching materials can be analysed in more detail in order to closely test the suitability to the prescribed task (single-use water bottle). Thereby, the Ashby and Johnson (2002) categorization (general, technical, aesthetical and environmental) is applied. Figure 6 illustrates PLA as one material solution for the single-use water bottle, from the set of previously selected four eco-friendly materials (alternatives), listing its main features categorized into the four attributes sub-groups (columns), amended with the user experience column.
The data for material attributes is listed according to the information proceeded from literature and on-line resources (material district, 1998 & 2018; Ashby & Johnson, 2002; Hemmert, 2010; Ashby, 2012; Ramon, 2013). The information in the user experience column is gathered as a function of the designers’ background (e.g. education, tradition, emotions etc.) and his/her experience, training and knowledge relating to the particular materials.

Having all previously presented aspects in perspective, it can be concluded that this concept encompasses various challenging and interdisciplinary issues which can be addressed via multi attribute analysis methods and techniques and by implementing AI (e.g. machine learning).

5 Conclusion

Bearing in mind that materials play a pivotal role in product development, comprehensive material research is inherent and necessary to achieve competitiveness and success in the products’ market, driven by designers’ preferences, consumers’ needs and manufacturers’ requirements. In this process, the primary strategy is to determine product requirements, while the second is to relate corresponding material attributes accordingly.

The rising environmental concerns related to product usage and their disposal methods, as well as the stringent requirements implied by the continuously stricter governmental policies, draw substantial attention on substituting common materials (which are a threat to humanity and the environment) with environmentally friendly ones. The material review and selection involve analysing various and often conflicting requirements which are described by sets of product and material attributes, mapped onto material criteria (fixed and alternate). This research outcome offers an answer to the first question posed in Section 1. Furthermore, the identified analogy for the product and material selection of a predefined task in the design process pointed out that when mapping product to material attributes and further transposing them to material criteria, special attention should be given to selecting and discerning fixed from alternate criteria. This outcome holds the answer to the second question posed in Section 1.

Additionally, an approach for material classification is proposed as a basis for developing a concept for assistive MIP, while being cognizant of the aforementioned problem complexity. It is comprised of product requirements and offers alternatives for the most suitable materials (in particular, environmentally/eco-friendly ones). In the process of
material selection, the proposed concept aims to resemble the act of human decision-making, in this case the decision-making process for product driven design and development. Such a platform has the potential to serve as a tool primarily for industrial designers, researchers and manufacturers since it saves time, keeps up with the constantly changing information and gives more accurate results than personal experience. This holistic approach has the potential to be developed into an open source MIP whereby information can be gathered from various resources and the experiences of extensive number of designers.

To investigate functionality of the proposed concept for material selection, single-use water bottle was used as an example. Four alternative eco-friendly materials were matched as most suitable to the requirements incorporated in the identified fixed and alternate material criteria. Whereas the case-study elaborated in this paper refers to eco-friendly materials as a solution to the stated task, the proposed concept for designing a MIP has the potential to accommodate further material groups and their attributes.

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Educational Tools to Teach Design Students the Dynamic Behaviours of Smart Materials

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Abstract: Materials teaching is part of a paradigm shift currently happening in the design education. It has become crucial to provide design students with an up-to-date knowledge about the latest advance in materials and manufacturing technologies with the aim to prepare them to more effectively cope with the next industry challenges. The introduction of smart materials started to revolutionize the way we design and interact with products. Their dynamic properties are changing our perception and understanding about what a material is in itself (a system), and especially, what it is able to do (its performance). This paper presents a multidisciplinary framework for teaching functional materials based on a 5-layer structure: from the material science basics (1), materials engineering (2), stimuli-responsive phenomena (3), material experience (4) and product experience (5). Among the research outputs, four design-oriented tools are described. Apart from an introductory lecture, descriptive cards provide information on the most common phenomena that describe commercial smart materials application (levels 1-3). The Smart Materials for Sensory Experiences Map (SM4SE) classifies such materials based on their input/output stimuli and puts them into relation with the explorative sensory modalities (levels 3-4). By selecting an application of smart materials, the Dynamic Product Experience tool encourages students to explore, describe and qualitatively rank the dimensions of product experience (usefulness, desirability, credibility, understandability, usability) (level 5). The tools have been tested in a one-week learning experience focused on smart materials teaching.
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within the Material Selection Criteria course in Design & Engineering at Politecnico di Milano. As an output of the full immersion, twenty-eight case studies on dynamic products were collected by students.

**Keywords:** material systems; smart materials; material experience; transdisciplinarity; design engineering

1 The Shifting Notion of Materiality

The study of materials, their individual properties and related fabrication processes, is an essential element in the education of a product designer. Materials are at the core of any physical artefact, and do not only contribute to its function, but also have aesthetic and emotional values which allow the designer to shape the character of a product (Figuerola, Lai & Ashby, 2016; Karana & Hekkert, 2010). With the rapid advancements in research and technology, the field of materials is constantly evolving, meaning that designers have to stay up to date, to not miss out on new opportunities that might present a solution to their next design problem (Hölter, Piselli, Colombo & Del Curto, 2019; Karana, Pedgley, Rognoli & Korsunsky, 2016).

The introduction of smart materials started to revolutionize the way we design and interact with products. Their dynamic properties are changing our perception and understanding about what a material is in itself (a system), and especially what it is able to do (its performance). Materials are no longer just static dead mass, but became something that is alive – and so will be the future products that we incorporate them in (Hölter et al., 2019).

The study of materials and products that exhibit dynamically changing properties in response to external stimuli has especially caught the interest of designers that work in the fields of interaction design, more specifically human-computer interaction (HCI), which focuses on the intersection between the digital and physical world. The growing complexity and invisibility of technologies inherent in today’s products, that came with the movement of Ubiquitous Computing and the Internet of Things (IoT), have led to a dematerialization of content and information, with which people are interacting on a daily basis (Brownell, 2014; Parisi et al., 2018). In this sense, the use of smart materials generates new opportunities in creating future forms of interaction, promoting the concepts of material move (Fernaeus & Sundström, 2012), material turn (Wiberg & Robles, 2010), material lens (Wiberg, 2016; Jung, Wiltse, Wiberg & Stolterman, 2017), and dynamic products (Colombo, 2014). Under the vision of tangible bits (Ullmer & Ishii, 2000), designers started to explore Tangible User Interfaces (TUIs) that incorporate smart materials and technologies. Creating engaging user experiences in physical interactions with the digital world, and thus bridging the gap between material and immaterial, has therefore become a new challenge for designers (Arnall, 2014).

This change in the notion of materiality, which is represented by the closing gap between what is material and what is immaterial, is also being explored under the umbrella of “Computational Composites” (Vallgårda & Sokoler, 2010). Based on their temporal and responsive nature, smart materials and computational composites that change their properties over time and in context, were, later on, also described as “Becoming Materials” (Bergström et al., 2010).

Most recently, connecting the material and immaterial world, the class of ICS Materials (Parisi et al., 2018) was defined, referring to Interactive, Connected and Smart materials that are overpassing conventional smart materials by inheriting additional degrees of intelligence. They are described as “composite entities in which artificial intelligence and materiality can be qualitatively combined” (Parisi et al., 2018), and said to present reciprocity of action and reaction with user and environment through variability (meaning that the material’s response is reversible and contextual), the possibility of being programmed or combined (through physical as well as digital means) and the ability to connect by transferring and/or receiving data (not only via a digital network).

As materials are currently part of a paradigm shift, from being the physicality of a product (Rojter, 2011) to representing a phygital layer that drives the experience with it (Hekkert & Karana, 2014; Bergamaschi, Lefebvre, Colombo, Del Curto & Rampino, 2016; Wang, Li, Liu & Liu, 2019), it is prerogative of material courses to develop new tools and methodologies of teaching such disciplines to design students (Del Curto & Pedeferrri, 2010).

2 Framework to Teach Smart Materials for Design

Smart or functional materials have the unique ability to respond and adapt to the environment, providing energy-transforming functions and changing their properties in response to external stimuli, such as light, temperature, stress, moisture, magnetic fields or electric current (Addington & Schodek, 2005). Through their dynamic behaviour, they offer novel possibilities for designers, especially when it comes to the design of interactions and experiences. To take advantage of smart material behaviours, it becomes fundamental to have knowledge of their material science...
Educational Tools to Teach Design Students the Dynamic Behaviours of Smart Materials

basics, their properties, both technical and expressive-sensorial ones (Rognoli, 2010; Piselli, Baxter, Simonato, Del Curto & Aurisicchio, 2018), and their commercial application (Lefebvre, Piselli, Faucheu, Delafosse & Del Curto, 2014). To provide basic knowledge and encourage the use of traditional smart materials in product design, informative tools and material-driven design practices have been developed (Barati, Giaccardi & Karana, 2018; Bengisu & Ferrara, 2018; Bergamaschi et al., 2016; Colombo, 2016; Parisi et al., 2018).

Despite this, there is still no evidence of a systematic framework for teaching technical properties and dynamic behaviours of functional materials in design courses. This research exploits the potentials of four learning tools tailor-made to integrate smart materials teaching in Materials for Design courses, with the aim of lowering the gap between theoretical fundamentals of such materials (material science and engineering ground) and dynamic products development process (design practice). A 5-layer framework was used to structure an introductory lecture on functional materials and to design the Descriptive cards, the Sensory Experiences Map (SM4SE) and the Dynamic Product Experience tool.

2.1 Introductory Lecture – Layers 1-5

In the context of materials teaching, the information provided on material properties are different and calibrated to course contents and students’ background. The approaches to materials teaching in the engineering and industrial design field differ in terms of language, purpose and information details (Piselli, Simonato & Del Curto, 2016). In general, materials science and engineering courses provide students with a detailed theoretical ground on composition, structures, technical properties, manufacturing processes and rational methods of materials selection (Ashby, 1992; Farag, 2002). On the other hand, industrial designers are more familiar with a hands-on approach. For this reason, at the Design Faculty of Politecnico di Milano, materials science is approached by merging lectures with practical exercises, using material selection software (e.g., Cambridge Engineering Selector) and web resources coupled with the involvement of the materials library physical resources to allow students to build a physical/sensorial experience with materials (Del Curto & Pedeferri, 2010).

While these methods are effective in teaching designers the fundamentals of traditional material classes, such as ceramics and glasses, metals, polymers, natural materials (wood, paper) and textiles, smart materials represent a multifaceted topic to be approached in teaching as it blurs the boundaries between matter and behaviour. Dynamic products that implement smart materials are both highly technical and highly experiential artefacts. Like with traditional materials, product designers are expected to be proficient with all these dimensions. Our objective was thus to provide students with a practical framework to deconstruct existing dynamic products that use smart materials, so that they could get acquainted with them through case studies. To achieve this, the amount and variety of information that characterize functional materials was structured into five different layers (Figure 1), from materials science basics to user experience.

In describing them, a case study of a cooking pan that integrates a colour changing thermo-spot is provided (Figure 2). For a given smart material, Layer 1 relates to the materials science basics, namely the composition, structure, physical mechanisms involved (e.g. a shift of the electron distribution towards the atoms is modified by temperature). Layer 2 focuses on the engineering aspects and aims at connecting the smartness carried by smart materials to the technical and manufacturing properties of traditional inert materials (e.g. the thermochromic pigments are deposited on the metal surface by PVD and coated by a food-contact Teflon film, that also provide durability to detergents and food

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Figure 1. Framework to structure the large amount of information available on smart materials

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chemicals). The focus of Layer 3 is on the transition phenomenon that characterizes a smart material as the link between an input and an output (e.g. the input stimulus is temperature change while the output is a colour variation. The change in colour from yellow to red is immediate and reversible). Layer 4 is dedicated to material experience, as the experiences that users have with and through materials at the sensorial (e.g., hard, smooth, fluffy, etc.), expressive (e.g., elegant, high-quality, natural, etc.) and emotional level (e.g., surprising, disgusting, etc.) (e.g. the surprising colour change is faint and continuous). Layer 5 focuses on product experience: the dynamic character of the product elicited by the use of a smart material can strongly influence the perception the user has of it. The pan is perceived as a high-technological product. Thanks to the thermochromic spot users can improve their healthy cooking experience. The limited use of fat allowed by the Teflon coating has a detrimental side-effect on olfactory and sound sensorial feedbacks during cooking, traditionally used for adjusting the heating power. The colour changing visual indicator compensates for this loss in a very natural and intuitive way.

This framework, developed from the collaboration of Politecnico di Milano (“Giulio Natta” Department) and Mines Saint-Etienne (“Georges Friedel” Laboratory), has been applied in an introductory lecture within Material Selection Criteria course in Design & Engineering at Politecnico di Milano. The lecture focused first on the description of functional materials characteristics and properties (Levels 1-3). Different smart material samples were provided during the lesson in order to practically explore their expressive and sensorial dimensions (Level 4). At last, commercial applications of these functional materials were shown (Level 5) both from the engineering sector (e.g. automotive, biomedical, ICT, robotics, etc.) and the product design field (e.g. fashion and jewelry, lighting).

2.2 Descriptive Cards – Layers 1-3

Functional materials can be classified based on their stimuli-responsive phenomena (Lefebvre et al., 2014). By confronting the common characteristics of the various types of phenomena (immediacy, transiency, self-actuation, directness and selectivity) (Addington & Schodek, 2005; Kamila, 2013; Piselli, Garbagnoli, Cavarretta & Del Curto, 2015) and by analysing examples of stimuli-responsive materials application, we can highlight that transiency and self-actuation are the core characteristics of smart materials in product design (Bengisu & Ferrara, 2018; Ferrara & Bengisu, 2013). A set of descriptive cards (Figure 3), presented in short text and simple icons, have been developed as a visual learning tool. They illustrate the main features of different transition phenomena, considered the working principles of the most popular smart materials.
The cards comprise the following information:

- **Transition phenomenon, environmental input** (on the left) and **output** (on the right). The type of input and output that characterise the phenomenon, represented by symbols, are linked together with an arrow containing the stimuli-responsive name. If the arrow is single-headed, the stimuli-responsive phenomenon is mono-directional. If it is double-headed, the stimuli-responsive phenomenon is bi-directional. Near the input/output symbols, additional information about the sources that can activate the change and the senses by which the user can perceive it are provided.

- **Maturity Level.** Correlated to the application of functional materials, it represents a simplified estimation of their Technology Readiness Level (TRL). Following the European Commission definition (European Commission, 2015), three categories are highlighted, “In Labs” in red colour (TRL 1-4), “Prototypes” in yellow (TRL 5-7) and “Industrialized” in green (TRL 8-9).

- **Material families, Elaboration process.** It represents the material classes that can be functionalized and the manufacturing/finishing processes used to implement the stimuli-responsive phenomenon.

- **Programmability, activation and relaxation time, change type (single, multiple or continuous).** These describe the inherent requirements and technical capabilities that characterize the stimuli-responsive phenomenon. Programmability is defined as the way to fine tune the effect (e.g., by changing the material composition, blending different pigments, by treatments ...). Activation and relaxation time (immediate, short, moderate and long) section represent the phenomenon transformation speed. If an “on-off” symbol is present in this section, that means the functional material needs a stimulus to return to its initial state.

- **Application example and additional notes.**

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**Figure 3. Descriptive card layout**

**Figure 4. Example of the photochromism phenomena descriptive card**
2.3 Smart Materials for Sensory Experiences Map (SM4SE) – Layers 3-4

After presenting the main characteristics of the principal classes of smart materials, design students are introduced to the potentials elicited by functional materials through sensory exploration. Elaborating on the formalism of Materials Experience (Karana, Pedgley & Rognoli, 2014; Karana et al., 2016) and merging two previous mapping studies on dynamic products (Colombo, 2014) and smart materials (Lefebvre et al., 2014), a new map has been developed with the aim to inform and inspire design students to integrate smart materials in developing dynamic objects. The Smart Materials for Sensory Experiences (SM4SE) is an input-output map (Figure 5) that consists of four circular layers:

- **Input.** Seven different inputs that activate the smart materials changing behaviours are identified: magnetic fields, electric fields, light, concentration (or presence) of chemicals, pressure, deformation, temperature.
- **Smart Materials.** Twenty-seven smart materials that directly affect the user’s sensory experience (they can be perceived by the senses) have been selected. Functional materials that transform light energy into electric energy were not included, for instance.
- **Product.** Nine simplified dynamic sensory stimuli information were selected based on the changes supported by the selected smart materials. Namely, the product’s dynamic features displayed are: colour, light, shape, physical sound, vibration, pressure, temperature, viscosity, natural aroma.
- **Senses.** Sensory modalities involved in the perception of product’s dynamic features.

The SM4SE design tool, validated in a workshop performed with 24 students from the first year of Design & Engineering Master’s Course (Politecnico di Milano), represents a practical aid for the designers who are looking for technical solutions to be adopted for dynamic products’ implementation: “However, in order for the tool to be effective, designers would benefit also from more detailed knowledge on smart materials’ features and applications. For this reason, authors developed specific lectures about smart materials and dynamic products to couple with the SM4SE map, in order to give designers a background knowledge useful for the design of such products.” (Bergamaschi et al., 2016, p. 18).

![Figure 5. Detail of the Smart Materials for Sensory Experiences (SM4SE) Map (Bergamaschi et al., 2016)](image)

2.4 Dynamic Product Experience Tool – Layer 5

After providing tools to explore the 4 different dimensions of smart materials (material science basics (1), materials engineering (2), stimuli-responsive phenomena (3), material experience (4)), design students are encouraged to explore Layer 5 (product experience). Adapting the work of Peter Morville (Morville, 2004), a pioneer in the field of user experience (UX), and considering the variable characteristics of smart materials, five descriptive factors of the dynamic qualities of smart products have been selected (usefulness, desirability, credibility, understandability and usability). The Dynamic Product Experience tool, inspired by other material experience tools (Van Kesteren, Stappers, & De Bruijn, 2007; Karana & Hekkert, 2010), consists of a checklist of 27 qualitative attributes that can be ranked by a 3-point scale for single valence attributes (e.g., intuitive) or a 5-point scale for dual valence attributes (e.g., unattractive vs. attractive). The list of dynamic qualities and attributes was defined and discussed with two experts on smart materials (material engineering background) and two experts on product design experience.
Educational Tools to Teach Design Students the Dynamic Behaviours of Smart Materials

Design students are called to use the tool to reflect upon the desired experiences: they fill a list that summarizes the qualities and sensorial attributes desired in a smart dynamic product, and that would represent the distinctive qualities of a smart dynamic product compared to other products. An example of a filled-in list is given in Figure 6. The aim of the Dynamic Product Experience tool, indeed, is to discuss the sensorial interaction with the dynamic product by offering topics that refer to aspects of the experience with smart materials.

Ex. 1.5 | USER EXPERIENCE

![Figure 6. Example of a filled-in Dynamic Product Experience analysis grid](image)

3 Using the Framework in an Educational Context

To get insights on the appropriation of the framework, Design & Engineering students of the Material Selection Criteria course (A.Y. 2016/2017) were involved. Students were called to work on a research project focused on an existing dynamic and/or interactive product that implements one or more functional materials. The research project, submitted under the form of a report, was carried out in groups of 2 or 3 students.

Like in the example of the thermochromic pan presented during the lecture, students had to explore the smart material features addressing the 5 layers approach. In particular, students were introduced to a qualitative evaluation of product experience (in a virtual way) by choosing a smart product and deconstructing it following the five layers based on data collected on the internet. 28 project reports were collected as an output. No specific quantitative instruction had been given, neither on the length of these reports, neither on the balance between technical and experiential information. Figures 7 and 8 display examples of the produced reports. They are representative of the collected reports in terms of length, combination of text and illustrations, and balance across the 5 layers. Overall, the reports were 6 to 12 pages long, combining text, photographs and schematics. The text development for each layer was between 50 and 400 words long per layer, with a good balance of information across layers. The information structure provided by the descriptive cards and SM4SE map were almost systematically used by students to describe layers 3 and 4, seldom for layers 2 and 5, and never for layer 1. The proposed framework was successful at fostering a balanced analysis of the case studies across all five dimensions, and the attributes classification proposed by the descriptive cards was effective at organising the information specific to stimuli-responsive materials.
In this section, the deconstruction of the smart product “RHEI clock” by Damjan Stanković and Marko Pavlović, is presented as an example. The smart product was analysed by two groups of students. The “RHEI clock” uses a ferrofluid material to display the time: the use of such functional material gives an organic movement to the numbers when they change as time flows (Figure 8). In order to qualitatively evaluate the information gathered into each layer, the textual contents of the reports were analysed in terms of word frequencies. Each layer of the deconstruction reports has been analysed separately.

**Layer 1. Materials science**
The two reports clearly exhibit similarities in word frequency occurrence: the words “magnetic” and “particles” have been used to describe the physical mechanisms involved in the RHEI clock together with the nouns “field” and “liquid”.

**Layer 2: Material engineering**
Among the most cited words to describe the technical properties of the smart material used in the dynamic product selected are the chemical symbol for iron (“Fe”), and the nouns “metal”, “salt”, “liquid” and “magnetic”.

**Layer 3: Stimuli-responsive phenomena**
The input parameter detected by the students has been clearly described by using the words “magnetic” and “field”. The output does not clearly appear but might be brought to mind with the words “shape”, “change” and “liquid” for instance.

**Layer 4: Material experience**
The material experience of the RHEI clock is expressed by numerous adjectives that have similar frequencies in both reports. However, it can be noticed that some groups of words relate to similar lexical field: for example, one related to the movement comprises the words “transience”, “continuous”, “movement”, “flow”, “dynamics”, “position” and...
“transitions”. A lexical field related to nature also appears with the words “natural”, “living”, “organism” and “molecules”. And finally, a field related to art is represented with the words “symbolizes”, “sculptures”, “aesthetics”, “artistic”, “fashion” and “attractive”. Based on this analysis, the material experience related to the smart dynamic product selected could be described as dynamic, artsy and living.

**Layer 5: Product experience**

This layer is dedicated to the product rather than material experience. The boundary between these two layers can be blurry for some products, in particular when the primary interaction with the product relies on the smart material. In the case of the RHEI clock, some interesting nouns were depicted as related to emotions and attention: “fascinates”, “emotional”, “playful”, sense”, “spectator”, “attention”, “expected” and “subjective”.

The analysis of the textual contents of the student reports gives insights on the type of words that are used to describe each layer. It could be useful to have additional reports to consolidate the insights collected based on these two student reports. However, it was observed that similar lexical fields can be extracted from the reports. For the engineering layers, the similarities between the data collected are very high. For the upper layers, a larger number of words have been used, but still remain in the same lexical field. In order to structure the textual information from these upper layers, an interpretative framework that proposes seven criteria has been tested. These criteria are the ones used by Morville (2004) for digital user experience. For each criterion, descriptors are given and five levels are proposed (two positive levels in green, one neutral level -black line- and two negative levels in red). From these observations, one may infer that the framework helps students at shaping the user experience associated to a material they cannot experience directly. These first anecdotal observations are currently being documented by a systematic investigation of the student reports by text mining and ontological classification methods derived from those used in semantic web research.

### 4 Discussion and Conclusion

As other materials, smart materials are also characterized by technical as well as sensorial properties. However, the added value of smart materials lies in their ability to dynamically change these properties. In many cases, changes in the technical material properties are used to improve products in terms of their functional performance, but for designers, variations in the sensorial properties of materials are especially interesting, because these can affect the product’s **sensory language**. The sensory language (Krippendorff & Butter, 2008) of a product, such as its form, color or texture, carries meanings and communicates messages to the user (similar to the **meaning of materials** discussed earlier), but it is usually static.

Through the use of smart material designers are able to implement **dynamic sensory features** (Bergamaschi et al., 2016) within physical products, which then can dynamically change their sensory language, allowing the communication of simple and intuitive messages to the user in a physical way and without the need for verbal, iconic or numeric language. This new class of products was coined as **dynamic products** (Colombo, 2014; 2016) and defined as artefacts with sensory features (**visual, tactile, auditory and olfactory**) that change in a proactive and reversible way over time, in response to external or internal stimuli, addressing one or more user’s sensory modalities.

With the material and immaterial world moving closer together, and GUIs like touch screens becoming the dominating element in product-user interactions, the exploration of alternative ways to transfer and display information is of increasing interest, especially within the design and HCI community. Physical, multi-sensorial interactions are more effective in eliciting emotions and in creating engaging user experiences, which makes smart materials and their dynamic sensorial properties a promising solution (Colombo, 2014; 2016).

Aiming at encouraging the learning and use of smart materials in designing more engaging user experiences, new tools have been developed for teaching smart material properties and behaviors to design students. In particular, the framework presented in this work, was evaluated by Design & Engineering students as an effective tool to think about the large amount of data concerning smart materials both from the technical side (material science and engineering) and the behavioural dimension (user-centred design). It has to be noted that, in a first effort to separate the contributions to the overall dynamic product experience and facilitate their analysis by students, the performative level of materials experience, as rationalized in the Material Driven Design (MDD) method (Giaccardi & Karana, 2015; Karana, Barati, Rognoli & Laan, 2018), was possibly overlooked. In the proposed framework, the materials experience level is limited to psycho-sensory attributes, while those related to interactions and user exploration are separated in the analysis and **moved** to the next layer (user experience). Indeed, during tutored research sessions, numerous questions regarding this formal separation were raised by students. In the reports, this layer was more focused on
products than on materials. While being effective at providing a practical approach for deconstructing complex interactions into a balanced account of their technical and experiential attributes, the present method might undermine an important aspect of smart materials, namely their ability to deliver emphatic user-product interactions seamlessly. Specific research on this aspect of smart materials versus traditional information sensing, processing and display systems is currently being carried out by the authors. This will hopefully allow to elaborate on the MDD approach and propose specific developments related to smart materials.

This paper is part of an ongoing collaboration among three research groups, in which one of the research questions addressed is “how to teach smart materials to impulse the development of innovative smart products?”. By structuring these data, the knowledge resources can be used by both design practitioners and engineers as a bridging tool to set a common language in case of co-creation actions. This framework acts as a mediation artefact. It is complementary to existing knowledge resources that are adapted to professional habits of either creative industries (materials’ library, books on materials with inspirational iconographic contents) or engineering concerns (technical data sheets, databases, books on materials with numerical contents). It has been shown that the structure of the framework is easily comprehended by students from design and engineering fields.

References


Educational Tools to Teach Design Students the Dynamic Behaviours of Smart Materials


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Abstract: The third mission of academia, i.e. public engagement, has become more and more explicit. Nowadays universities have to engage with societal needs and market demands by linking the university’s activity with its own socio-economic and cultural context. In this perspective, this paper will deal with the educational activities of academia through the activities of a material library: the spread of recent and continuous innovations of materials for design. In the landscape of academic material libraries, the case study of MATto appears as of particular interest, especially concerning the topic of the continuous updating proposed to its contacts, therefore it will be investigated and explored. A new strategy, whose main objectives are generating widespread learning based on a continuous dialogue, nurturing a polytechnic knowledge on materials through on-going updating and involving the wide public into informative processes by generating curiosity and interest on the research on materials for production, was designed ad hoc. The most interesting and effective tools in relation to the attended results were selected and the working methods are based on a series of informal live-meetings and a new media presence growth action plan. After one year, the results of this new approach to public engagement are still embryonic but yet promising. This work can be an example for other institutions facing issues such as contemporary methods to teach or, at least, to spread materials and design culture.

Keywords: innovative materials and design; design education; consultancy services; materials library; public engagement.
1 Public Engagement for Academia: How to Diffuse the Materials Culture for Design?

The concept of public engagement is defined as the bridge linking the world of academic research to the society in its broader sense (APEnet. Atenei ed enti di ricerca per il Public Engagement (Academies and research public authorities for the Public Engagement), 2018). Besides the first mission of qualifying the human capital (i.e. education), and the second mission of producing new knowledge (i.e. research), the third mission of academia stresses its role as catalyst of economic, social and cultural development processes, together with all the other social actors (APEnet. Atenei ed enti di ricerca per il Public Engagement (Academies and research public authorities for the Public Engagement), 2018).

“The label of Third University Mission, aim[s] to understand how the enhancement of economic and social outcomes of scientific and technological research is possible” (Capogna, 2012, p. 33). The third mission of academia, i.e. public engagement, was originally developed in a natural and unplanned manner, through the well-known technological transfer concept based on collaboration with firms and on the education of generations of students that will become professionals, firm managers, and executives later on. Over the last twenty years, this mission has become more and more explicit, with specific initiatives – sometimes also strongly pioneering – on a national level (Politecnico di Torino, 2018). Nowadays, universities must engage with societal needs and market demands by linking the university's activity with its own socio-economic context (Carvalho, 2016). However, this recent evolution of the third mission entailed, over the last years, new approaches and new spheres of action of academia, such as sharing and co-generating knowledge in relation with firms, or the dissemination of the results of research to the wide public (Laredo, 2007).

Therefore, as today's universities develop their strategies around these three missions, every researcher, every laboratory, every activity developed in academia should pursue the same objectives on those three levels.

The paper will deal with the educational activities of academia in a specific field of action: the recent and continuous innovations of materials for design. Materials have become more and more important in design culture and education (Bertola and Manzini, 2004), for professionals but also for companies, as the field of materials is expanding at a rate faster than we can study. As underlined by Dehn (2014, p. 165), “recent collaborations between academia and industry have demonstrated the benefits of materials consultancy”. Moreover, for example, in the H2020 programme, different actions involve innovation in material fields (from the area of buildings to the additive manufacturing to nanotechnologies): innovative materials can help companies and researchers to define and develop projects to improve performances and eco-efficiency, among other attributes, of productions and processes. On the other hand, due to the increasing digitalization of design practice, the progressive loss of a strong material culture depletes one of the most traditional know-how of a good designer: the knowledge about materials. Nowadays, materials still matter in every stage of the design process beginning with the concept definition because materials determine the physical and technical properties as well as the identity. Indeed, the designer still has the responsibility to select the proper materials that interact efficiently with the users and the context: in response to the loss of direct knowledge about materials, many tools and methods for acquiring materials experience have spread in the recent years, addressed to professionals and production companies, but also to students (in Architecture and Design disciplines).

2 Innovative Materials for Design: An Introduction to Material Libraries

Material libraries are physical or virtual material archives that collect and share a relevant quantity of samples and the related information, derived from very different applicative fields, such as architecture, design, fashion and industrial production in general (Campogrande, 2009). Observing the current situation, the material libraries can today be classified into two different categories: the first is the category of commercial material libraries, focused on providing consultancies for a profit, usually sponsored by external firms and frequently associated with international networks. These material libraries differ deeply from academic material libraries (the second category), usually belonging to universities or research institutions and mainly focused on technology transfer and knowledge generation (Lerma, 2010). Starting in USA in 1997 with the pioneer Material Connexion founded by George M. Beylerian, the material libraries have spread everywhere in the world, from the USA to Europe, from Israel to Japan and they contribute actively to the constant updating of designers, firms and R&D departments on the topic of innovative materials (Lucibello, 2005; 2009; Rognoli & Levi, 2005): presently, the materials libraries present various services addressed to companies and professionals, characterized by different aims (inspiration, technical information, etc.) and, moreover, each material library can present specific methods of material selection. Each material selection method can evolve into more active events (fairs, exhibitions, seminars, books, etc.) and in more and more complex and specific categorizations and collections (i.e. only plastics, eco-materials, materials form circular economy). In fact, currently “the field of materials is expanding at a rate faster than we can study, with a recent estimate counting over 160,000 unique materials in the world.” (Corbin, 2018, p. 6). Thanks to these material libraries, designers and companies sometimes experience the problem of how to deal with the hyper-choice (Manzini, 1986). Indeed, nowadays
designers are immersed in a surge of hyper-materialism, ultra-performance and environmental responsibility, material mutations, sensorial maximalism of luxury and effect: new materials have produced a vortex of hyper-choice (Kula & Ternaux, 2009; 2009) and infinite material dialogues (Margolis, 2010).

3 Case Study: MATto, the Material Library of Politecnico di Torino

In the complex and articulated scene of academic material libraries, a significant case study considered of particular interest by many firms – especially taking into consideration the issue of the continuous updating offered to its contacts on the matter of materials and innovations – is represented by MATto. The topic of generating new knowledge, nurturing curiosity and bridging the gap between civil society and academia is today, a very up-to-date issue. In this context, this case study can represent an interesting starting point for proving how an academy can undertake a third mission action on the topic of innovative materials. MATto is a good example to reveal how areas of design are linked to the sustainable innovation of the process and the product as well as the relationship with the territory, and with academic and local authorities.

MATto is the materials library of the Politecnico di Torino that, alongside the Torino Chamber of commerce, provides manufacturing companies with consultancy services regarding innovative materials and production processes in order to support and foster innovation in industrial and craft businesses, since 2010. As a mission, MATto aims to build relationships between companies and, thanks to its research approach, to bridge the gap between design needs and the technical solutions with a focus on sustainable and sensory development. According to the scientific director of MATto, professor Claudia De Giorgi:

A material library, or rather, an interdisciplinary centre for discussing design, sensorial elements and sustainability in a scientific context, with experts able to work alongside in-house designers and freelancers in the quest to solve problems connected to creating new products and to improving existing ones. What university is offering is not just an interpretation of the parameters of the existing situation and not just theoretical references to a hypothetical sensorial state which often makes way for mere suggestion or for the empirical; instead it is opening itself up to companies and designers with the aim of providing a useful and effective service (De Giorgi, 2012, p. 72).

Since 2010, in collaboration with the Torino Chamber of commerce, MATto through its operation “MATto materials for design”, helps the local companies in their projects through customized consultancy services. The consultancies are subscription services, not free of charge, partly sponsored by the Torino Chamber of commerce.

Within the whole MATto offer, since 2010 almost 200 regional companies and design studios from different sectors have been met: product (31%), communication (9.5%), transportation (12%), production of industrial machinery and components (6%), production of materials and semi-finished products (22%), architecture/building sector (16.5%), design and prototyping (3%). The rate of appreciation of the “MATto materials for design” service was monitored over the years by a customer satisfaction module administered to the firms after having benefited from the consultancy service. Overall, the appreciation level was very high, especially concerning the rate of service customization and the satisfaction compared to the firm specific needs (satisfied/very satisfied).

The Torino Chamber of commerce has been especially important in the development of the material library and of its consultancy services: since 2010 it has stood out from other authorities in supporting the design system in Piedmont region, “the Chamber of commerce has played a primary role in driving the growth of the local economic fabric through a variety of recurrent initiatives over the years. In this instance, it provides frequent meeting opportunities for professionals, companies, designers and the public to exchange knowledge” (Bolatto, 2014, p. 22).

At MATto, researchers and professors from the Politecnico di Torino, designers specialized in materials and processes, interpret the requests of companies and go on to research and select materials and technologies, supporting the company and its designers in a collaborative relationship. Every design project has specific characteristics due to its aims, context, and materials. The MATto materials library aims to help companies and their designers achieve success by improving their production processes and guiding their choice of the materials that best meet their needs in every phase of project development, so as to help them identify:

• ideas for new future products;
• improvements to products in the design or prototype phase;
• improvements to products already in production;
• ideas for an alternative and innovative use of existing materials and/or processes;
• guidelines for the development of innovative process/product solutions;
• recommendations for the development of sensory and/or environmentally sustainable projects.

### 3.1 The Material Archive

The MATto materials archive boasts innovative, state-of-the-art materials that are analysed and chosen with a particular emphasis on their environmental sustainability. The archive is home to a whole range of different materials: light and shape-memory metals, flexible ceramics, fragrant plastics, transparent cement, soft and flexible woods, 3D fabrics, anti-bacterial, and self-cleaning glass. Over 700 innovative material samples and semi-finished products that are hosted in the library come from manufacturing companies, suppliers and distributors based both in Italy and abroad.

The samples that are included in the archive are selected by researchers from the Politecnico di Torino on the basis of their actual innovative content. They are sorted according to their material families and physical forms and they can be seen, touched and handled by interested professionals and companies during events held at the materials library.

For each catalogued sample researchers include a technical report with specific information on each material, such as regarding their chemical, physical and mechanical parameters, their fire, weather, and chemical resistance, their durability or price range. They also include assessments regarding environmental sustainability, sensory perception/expressive potential, main uses and possible uses.

It needs to be noted that, the technical reports are used as research and analysis tools by MATto researchers, with the aim of directly supporting every need of the companies and considering the complexity of every single project, and therefore, are not available for private consultation. On the other hand, each material sample is complemented by a fact sheet, usually presented during company consultancy visits. It lists information concerning the production process, the material’s main technical features and current uses of the material, with visual references included. Moreover, the contact details of the manufacturers and suppliers are provided as well as, when available, the approximate cost.

### 3.2 The New Offer of Services

Apart from the material archives, MATto also offers companies tailor-made consultancy services to help them find innovative materials, assisting them in their choice of the best solution to their design and production problems and evaluating a material’s perceived quality.

In order to provide incentive and support to the innovation and work of local SMEs in the manufacturing industry, the MATto material library team has carried out in 2018 an important reorganization of the consultancy services offered to companies, in order to better answer the most updated needs of local firms. In fact, the new set of services has been specially created to help companies and their designers, whether they work in-house or are outsourced. MATto is indeed the place where different types of organizations - designers, companies, and manufacturers - can meet, brought together to discuss the topic of innovative design materials.

#### 3.2.1 MATto Consultancies

In order to pursue the third mission of academia traditionally intended as the technological transfer, three typologies of consultancies have been organized by the material library, and are called MATto_STANDARD, MATto_PREMIUM, and MATto_PERCEIVED QUALITY, respectively (Figure 1).

**MATto_STANDARD**

This service, started in 2010, is particularly designed to help manufacturing SMEs with the selection of innovative materials and technologies in order to solve problems of controlled complexity (e.g. the replacement of materials in existing products, the identification of alternative manufacturing technologies, etc.) and it features three steps:

1. an initial meeting in person or online in which researches learn the brief and the needs of the client;
2. a search for the right materials and technologies, conducted by MATto researchers both from among the samples in the archive as well as from other manufacturers, in order to find the most up-to-date and effective solutions;
3. a second face-to-face meeting approximately two-three hours long, where samples of the chosen innovations are presented, together with fact sheets and contact details of the manufacturers, suppliers and processing
companies, organized in keeping with the concept of a zero-mile supply chain from the company’s headquarters.

**MATto**

The most advanced service supports companies and designers in the identification, analysis, and selection of innovative materials, technologies and processing methods of all kinds, from traditional options to the most ground-breaking developments. The service is set up to support a company’s R&D department and its designers when technical/scientific networking skills are required for carrying out complex research. The aim is to solve problems of high complexity, where the right material and/or processing method will make the difference and ensure the originality of the design and the product. The service can count on instruments that select materials according to their technical characteristics such as the CES – Cambridge Eco Selector and a vast network of both national and international specialists working both at the Politecnico di Torino or collaborating with it, a network that is constantly updated and implemented. MATto is also available as a partner in competitive tenders for research projects on European structural funds focusing on topics to do with innovation in the field of materials, technologies, and products.

**MATto**

Having acknowledged the importance of perceptive features of materials, multisensory aspects have become important in the classification of materials in material libraries (Lerma & Dal Palù, 2016). In these archives, material classification is based either on a technical approach (reflectivity, heat conductivity, thermal properties, etc.) or on empirical perceptive criteria (Lerma, De Giorgi & Allione, 2013). With this service, an initial assessment of the efficacy of existing products and design solutions can be carried out. Unlike other materials libraries, MATto carries out such an assessment starting with a scientific analysis of real and/or virtual prototypes, conducted with the application of methods and instruments of high added value, analysing and assessing sensory and perceived quality. Such instruments include, for example, our eye-tracking machine, the Sensotact®, the SounBe, and the Semantic Differential scale. Consumer focus groups are also involved in the analysis of perceived quality, since an understanding of the attitude and preferences of consumers towards a product can be useful when evaluating its usability, comprehensibility, function and communicational efficacy.

### 4 The Actions of MATto for Public Engagement

Despite the technological transfer, fostering the public engagement of a materials library is quite a novel topic, and there is still not a consolidated literature on the matter. In fact, even though the mere communication of a material library is an ordinary activity –especially for marketing purpose in commercial realities–, the point of view and the missions of a didactic reality are thoroughly different. In fact, some key points grounding the actions undertaken by
MATto library in the last year, consistently with the objectives of academia in general (Montesinos, Carot, Martinez & Mora, 2008), are aimed at:

- supporting the growth of micro, small and medium enterprises – that represent the typical granulometry of Italian, and above all of Piedmont region, industrial structure – in acquiring a more aware competence on materials;
- contributing on a local scale to the territorial development and, on a larger scale, on our country development by introducing innovative materials in the productive process;
- generating a widespread learning plan, based on a continuous dialogue with students and ex-students mainly from design studies (but not only from that), through their entrance in manufacturing companies and local realities;
- nurturing a polytechnic knowledge on materials through on-going updating;
- involving the wider public into informative processes, generating curiosity and interest in the research on materials for production;
- making research results more accessible to everyone, from the experts in other disciplines to the common men.

Starting from these objectives, the working methods have been designed ad hoc, starting from the most interesting and effective tools in relation to the attended results. In other words, this path is quite experimental, and for this reason, it had to be deeply investigated and thought out; nevertheless, it is still subjected to an on-going refinement and implementation. Hand in hand with the renewal of the MATto package, the material library has therefore launched:

- a new series of informal live-meetings, to focus the attention of the material library activities and generate curiosity on the innovative materials topic on a local and national scale;
- a new media presence growth action, targeted towards the circulation and promotion of its activity and the newly generated knowledge to a broader audience.

In the following paragraphs the scientific plan, the objectives, the methods and the results of these actions will be summarised.

4.1 The Live Meetings

The live-presence of MATto was recently strengthened through a plan of informal meeting and appointments in MATto headquarter but also in other key places (fairs, conferences, etc.), where it is possible to better learn the role of the material library and discuss innovative materials.

4.1.1 MATto_MATERIALS&COFFEE

Four times a year, MATto opens its doors to designers, architects, entrepreneurs, R&D professionals, students or simply curious people to let them discover the word of innovative materials, learning how a material archive works, spread the research opportunities offered by MATto new services and show a selection of previous results achieved in past research, in an informal and friendly mood accompanied with a cup of coffee and cookies (Figure 2). Each meeting is based upon a theme, selected in order to show the endless opportunities that are possible when working with innovative materials. For example, the themes selected for the year 2018 were: “Living Materials” (for the spring edition), “Fresh Materials” (for the summer edition), “Unusual Metals” (for the autumn edition) and “Hi-tech Wood” (for the winter edition). Each meeting is also an opportunity for the case study of a local firm (producing innovative materials, semi-finished products or finishing on the theme), invited to share their experience in their own words with the other participants.

4.1.2 Presence at Fairs, Conferences and B2B

MATto undertakes dissemination and communication activities in order to effectively spread information about its project and to convey their outcomes to multiple audiences, including the media and the public. For this reason, the MATto research group, in collaboration with Torino Chamber of commerce, starting from 2018, defined a very dense program of activities to disseminate the material library culture and projects. Since 2010 MATto is present at the seminars organized by Torino Chamber of commerce with the aim to promote the material and design culture to companies and at specific conferences in order to present its consultancy services. Moreover, MATto took part in various seminars linked to specific themes (i.e. innovative materials for automotive sectors, the role of design in environmental sustainability, etc.) as expert in innovative materials. In recent years, MATto has been present at many meetings and B2B sessions (Business-to-Business, i.e. meeting days in which different companies can connect with one another, and generate new productive relationships) for generating meaningful networks and discussions with
companies and people who are truly relevant for its businesses and projects, as well as in order to present its activities to a selected public, sensitive to the design theme. Furthermore, MATto will be involved in the activities of specific professional associations (in the architecture field) to face the materials innovation issues and to teach and spread materials and design culture.

Figure 2. During the MATto_MATERIALS&COFFEE a selection of materials, achieved in past research, are showed, all in an informal and friendly atmosphere.

4.2 The New Media Growth Action

The MATto social network strategy was mainly structured through 3 communication channels, selected for reaching a high number of people as well as a broader set of personas: a blog on MATto website, a Facebook page, and a LinkedIn presence. A specific and diversified strategy developed for each of the three channels was designed in order to provide new knowledge a little at a time, as collateral informing activity to more structured update courses.

4.2.1 The MATto blog

The MATto blog, published on MATto’s own website (www.matto.design), is primarily designed to create high-quality content and provide updates on the world of innovative materials to its readers, with a focus on the most trending and interesting topics to its audience, based principally on the most frequently asked questions on the forum and blog concerning innovative materials. The secondary and more technical aim of communication through this channel is to strengthen MATto’s presence on search engines by means of inserting new and trending keywords on a regular basis – in other words, a pull-strategy. The editorial line of the MATto blog plans, generally speaking, the publication of one blog post per month, with free topics that are not bound to a specific content style (e.g. “Fruits and vegetables becoming innovative materials”, “A new life for plastics from seas and oceans”, “Geopolymers: new materials from the past”, etc., MATto, 2018), written in a language that is technical but also comprehensible to a broader audience, with a constant adjustment to the SEO register.

4.2.2 The MATto Facebook page

The Facebook page has, instead, a different, wider strategic goal: to reach young designers, students, and alumni entering the working world and the local companies through Facebook, currently still one of the world’s most popular social network. Therefore (as of today), five categories of posts have been designed for the page in order to tickle the curiosity of followers (“What material is it?”, “The good design practices”, “Everyday life materials”, “It looks like, but it’s not” and “Processes and technologies”), to be constantly updated to maintain a high level of public appeal (Figure 3). The page is also a showcase for special events organized by MATto (i.e. MATto_MATERIALS&COFFEE) and for short daily pieces of news (i.e. the publication of design contests, save-the-dates for exhibitions and events dedicated to specialists in the field, etc.). Since its launch in early-February 2018, the page counts 390 followers, with an average (organic) reach per post of 280 views and over 2000 individuals reached since the first event MATto_MATERIALS&COFFEE.

4.2.3 The MATto LinkedIn corporate page

Finally, the corporate LinkedIn page is addressed to a strictly professional audience and is born out of the idea of collecting the contacts of all people, companies (SMEs to large enterprises), and institutions which have had – to different extents – the occasion to work with MATto. The goal is to create a portfolio of professional contacts to keep active and informed on current research projects, and to give relevance to the fine-tuned consultancy services provided in the new package, in order to attract a growingly high number of potential users interested in the
consultancy services offered, broaden the network of companies to get in contact with, and to find potential partners for larger research projects, in the scope of strategic marketing.

Figure 3. Some examples from the MATto’s Facebook posts: “What material is it?”, “The good design practices” and “Everyday life materials” series.

5 Discussion and Conclusion

These new approaches to knowledge generation and knowledge dissemination, through informal live-meetings and informative pills were highly appreciated from the beginning. However, one should always keep in mind that the results, consistent with the third mission of academia, will be observed on a medium or even long term. In fact, undertaking these kinds of actions, one has to be aware that results derive from the consolidation of relationships in space and time; therefore, it isn’t advisable to look for or rely on immediate and misleading returns. Investigating and proposing research results from different fields and different productive chains can improve and foster cross-disciplinary thinking, that is the typical poly-technic approach to problems:

The skill of the twenty-first century’s great thinkers will not be cleverness in one particular discipline, but rather knowing how to use materials as a bridge between disciplines. As a global society, we’re going to need lots of people with different skills to tackle the complex issues that face us today. The power of materials is that they transcend the boundaries of multiple disciplines (Corbin, 2018, p. 7).

In this sense, MATto acts as catalyst bringing different agents together and proposing different stories, derived from the material culture, from research case-studies and form best practices in the local context, in order to generate not just vertical knowledge, but also horizontal links, that ground the idea of a growing network of expertise. The learning and educational activities on ‘materials experience’ topic can be shared with professionals and companies thanks to the role of the University in knowledge production, in order to “support and disseminate scientific and technology research results” (Capogna, 2012, p. 34).

A deeper knowledge of the local and territorial realities is a positive starting point for new synergic cooperation: nurturing the interest towards innovative materials within the firms can start with the new generations of younger
designers supplying the necessary messages. At the level of public authorities, the “Chamber’s commitment also complied with European policy for advancing the long-term contribution that design may provide in order to aid smart, sustainable and inclusive growth, by strengthening competitiveness and by pursuing a better quality of life for all European citizens” (Bolatto, 2014, p. 22).

MATto represents a good example of collaboration between University, public authorities, and companies in the territory and of the relationship with the territory, intended as a complex system of cultural and social-economic references. Materials can be read as an excuse to think about design and speak with companies about projects and products developed, in order to spread virtuous researches. Finally, a continuous and drop-by-drop infusion of new ideas is proved in the literature (Kuh, 2008) being far more inspirational than a full-immersion of new information, and this approach contributes to a sense of community of designers, that constitutes a positive precondition for local and territorial development.

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The NautICS Materials Workshop: Teaching and Learning Interactive, Connected and Smart Materials for Yacht Design

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Abstract: Knowledge about materials is a key element in design education, considering not only their technical properties but also experiential and expressive-sensorial qualities of materials. To comply with this transition and with the emergence of novel materials, educators need to adapt or develop new formats, tools and methods for teaching and learning materials in design curricula. This paper presents a tentative design methodology experimented and validated in an educational workshop named NautICS Materials, with the aims of (i) teaching ICS Materials in the absence of material samples, (ii) exploiting the potential of ICS Materials in driving yacht design concepts; (iii) designing for ICS Materials; and (iv) introducing and applying the notion of materials experience. ICS Materials is an acronym that stands for Interactive, Connected, and Smart. Indeed, the domain of materials for design is changing under the influence of an increasingly technological advancement, which brings miniaturization of technology and material augmentation with the use of sensors, actuators, and microprocessors. Examples of new hybrid material systems with dynamic and computational qualities are increasingly emerging and raising the need to forecast their potentials in the design space and to reflect on their future application critically, both in design and in teaching. The workshop NautICS Materials -ICS Materials for the Nautical sector- is described by its objectives, structure, methodology, tools and results, in order to present a model to transfer to other sectors or to scale up in larger experimental and applied actions.

Keywords: ICS Materials; materials experience; yacht design; design tools; design education

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1 Introduction

Knowledge and skills about materials are fundamental elements in design practice and education. Conventionally, their contribution in the design space was limited to the selection of proper materials for integration into students’ projects, contributing in the process of materialization. To do that, students were typically asked to acquire knowledge about material families, their technical properties, manufacturing processes, treatments and finishes, and – not least – their sensorial qualities. In fact, in the scope of design education, the role of the sensorial and experiential qualities of materials has remarkably increased. In the last 30 years, scholars and educators working in the area of materials for design moved their attention from the technical properties of materials to the expressive, sensorial, and experiential qualities of them (Manzini, 1986; Cornish, 1987; Ashby & Johnson, 2002; Rognoli, 2010; Karana, Pedgley & Rognoli, 2015). It is acknowledged that materials have qualities that go beyond the fulfilling of practical demands. They have intangible properties that captivate appreciation and that affect the experience of an artefact beyond its functional value. They are qualitative, non-technical, and intangible characteristics related to emotions, personality, and cultural meanings. These qualities of materials have been explored and classified by different scholars, constituting a substantial body of work identifiable as the notion of Materials Experience (Karana, Pedgley & Rognoli, 2013). Since materiality contributes to the definition of product experience (Desmet & Hekkert, 2017), the concept of materials experience arises as “the experience that people have through and with materials” (Karana, Pedgley & Rognoli, 2015), which is framed into sensorial, emotional, meaningful, and performative layers of experience (Giaccardi & Karana, 2015). The concept of Materials Experience grounds on a previous body of work, such as the Meanings of Materials (Karana, 2009) and the Expressive-Sensorial Dimension of Materials, i.e., the sensorial, subjective, qualitative, and unquantifiable profile of materials (Rognoli, 2004; 2010).

Because of this transition, traditional approaches and tools for materials teaching and learning in the design space are no longer adequate. Novel teaching and learning formats, tools, and methods have been inquired and developed to merge the duality of engineering-based and experience-based information in a consistent and complex frame that can be introduced to design students. The Expressive-Sensorial Atlas (Rognoli, 2004; 2010) supporting designers in their understanding of the material qualities and unfolding their relations with engineering properties and the sensorial evaluation scale (Karana, 2009) are two examples of these tools. These embrace a transition of educational approach from a theoretical one to a more explorative and practical one, integrating material education into design studios and experimental activities, such as workshops. In this respect, design students are enabled to design focusing on the appearance of materials, the feel and experience they induce, or start from a particular material and design meaningful applications for it, contributing to the development of materials and the identification of innovative solutions. This is evident in the application of Material Driven Design method (Karana et al., 2015) and Material Tinkering approach (Paris, Rognoli & Sonneveld, 2017) in design studios, just to mention some examples.

One emerging challenge for materials education for design is the introduction of novel and unconventional classes of materials different from the traditional ones, such as Interactive, Connected, and Smart (ICS) Materials. The integration of these materials arises the need for new approaches, tools, methods, and formats for teaching and learning. In this scope, Materials Experience appears as a key notion for their understanding, conceptualization, and integration into a concept artefact.

1.1 ICS Materials

Novel materials with dynamic and interactive qualities, able to sense, process, and materialize data, are emerging under the influence of an increasingly technological advancement that fuels miniaturization of technology and material augmentation. These are explored by the basic research project ‘ICS Materials’ (Ferrara, et al., 2018; Bionda & Ratti, 2018; Parisi, et al., 2018 a; 2018 b), an acronym that stands for Interactive, Connected, and Smart Materials. Many of these materials are at their experimental and prototypical stage without a clear application. The practice of design has always facilitated the development and integration of novel materials (Ashby & Johnson, 2002). However, design practice and education lack a methodology to approach these materials. The purposes of the research are: (i) to develop methods and tools for design practitioners and students to understand, conceptualize, and design (with) them; (ii) to forecast their potentials in the design space, considering the role of the experiences enabled and implied by such materials; (iii) and to reflect on their future application critically. This paper is a step in this direction, by proposing a tentative methodology for material education for design, aimed to design with and for ICS Materials and describing its application and results in a Yacht Design educational workshop.

The definition of ICS Materials is here proposed as Hybrid Material Systems, i.e., material-based systems with different degrees of complexity combining inactive materials, smart material components, and embedded sensing, computing, and actuating technologies. Individual aspects of such materials have been explored and formalized by previous and
current researches of colleagues in the intersection of Design, Materials, and Human-Computer Interaction (Vallgårda & Sokoler, 2010; Razzaque, Dobson & Delaney, 2013; Barati, Giaccardi & Karana, 2018). They mainly perform shape-shifting, light-emitting, and colour-changing behaviours. The seamless combination of elements into a material system might enable less intrusive and more inclusive experiences, a more immediate and engaging interaction, and sustainable integration of technologies into everyday practices.

The research is positioned in the intersection of design, new materials, and interaction. We assume a *behaviouristic* view of interaction (Saffer, 2009), which underpins a broad meaning of the term, by also considering other means of interaction different from digital and computational, and adopting an inclusive approach (Buchanan, 2001). Thus, we consider a broad range of materials empowered by computational, mechanical, chemical and biological components as sensors and actuators. ICS Materials arise as potential enablers of meaningful dynamic and interactive materials experiences as tangible interfaces for a diversity of applications, from interactive architecture to smart fashion, from autonomous vehicles to smart and conversational objects.

1.2 Emerging Trends in Yacht Design

With emerging technologies and cutting-edge materials, the yachting industry is evolving rapidly to meet the needs of modern yacht owners and is growing both on sales volume and boat size. The market, indeed, is continuously rising and since 2014 has benefited from the upward demand for yacht charter and water-based luxury experiences moving towards the large yacht segment (Boat International, 2018; Deloitte, 2018). Between 2010 and 2017, the 60 meters plus market segment, so-called megayacht, has grown by an average of 11% and with the perspective to reach US$ 74.7 billion by 2022 (Global Industry Analysts Inc, 2017), confirming the theory that the high-end sector appears to be more resilient to any crisis in international markets (Campolongo, 2017). As yachts are evolving into superyachts and megayachts, the design projects are moving away from the traditional conservative nature of this industry with ergonomic-based use of space at the centre of design practice, to luxury design boats where a project is highly influenced by the client personality and aesthetic, and where the design criteria are revealed with [emphasized and special characters” (Celaschi et al., 2015). Designers are now experimenting with new soft features for higher sensory expressions, looking for new types of interaction between yacht, sea, and human behaviours. As introduced in The Future Yacht by Boat International (2017):

Lifestyle design is the new undercurrent of yachting, promoted by fellow disruptors who assert that most currently available yachts don’t live the way today’s new affluent society does. The disconnect is palpable. People want a vessel that will give them experiences they can’t have elsewhere, and for too long have been handed designs for vessels that simply replicate all their land-based elsewhere, albeit with a pointy end. These are exciting times, yachting at the cusp of change.

Looking with the lens of experience design we can identify the following key elements as yacht design trends (Bionda & Ratti, 2018):

- **Experience the sea.** Soft features and flexible/convert spaces highlight the continuity between indoors and outdoors. Living areas themselves are evolving with the advancing glass and material technology. Material experience assumes an important meaning as it becomes a great catalyst of emotions able to throw the yacht owner into an augmented experience.
- **Innovative layouts.** The General Arrangement is moving away from traditional structures with divided interiors and smaller outdoor spaces. There is an increased focus on larger outdoor areas and lighter open plan interiors. The structural constraints are becoming less, leading to more interesting ways of designing spaces and combining areas with organic structures and pop-up spaces explored in several yacht design concept.
- **Focus on health & wellness.** Owners are looking to carry their balanced lifestyle into the world of yachting. The spa experience is accelerating: gyms, cryotherapy chambers, salt inhalation rooms, hot yoga studios are just a few of the ideas on the drawing board.

2 The NautICS Materials Workshop

Among the diverse potential areas of use of ICS Materials—from automotive to smart architecture, from the health sector to consumer electronics—, the Nautical transportation demonstrates to be one of the most suitable and competitive sectors of integration. Here, ICS Materials may be the enablers of meaningful experiences, expanding the unique interaction between the living space, the sea, and human behaviours. On this theme, a 3-day educational workshop named *NautICS Materials* was organized and run by the authors at Politecnico di Milano, Master in Yacht
Design program. The educational workshop involved 28 students with the goal to foresee and ideate future scenarios in the yachting sector, by conceptualizing new ICS materials and applying them in Future Yacht design concepts.

This workshop was designed to be adopted as a training program in a design firm or in the new yacht department of a shipyard, involving students with different backgrounds who had no knowledge of ICS material and materials experience. A specific set of activities framed in a tentative design methodology —namely Design for ICS Materials— with their supporting tools were developed: Yachting Scenario Boards, ICS Materials Cards, and a Concept Canvas. The workshop had the objective of experimenting and testing a tentative methodology to: (i) teach ICS Materials in the absence of material samples, (ii) exploit the potential of ICS Material in driving yacht design concepts, (iii) design for ICS Materials and (iv) introduce and apply the notion of Materials Experience.

2.1 Master in Yacht Design

The First-level Specializing Master in Yacht Design (MYD) at the Politecnico di Milano-POLI.design was founded to meet the strong demand for training in the pleasure-craft segment and provides the tools for managing the design and construction of sailing and motor boats, from project brief to definition of general plans, hydrostatic and hydrodynamic calculations, fitting-out of interiors, deck and board equipment, boat systems, production in the yard and control of executive stages. Students attending the programme have different backgrounds, both academic—architects, product designers, and engineers—and cultural.

NautiCS Materials is a three-day educational workshop program designed as a first step in approaching ICS Material for a yacht design project, organized and run by the authors at MYD. As the workshop was conceptualized to be the first experience in design with ICS Materials, the 28 MYD students involved had no knowledge either about Interactive, Connected and Smart materials nor about material experience. Indeed, the teaching activity on materials offered in the Master program is conventionally limited to the technical proprieties, manufacturing processes and finishing of construction materials. The materials contribution to yacht design projects are restricted to a selection of materials, with their treatments and finishing integrated as a material board in students’ works. Since previous didactic units on materials under a technical profile have already been provided to the Master students, this workshop aimed to introduce the notion of Materials Experience and apply it to designing with and for emerging and complex materials. The workshop was organized at the halfway of the Master learning path, when students have already developed yacht design skills in managing the shape and the general arrangement of a boat, as well as in construction material and system engineering. Regarding students’ experiences in yacht design processes, the NautiCS Materials workshop aimed to overturn the traditional way of designing a yacht, by exploiting the potential of ICS Material in driving the concept design of functional and aesthetic elements for future yachts, embedded in the interior layout of the vessel.

2.2 Workshop Methodology

The workshop methodology was designed by the authors to reach the intended workshop objective of (i) teaching ICS Materials in the absence of material samples, (ii) exploiting the potential of ICS Material in driving yacht design concepts; (iii) designing for ICS Materials; (iv) introducing and applying the notion of Materials Experience. The methodology of the NautiCS Materials educational workshop could be adopted as a training program in Academia as well as in a design firm or in the new yacht department of a shipyard, as it is addressed to professionals with different backgrounds and no previous knowledge in materials experience or ICS Materials. To achieve its objectives, the workshop had three features:

- the students were divided into five multidisciplinary groups of at least five members to reflect a common yacht design studio;
- the work time period and tasks were split into sections to give a rhythm to the design activity, verify duration of tasks, and increase efficiency;
- a personalized toolkit was given to each team to drive the different design phases. The toolkit contained Yachting Scenarios Boards, ICS Materials Cards, and a Concept Canvas specially designed for the workshop (to know more, go to http://www.icsmaterials.polimi.it/);
- the students were asked to develop a yacht living area (whether in a sailing- or a motor-yacht) driven by the material experience and stimulated by a given scenario without pre-assigned vessel typology and size.

The workshop was organized in the following seven sections conducted for eight hours a day, with a one-hour lunch break, for three days:
Introduction and preparation [2 hours]: presentation of the macro-trend of the yachting sector and ICS Materials research by the tutors; division of the students into groups and toolkit distribution.

Exploration [2 hours]: opening of the toolkit and getting familiar with trends, ICS materials, and Yachting scenarios. Answering the question “what does the future hold for superyacht design?” to start thinking about how the next level of yachting would be like with new smart materials. Tools: Yachting Scenario Boards and ICS Materials Cards.

Definition [2 hours]: to narrow the area of intervention, selection of a part of a yacht journey (sailing, mooring/at anchor) or a part of the day and definition of an onboard space in which the concept project of the new material system will be developed. Tools: Yachting Scenario Boards and ICS Materials Cards.

Conceptualization [4 hours]: ideation of new material system concepts and visualization of yacht experiences enhanced by ICS materials, through sketches, mood boards, storyboards, and textual notes. Tools: Yachting Scenario Boards, ICS Materials Cards, and Concept Canvas.

Integration [4 hours]: integration of the material system concept ideas into feasible design proposals. Tools: Concept Canvas.

Design [8 hours]: development of Yacht concepts, using conventional design and representation tools and techniques, i.e. drawing and rendering by hand and software.

Delivering [2 hours]: exhibition and presentation of the final work to the other teams and open roundtable discussion. Outcomes: 3 posters (A2 landscape format) for each group.

2.3 Tools

2.3.1 Yachting Scenario Boards
Based on the first experiences of ICS_Materials research project, Mapping ICS Materials Workshop 2017 (Parisi et al., 2018 b) and ICS4YD Workshop 2017 (Bionda & Ratti, 2018), different case studies were divided into five groups, taking into consideration both the characteristics of each reactive and proactive materials and the sensory stimuli/information while sailing in a yacht. Then, the following five new scenarios for the yachting industry were finalized: The Warty Jellyfish Mood, Moisture Poetry, Wave of Good Noise, Thermo-Taste, and Dynamic Equilibrium. Each scenario was presented through an inspirational A4 board providing a mood board, an envisioning textual storytelling, and different keywords regarding the sensorial, emotional, interpretive, and performative layers of the proposed onboard experiences (Figures 1 and 2). This tool was used mainly in the exploration phase to drive the first design choices and to start envisioning how the next level of yachting would be like with new smart materials.

Figure 1. Thermo-Taste yachting scenario board - front.
2.3.2 ICS Material Cards

A deck of 48 cards was designed with the purpose of helping students understand all the elements of ICS Materials and build new concepts with them, by gaining an understanding of what they are, how they are made, how they work, and how they appear, and identifying their inputs and outputs of interaction. Each card shows an example of ICS Material, with pictures and textual information, i.e., name of the project, name of the author, a short text describing how it functions and performs, and a graphical schematic representation showing its components, inputs, and outputs (Figures 3 and 4). To do that each example was deconstructed into its constituting elements. The examples that have been selected by the authors to build the cards deck encompassed materials, surfaces, and material-based objects and systems used in many applications, with different behaviours, complexity, and technological readiness levels. In the Exploration stage, the students were asked to read the content of the cards, cluster them and select the most promising examples according to their scenario.

Figure 3. ICS Material Card of the case: Chromosonic by EJtech (front and back).
2.3.3 Concept Canvas
A Concept Canvas in A3 size was designed to be used mainly in the conceptualization phase (Figure 5). The purpose of the canvas was to guide the students through the novel design methodology to conceptualize a new ICS Material (Figure 6). The canvas was divided into three sections, namely (i) material system building, (ii) material system sketching / picturing, and (iii) material system description. The first section provided an empty schematic graphical representation of a material system with blank spaces to be completed with the names of components, input, and output. This recalled the same design used in the cards. The purpose was to use the scheme to build a novel material system by getting inspirations from the examples showed in the ICS Materials Cards and combining their constituting elements in a new coherent design. Although the scheme represents a simplified laminate construction, other ways of integrating and combining elements in a composite structure may be considered. The second section provided a blank box where students could start materializing the first concept idea with sketches, collages of pictures, or mixed techniques. The third section asked to outline the concept with textual technical description (how it works), performative description (what it does), sensory and experiential description (how it feels, looks, and sounds), based on the Materials Experience framework (Giaccardi & Karana, 2017). This last section aimed to reflect upon the performances and experiences enabled and implied by the concept, based on the individual material components and the composition of them in an articulated system. Even though we suggested to follow the steps sequentially, the three activities could be carried out in parallel with an iterative approach, as each section inform the others.
Figure 5. ICS Material Concept Canvas.

Figure 6. Activities and intermediate stages of the NautICS Materials workshop.
3 Results

During the NautICS Materials workshop activity, students conceptualized novel material systems, through the recombination of depicted components, and fully integrated them into the design concepts of functional and aesthetic elements embedded in the interior layout of the vessel. As tangible interfaces, they materialize external and imperceptible environmental data, so that humans could experience them through augmented expressions. Changing their characteristics on external stimuli, ICS Materials influence the aesthetics and perception of spaces, encouraging sensory experiences while sailing or mooring. Five resulting design concepts related to Future Yacht driven by the ICS Material experience are described below.

The sailing yacht concept Glowrious (Figures 7 and 8), based on The Warty Jellyfish Mood, re-images the relationship between the on-board natural and artificial light transforming the yacht hull into a luminescent night illusion system, by embedding photo-luminescent pigments into a smart glass controlled through Arduino. The smart windows catch the external light coming from the sun, by absorbing it with photo-luminescent pigments located on the glass surface, and reflect it on the water. A LCD panel is located between the internal and external glass to provide an electrochromic effect. The electrochromic glass gives the freedom to control the interior light intensity from both daylight as well as the photoluminescent elements. The sensorial experience is a bioluminescent plankton effect, a diffuse light wrapping the yacht hull. Inside, the warm and pleasant light refracted from the water with different intensities gives an extrasensory experience during mooring and sailing.

Figure 7. Glowrious yacht concept.
The Floating Forest, developed from the Moisture Poetry yachting scenario, uses inboard moisture to create a futuristic biosphere providing onboard water and light through a twofold hybrid material system. The first ICS Material developed has the primary objective of transforming the excess moisture inside the biosphere to drinkable water and is composed of four layers: a hygrometer sensor, activated absorbent, porous plate, and a hydrophobic slider. The second material is a light emitting one that takes moisture concentration in living spaces as input. This material is made out of five different layers, which also act as a structural component of the vessel: a hygrometer sensor, an absorber sponge to collect the moisture of the space, a porous aluminium foil as a capillary, a hydrophobic slider and hydrochromic pigment to produce light.

Taking the inspiration from the Wave of Good Noise scenario, Dynamic Flow materializes the wave sound frequencies in an interior waterfall thanks to external sound sensors. The sound of waves is reproduced in a visual effect through a complex system made out of an external microphone for short-range sound waves, a microcontroller, a tune generating software and the electrical and water system that provide energy and water to the interior waterfall.

The Underwater Breathing Nest is based on the Thermo-Taste yachting scenario and reinterprets the yacht interior as a living creature able to react to the human presence and heat, creating comfortable areas through shape-shifting smart textiles covering the interior surfaces. Heat sensor work together to identify human presence and temperature through proximity. Once detected, the information is transferred to the electrosensitive layers that react expanding themselves like a living creature. The interior effect is a boat breathing from the gills enriched with a dynamically controlled comfort temperature.

The last concept developed was Heckquilibrium inspired by the Dynamic Equilibrium yachting scenario. Through light, it shows the effect of wind and water forces on a sailing boat, enveloping the interior with movable plywood panels covered with light-emitting smart textiles and optic fibres responding to pressure sensors. When the vessel is stable, the panels are closed giving a simple cladding effect. However, when the boat heels the panels open up, offering a dynamic experience by following the angle of the heeling hull. Moreover, dynamic textile patterns added to the plywood panels react to rough sea emitting light according to the wave pressures. From a technical point of view, a nano pressure sensor located along the length of the hull measures healing angle and water pressure. The signal is
received by a control unit that controls independently both the panels’ servo motors and the light emitting optic fibres on each panel.

4 Discussion

At the end of the workshop, students were asked, by means of a questionnaire, for their feedback in order to measure the effectiveness and reception of the activity. The NautICS Materials workshop confirmed the effectiveness of the tentative methodology in achieving the objectives. All the students, with no previous knowledge on ICS Materials and materials experience, were able to conceptualize novel material systems with different degrees of complexity combining inactive materials and smart material components. The toolkit proved its potential in guiding the design phases from the material understanding, to the new materials conceptualization, and their integration into yacht design concepts. The cards overcame the limitations caused by the lack of physical samples of the actual materials and provided immediate and effective information on the materials. However, future development of the methodology may integrate material samples and prototyping. Both students and tutors realized that time-wise a 3-day workshop is too limited for the development of innovative design concepts that could integrate a mix of aesthetic, functional, material and typological innovation. Indeed, just two of five concepts revealed significant implication of the material development into innovative yacht shapes and functions. In most cases, the yacht concepts were disconnected or not influenced by the material that have been conceptualized, resembling conventional yachts especially on the outside. However, taking inspiration from another industrial sector, the design concepts implemented a new generation of material for composite structure, exterior and interior design and sails with dynamic, augmented, and proactive properties. The notion of Materials Experience has been learnt and applied by students, providing inspiration and details to the concepts. The visionary and speculative approach implied by the theme of Future Yacht and ICS Materials have been appreciated by students and requested to be integrated in other didact units of the Master in Yacht Design. Furthermore, the workshop proved the potential of ICS Materials to influence the yacht spaces perception enhancing the onboard experience: as tangible and material interfaces, they materialize external and imperceptible data enabling multi-sensory and engaging yachting experience and allowing the user to be more proactive and engaged in their interaction with spaces and the navigation. To foster and exploit the potential of ICS Materials, future application of the methodology in a design workshop could direct such materials to create awareness, alleviate, or contribute in solving today’s environmental problems. Just to mention some examples of potential directions in the Yacht sector, ICS Materials may visualize environmental information to create awareness on the quality of air, help in the filtration and depuration of polluted water while sailing, or be used as an alternative and sustainable source of energy-harvesting for self-sufficient boats. Furthermore, future workshops could addressed the design of new ICS materials from natural sources or with a low impact in production, such as second row materials or DIY materials.

5 Conclusion

The paper drafted the main theoretical foundations about the research ICS Materials in relation to material education for design and depicted the educational workshop NautICS Materials by its objectives, structure, methodology, tools, and results, in order to present a model to transfer to other sectors or to scale up in larger experimental and applied actions—not only in education, but also in practice with industrial partners—for the integration of smart materials and technologies in the design space. Taking into consideration the outcomes and inferences from the pilot application in the Yacht Design sector, the methodology could be applied and extended to other fields, including, but not limited to, transportation and automotive, health, smart, micro and/or temporary architecture, mobile space suite, consumer electronics, and smart and conversational objects.

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Impossible Design: Fostering Creativity by Quick and Dirty Prototyping

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Abstract: In this paper, we will present the results of challenging students into designing impossible artifacts using quick and dirty prototyping. We have worked during 2017 and 2018 school years with three different groups of undergraduate industrial design students. The challenge was to imagine how living would be in a house in the year 2050. The results show that imagining living in a near future triggers generation of impossible scenarios. Also, working with a limited time to complete the challenge using quick and dirty prototyping allows the students to think less and skip the early phases of the design process, eagerly engaging in the ideation phase while they are also discussing different possibilities with their teammates. Thus, quick and dirty prototyping is seen in this paper as a thinking tool, fostering creativity and promoting dialogue among students. The more uncertain the challenge becomes, as the year 2050 could be, the more dialogue the teammates will need to complete it. Therefore, impossible design activities should aim to bring uncertainty in challenges that could be addressed using quick and dirty prototyping to foster hands-on thinking and creativity in students, while learning about the design process.

Keywords: quick and dirty prototyping; impossible design; border thinking; creativity

1 Introduction: The Role of Prototyping in the Design Process

For schools, teaching the design process has become one of the main concerns. Thus, the hours that students spend in design studios and hands-on activities are more significant than those spent on seminars and theory-oriented classes. Students practice the design process iteratively throughout their professional education, gradually addressing simple and complex problems. Therefore, they learn to the bone perspectives and stages of the design process among which there is design thinking that commonly revolves around six phases: empathize, define, ideate, prototype, test and implement (Gibbons, 2016). In all the activities that could be performed during the design process, prototyping is one “that conventionally takes place at a later stage” (Innella et al., 2016, p. 22) and a “relatively small part of the entire design process” (Lim, Stolterman & Tenenberg, 2008, p. 2). In addition, prototyping has been traditionally used just as a developmental tool as a means of representing a final idea of the design process. However, scholars and educators
have identified different advantages in practicing prototyping at early stages of the process (Innella et al., 2016) such as fostering creativity among other benefits that will be presented in this paper further ahead.

Quick and dirty prototyping is haptic and allows exploration. This tool, used for serious play, is defined as creating “in a goal-oriented but playful way” (Schulz et al., 2015, p. 323). Consequently, we propose impossible design as a class activity that promotes teamwork, goal-oriented playfulness, and hands-on thinking. Our study highlights how these activities positively affect the learning experience of first-year design students and the benefits of implementing them in design education. Additionally, there are recent practices that require different methods to handle open and interdisciplinary forms of collaboration in innovation processes (Schulz et al., 2015). For instance, co-design, co-creation and open innovation are practices that bring together collaborators from different disciplines in which prototyping could become a tool for triggering dialogue and creativity, promoting teamwork even in groups with many participants. These qualities could be a plus in design education because nowadays some Latin-American universities have larger and larger groups of students, especially in the first year of design education, in which groups tend to be larger than 35 students. These characteristics are similar to the case of the University of Aguascalientes, and other public schools where fostering exploration and creativity becomes challenging. Therefore, different approaches have emerged among which quick and dirty prototyping stands out because it allows collaboration in larger-heterogeneous groups and inexperienced designers.

2 Referencing Hands-on-Thinking: Understanding Prototyping and Cognition

Prototypes become instruments for exploring technological possibilities, experiment with design possibilities, an instrument for learning from others and for facilitating “a concrete discussion of visions.” The confrontation with the prototype can trigger “a more extensive idea generation” (Bødker & Grønbæk, 1991 p. 14-15). According to Scaletsky and colleagues (2014), prototyping can be used by designers as investigation, because designers are “thinking while doing, doing while thinking and, in general, are expressing ideas through their making or visualization of concepts” (p. 3). They also state that this type of practice can also be known as Thinking, and when designers have time and space to practice it, they perform better in communicating and generating creative ideas. Hand and brain coordination then can become both a tool for communicating and fostering creativity (Jensen, 2000; Roos & Victor, 1999; cited by Schulz et al., 2015 p. 327).

Donald Schön is one of the pioneers that looked closely at the link between hands-on activities and thinking, proposing the concept of reflective practice, a “dialectical process in which thought and action are integrally linked” (Kinsella, 2009, p. 7). According to him, this process represents a “dialogue of thinking and doing” through which the practitioner could develop abilities and become more skilful in the workplace (Schön, 1987, p. 131).

Therefore, prototyping becomes a different form of dialogue than verbal communication. During the creation process, “participants have to develop a common language to understand each other in terms of the desired innovation as well as regarding their cooperation processes” (Schulz et al., 2015, p. 324). Thus, the process of making objects can become a “communication tool to better share thoughts and ideas” (Kolodner & Willis, 1996, cited by Innella et al., 2016). To foster this dialogue of thinking and doing, quick and dirty prototyping represents an advantage because it does not allow the students to overthink about the project in a planful manner. This readiness provokes that students jump in directly into a dialectic process in which they begin transforming materials with their hands such as cardboard, paper, chalk, among other materials, characterized as toolkit-based modelling (Sanders & Stappers, 2008), while they are developing and discussing the project. Toolkit-based modelling aims “firstly to explicate thoughts through haptic models to provide shared understandings among diverse people, and secondly to facilitate creative idea development at early stages in the innovation process” (Schulz et al., 2015, p. 325). Such models, when finished, become a representation or explanation of the thinking process of its creator (Schulz et al., 2015, p. 324); a reification of thinking and knowledge about the design process (Galey & Ruecker, 2010).

Finally, “a primary strength of a prototype is in its incompleteness” (Lim, Stolterman & Tenenberg, 2008, p. 7), and because designers did not invest too much time and effort in building these unrefined prototypes, they are more likely willing to make changes or discard decisions. Thus, quick and dirty prototyping broadens the negotiation range between team members. Since the resulting prototypes are only an approximation, this is seen as a positive, because it allows “a degree of ambiguity that fosters the design process instead of blocking it” (Innella et al., 2016 p. 22).

Implementing quick and dirty prototyping in the design studio could embody several positive consequences regarding the teaching and learning process of design:
Impossible Design and Border Thinking: Prototyping as Worldmaking

Impossible design is defined in this paper as the practice by which designers develop artifacts that are not yet able to function in the actual world. Usually, the possibility to function is restrained by technology. In other words, these artifacts would need structural inventions to perform the tasks that they were designed for. Impossible design allows the students to enable border thinking, understood in this paper as “the epistemology of the exteriority; that is, of the outside created from the inside” (Mignolo & Tlostanova, 2006, p. 206). In other words, the inside or central aspects of design practice are characterized by possibility: those artifacts that if created will be able to function correctly; the outside and peripheral aspects of design practice are distinguished by impossibility, that is, artifacts that have not yet developed the technology to function correctly in the actual world. Impossible design is situated in the border of the central-possible and the peripheral-impossible. Center and periphery are conflicting structures (Lotman, 2009); therefore, enabling border thinking means finding ways to negotiating those conflicts. Usually, innovation occurs because of peripheral activity, since the center is seen as inactive and unable to evolve, and the contact between both could represent a process of renovation (Vólkova, 2017). At the center are located actual artifacts and practices, at the periphery and outside the border are emerging impossible artifacts and even perspectives that are challenging the very definition of design. For that reason, border thinking becomes a way to foster creativity and dirty prototyping the means to funnel it.

By thinking about a world were non-functional artifacts exist, impossible design takes the perspective of social constructionism (Berger & Luckman, 1976). When designers unstrain themselves from technological boundaries, they are at the same time collectively constructing new worlds. According to Goodman (1978), worldmaking is a human activity by which humans continuously make and remake versions of the world. Humans can construct worlds by using words, pictures, objects among other symbols. In this sense, prototyping is an activity for worldmaking. By building prototypes, designers are bringing to the actual world models and simulations of possible worlds (Skaletsky et al., 2014, p. 2) therefore, constructing new worlds. A prototype then becomes an interface between the actual world and the possible world. The prototype becomes one step closer from the possible to the actual world in each stage of iteration. If and when, the prototype becomes fully functional, both worlds merge.

Impossible design brings uncertainty to the process of thinking and worldmaking of practitioners. According to Kinsella, “practice is characterized by uncertainty, instability, uniqueness, and value conflict, and that this is where the important questions of practice are negotiated” (2009, p. 6). Thus, the border between the possible and impossible of design practice will enhance those uncertain aspects of design, provoking that dialogue and negotiations between team members become fundamentally important. In other words, bringing impossible design as a class activity will enhance those positive outcomes that dirty prototyping, hands-on collaborative thinking, represent for students: unrestrained creativity.

4 Countdown to Creation: Activities for the Design Studio

The activities presented in this paper were implemented during a first-year class in the industrial design undergraduate program at the University of Aguascalientes during 2017 and 2018 school years. The participants of the activity were students currently taking Strategies for Design course which aims to introduce first-year students to the design process. The primary objective of this course is that students attain a general overview of the different stages of the design process, traditionally explained on a linear perspective. However, these activities aim to present a different approach to the design process enabling prototyping at early stages as a technique to foster the creative process instead of demonstrating it.

Instruction for the impossible design activity was presented to students as follows:

Imagine how living would be in a future scenario.

- How would inhabitants rest, clean up, feed, work and have fun the inhabitants of a house in the year 2050?
- How would the power supply be of this house?
• Where would it be located and how would it be configured/built?
• Who would inhabit this house and how would these people relate and communicate between each other?

After you have reflected upon these questions you should team up and build the house of the future using quick and dirty prototyping. You have only one hour to complete this activity.

In these design activities, students face a given challenge: to think about how it would be like to live in the year 2050. They must build the 2050 house using quick and dirty prototyping within an hour, using available resources which usually are cardboard, paper, laminated and some other second use materials. These requirements aim to build creative confidence in students, allowing them to imagine impossible ideas that could come to be in the given 2050 scenario. Impossibility incites students to explore uncharted routes of creation.

The 2050 scenario brings uncertainty to the process. This uncertainty triggers dialogue between team members, the reason why students are asked to team up in larger groups because it is expected that each team member fully participates in the conception and development of the 2050 house rooms and areas. A common practice during this activity is to group in large teams of 8 to 12 participants approximately.

Time and available resources become a determinant element because students tend to feel limited. These aspects are planned for impossible design activities because it brings the students to a thinking/not-thinking border. Students do not have time to fear of what people will say, so they begin to express carelessly every crazy idea that comes to mind; also, they do not care about the quality of the prototype allowing them to discard ideas easily while they are building and modifying the prototype. As pointed out before, the prototype becomes a thinking and negotiating tool, a hands-on conversation, instead of representing an outcome (Figure 1, left and right). Therefore, a 60-minute countdown also helps students to maintain focus on the given challenge instead of focusing on building perfect models or carefully planned well-done solutions (Schulz, 2015).

An essential aspect of these activities is that they have fewer restrictions than the usual design studio activities. Thus, outcomes are not bound to functional, procedural, production, market or technological possibilities. Therefore, the creation process begins freely; the impossible suddenly becomes possible. Outcomes show that students usually part from commonly known future problems. Hence, solutions also have common attributes with impossible updates. Border thinking then is visible through these hybrid impossible/possible, functional/non-yet-functional prototypes, because students are thinking of exteriority-impossible, created from the inside-possible and familiar aspects of everyday life as we know it.
5 Borders and Provocation: Results and Experiences from Students

Impossible design: The House of 2050 has been implemented as a class activity for three generations, and there are some similarities in how students imagine the future. When thinking about the year 2050 they are imagining impossible scenarios such as subaquatic living, suspended in the atmosphere housing or even underground habitations. Students argue that these types of living will be necessary because of resulting environmental damage due to human activities, wars, and natural disasters. Thus, inhabiting the earth surface will not be tolerable. Therefore, to think about that living as we know it will not be possible, they have to imagine how to live like nowadays in impossible scenarios. This border thinking allows them to work in an unrestrained manner, fostering creativity, bringing every impossible idea into the conversation.

Three aspects of the imagined future stand out in students’ projections. Firstly, it is interesting that students imagine apocalyptic scenarios due to the possible lack of vital resources such as water. According to them, future users would have to cover their basic needs sanitizing their body with technological artifacts that produce steam. This way, a steam shower could cleanse the body in a few seconds; therefore, this technology could help humans to save water (Figure 2, left). Secondly, there is also destruction as a recurrent scenario, so the use of recycled materials for house building could be a common practice. Debris would become a common building material since it will be available because of natural disasters or war destruction. Thirdly, technology continues to grow its participation in everyday activities becoming the primary mediator between users and the world. Holograms, sensors and virtual interfaces will allow automatic communication between users and house appliances, allowing them to create or modify instantly clothing, room arrangements, and even food. Everything will be available and ready just by merely thinking of it (Figure 2, right).

These aspects highlight the final outcomes of impossible worldmaking; however, it is important to focus on the process, how students experienced it, and how implementing activities as simple as the aforementioned task during class could provoke border thinking and unconstrained creativity. After the activity was over students were asked to answer a brief questionnaire to help them reflect upon their experience and highlight their impressions. Results show, in general, that students had a positive experience. Their perspective and direct quotations are presented in this paper regarding five main resulting actions:

1. For as long as necessary. Gaining creative confidence. The creative process during the activity was perceived by some students as quick, improvised, strange and unorganized. Although all these concepts could mean chaos in a negative manner, students referred to them as positive aspects of the experience. For them, the process was “funny and encouraging” meaning that working in this kind of activities allowed them to generate a lot of ideas.
and to recognize their own creative potential, therefore, increasing their creative confidence. A student expressed: “a bunch of ideas came to me and I could realize how creative I am”\(^\text{1}\). The list of ideas that students could put together is also perceived as positive, referring to them as creative, spontaneous, innovative and interesting. This experience allowed them to express uncommon ideas fearlessly of what people will say, in this case, without feeling judged by their teammates: “I thought it was a really fun activity because you are not stressed about your idea, thinking that it might be too crazy”.

2. Provoking boundary breaking. It was notable that some students felt somehow insecure at the beginning because of the uncertainty of the outcome, and they were hesitant on organizing themselves to address the challenge. The uncertainty that this task represents began to disappear when they reached the border between the possible and the impossible: “to be honest, I was finding it a little complicated since I never go beyond the feasible […] but once I started breaking through that thought, I began having a lot of fun”. In other words, uncertainty provokes border thinking, which is perceived from students as a dynamic, free, interesting and fun activity. Also, besides breaking the possible/impossible, the borders of the traditional design process began to break. Some students declared being able to let themselves go and not following any preconfigured-structured process. According to them, this was possible because the activity allowed that kind of openness and freedom: “I didn’t really follow any steps, I just began putting pieces together in the way that I liked, shaping some objects or elements that could become part of the house while taking into account my teammates’ ideas”.

3. Developing teamwork skills. Students perceived that working in teams with numerous participants was a fluent, fun and dynamic experience, although at first, they expressed having felt confused and stressed out because an apparent disorganization and chaos. Having a lot of participants in the team is the main reason for this feeling, because the more participants it has, the more thoughts, ideas and possible routes the team will generate. Therefore, this could become a disorienting factor for those that have never worked in teams with those characteristics: “I have never been in a group so large to do teamwork and at first everything was chaos. Everyone was sharing ideas, and nobody was structuring anything. Soon leaders began to emerge, and we could pick up the reins on the project making the most of the proposed ideas. Finally, we divided into groups and began building [prototypes]”. As formerly expressed, lack of leadership was identified as a barrier for teamwork. Without a leader, organization and communication was harder for the team, as well as demanding the same level of commitment and performance from each team member. According to students the ideal number of participants in a team for this type of activity should be from 4 to 6 members. This shows that students do not have yet the necessary tools and skills for working in teams. However, teamwork was also perceived as a safe space for proposing and communicating ideas while receiving feedback form teammates. Students expressed having felt comfortable since the impossible design project allowed every voice to be listened, sharing a criticism-free space between them: “I liked teamwork because instead of criticizing our own ideas we supported each other to project a more creative house”; “Nobody kept quiet during brainstorming which I think is important”.

4. Engaging hands-on thinking. The experience of building ideas through quick and dirty prototyping was enjoyable thanks to the flexibility of that technique according to students: “You materialize your ideas instantly and they come up naturally. I think this is the main advantage: the given freedom to create things”. Most of the participants jumped in directly, without sketching anything, to building with their hands whatever came to mind: “I didn’t do any physical sketches, only mental sketches, and as soon as ideas were coming up, I tried to shape them before it was too late, and they could disappear from my mind”. As a creative tool, these experiences highlight the importance to foster quick and dirty prototyping among class activities, because it allows the student to express unrestricted ideas immediately. Some students managed to see the potential in this technique, particularly to promote idea generation in early stages of the design process.

5. Saving time and materials. Finally, students highlighted as benefits of quick and dirty prototyping a more effective use of time and resources: “I consider that the best advantage is the versatility in the creation process because you don’t need anything else than second use material and your imagination, you skip sketching or thinking about exact measures”. They also point out other benefits such as materializing ideas quickly, identifying errors and correcting them ipso facto. Another benefit is that because of its imperfection and quick making, dirty prototyping allows the creator to focus only on the creation phases of the design process: “I think

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\(^{1}\) Direct quotations are taken from answers to the questionnaire given as homework. They will appear between quotation marks and in italic type to differentiate them from author’s quotations.
that because you do not have to worry about outcomes and refined finishes of the prototypes, you can focus on being more creative.”

6 Final Discussion: Fostering Creativity in Design Students

Fun, versatile, free and engaging are aspects that sketch out how students experienced the class activity. Impossible design fosters border thinking, which provokes challenging tangible certainty. In other words, border thinking invites students to leave the center and get closer to the periphery. This means abandoning the certainty and assurance of following steps in the design process or traditionally predefined stages such as discover, define, develop and deliver (Design Council, 2007). This is probably a contradiction to design schools’ goals, because they are commonly aiming their efforts to transfer knowledge, teach methods and processes so that the student develops professional skills, and that his/her professional practice and creative decisions will not be based on speculative information or random discovery. However, this focus could also be constraining the development of creative skills, undermining other activities such as exploration, experimentation, in which delivering incomplete products is not of importance. As it has been stressed out previously, although there could be tangible outcomes from impossible design activities, its value does not rest in the marketable or profitable possibilities of the resultant artifacts, it resides in the development process and how it impacts in the creative awakening of design students. Undergraduates should probably need both during their design training: firstly, to learn a structured, step by step vision of the design process through which they can perform professionally; and secondly, at the same time develop the capability of skipping steps and engaging disruptive exploration to foster imagination and creativity. Therefore, as findings from the activities presented in this paper, we can highlight that, bearing in mind the characteristics pointed out before such as teams with ten or more participants, a limited time, and considering undefined, uncertain, or even impossible aspects of the project, working with quick and dirty prototyping could become a way to foster creative balance to the training process of design professionals.

References

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Bundles of Spatial Ingredients: Designing Through the Prototype

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Abstract: Learning by doing has proven its efficacy in the educational field and, in this context, prototypes may play a key role. If used in an active way, provocatively diverging from their representative function design models can lead to different and lateral thinking modalities. They can provide inspiration for unpredictable paths and, potentially, innovation. A similar approach towards the purpose of prototypes in the design process has already been undertaken by professionals, from renowned Italian designers to contemporary architects. Yet, this contribution is based on a daring contamination from literary experimenters whose methods originate from strict and almost absurd rules. Their aim is to stimulate creativity in an apparently playful and even serendipitous activity. In particular, the paper refers to a three-year educational experience assessed in a Project Foundations Studio of an Interior Design course at Politecnico di Milano. Hence, the developed and employed approach is described and its results discussed, outlining how effectively the use of prototypes as active tools of the design process can liberate students’ imagination and change their attitude towards the designing of interior spaces. Even though the described approach may present some limits, the aim of this argumentation is to illustrate the different contribution a prototype can make in future applications.

Keywords: subversive prototypes; learning by doing; design method; design through the prototype; thinkering
1 Introduction

1.1 Towards a Thinkering Thinking

Educational methodologies fostering a learning by doing approach and ascribed to the activism pedagogy are characterising the contemporary paradigm to be pursued in educational, professional and corporate processes.

In learning by doing, education is induced through a concrete and meaningful experience. In problem-based learning, the pursuit of a solution is the starting point of the instructive process. For project work, learning is a direct confrontation with a real project, usually to be developed in classroom. Business games transform education in a simulation of marketing or company activities. In role playing, learning is provided by the interaction of students/characters within a fictional world, inspired by narrative or cinematography. Didactic fab labs bring experimentation to a tangible level through digitally fabricated models. Creative ateliers are workshops aimed at valourising the discrete charm of crafts with an integration with modern digital technologies and where artistic, musical or visual – and often ludic – artefacts are realized. Nowadays those are embodiments of the multifaceted current representation of activism pedagogy. The discipline is not about action for its own sake, on the contrary, the concept of metacognition (Dunlosky & Metcalf, 2009) is strengthening. It intends to gather operative and reflective dimensions: it is necessary to think and to acquire awareness of one’s actions, but also to discuss with oneself and with others (Moura, Fahnstrom, Prygrocki & McLeish, 2009, p. 52; Dillengourg, Baker, Blaye & O’ Malley, 1996) in a vision indissolubly connecting learning by doing and learning by thinking.

In this framework, the paper focuses on a design-oriented research and on the role that prototypes have achieved and may gain in the design process for internal spaces, specifically in the Italian and Polytechnic practice. In particular, some methodological reflections derived from other disciplinary fields. Designers are usually trained to express their ideas in a visual and practical way (sketching or prototyping), a practice that Basapur and Mathew (2010) define as thinkering. In this sense, proactive exercises –which can be free expressions or works developed from firm rules– are important for stimulating creativity as well as for testing or reflecting on ideas. Even if the word prototype comprehends a wide range of artefacts –such as sketches, low-fidelity paper prototypes, software simulations or hardware diagrams in the early design process, and full or partially functioning software or hardware, reaction-eliciting and high-fidelity objects later in the process (Scaltsky, Ruecker & Basapur, 2014, p. 3084)– in the following dissertation, it will strictly be referred to as physical, three-dimensional and scaled prototypes that will be indifferently addressed as prototypes, models (from Latin modellus, which means measure or module), or maquette (French term from the Beaux Arts Grand Dictionnaire de Trévoux indicating the first visualisation of the artist’s formal intention (Crippa & Di Prete, 2005b, p. 7)).

The presented research depicts an experimental didactic approach to the employment of prototypes, which aims to be innovative in its context. Though it may appear rash, it has been assessed from a three-years period in a Project Foundations Studio at the School of Design of Politecnico di Milano. As a matter of fact, the studio propositions are based on a series of prestigious explorations which have been visionarily fulfilled in both literary and artistic fields. It is an original and ludic process, intendedly provocative and aimed at the construction of knowledge.

1.2 The Background: Designing Through the Maquette

Traditionally, interior design had to deal with the dimension of doing, specifically with spatial manipulation and simulations. Accordingly, Bruno Munari used to quote an ancient Chinese proverb:

I hear and I forget. I see and I remember. I do and I understand. (Confucius, 500 B.C.)

This clearly underlines how physical exploration is fundamental for a deeper comprehension of an object, a space or a process. In particular, in the field of interior design, this sort of investigation is fulfilled by scaled prototypes which are able to convey formal, perceptual and emotional features of an environment.

Whether they are aesthetic, functional or structural prototypes, their contribute in the design process is indeed essential, as the 1998 ADI Compasso d’Oro Award to Giovanni Sacchi—one of the most renowned Italian modelists—demonstrates. He was honoured with this reward for his career. Specifically, his contribution to the discipline has been acknowledged as the other side of design (Polato, 2000) to stress his role as project counterpart. All of the most famous Italian designers and architects of the second post-war period passed by his workshop, in Milan, via Sirtori n. 10: from Castiglioni to Zanuso, from Rossi to Sapper, from Botta to Piano. That atelier –like the one of Pierluigi Ghianda, Sacchi’s friend– represents one of the places where the history of Italian design has been done and thought.
It may not surprise that for all the above-mentioned designers the prototype was a moment of analysis and test, indispensable in the design process. A maquette can express a *sense of possibility* (Tagliagambe, 1998, p. 3) that simplifies and, sometimes, encourages the design work and the architect’s imagination. It is an artefact which stands in-between an itinerary of desire and research, it is projection and utopia (Celant, 1987, p. 79). The model allows a constant effort for improvement that gets always closer to the optimal result; definitely it is possible to *learn from the prototype*, as it *communicates*: it denounces errors, it makes lacks patent, it emphasizes the tiniest incongruity, it suggests alternatives and fosters creativity.

In this perspective, some experimentations developed by masters of contemporary architecture are relevant, as they interacted with the prototype in a dialogical way, giving models a proactive role and not treating them just as *previsions* of spaces or as objects anticipators. Some instances are the sculptural compositions by Frank O. Gehry (Bruce, 2001, p. 49): assemblies of pure forms aimed at establishing a dialogue with the client and then covered, deformed, and assumed as functional matrix of the project development. Less renowned is the case of Coop Himmelb(l)au’s *psychogram*: a *three-dimensional sketch* drawn instinctively, with poor and common materials, in the early phase of the creative process, which guides the entire definition of the project. The *psychogram* is the reference in moments of doubt, it is the goal and the unconscious track of the design process (Crippa & Di Prete, 2005a).

Models may represent different values: inspiring, verifying or conveying design contents. Actually, Scaletsky et al. (2014, pp. 3082-3084) state that designers use prototypes as generation, communication, testing, research and even theory-builder tools for ideas. They can lead to different results, such as: invention, meaning-making, reification of concepts and mediation among different interlocutors. Therefore, an overtaking of the deeply-rooted model based on the “research, analyze, ideate, build and communicate” approach (Agogino et al., 2015, p. 3) is required, and more often it demands to recur to a *cross pollination*. Indeed, the purpose of this contribution is to reorientate the current predominant methodology in the Italian design education. Prototypes are to be investigated as essential means for the design ideation and development, and as temporary shelters in a serendipity-driven explorational journey. In this context, models are no longer depicted as progressions in a linear and consequential process, yet they become extraordinary objects for conceptual rather than physical manipulation. The prototype will be finally presented as an irreplaceable tool to trigger short circuits between *provocation and feasibility*.

### 2 Ingredients for an *Imperfect* Recipe: A Design Approach

#### 2.1 Inspirations and Theoretical Foundations

A space is nothing but a blank page. This interesting assimilation has been developed by the French writer Georges Perec in his work: *Espèces d’Espaces* (1974/1989). The opening of the essay is an emblematic map of the ocean, derived by Lewis Carroll’s *Hunting of the Snark* (L. Carroll, 1874/1981). The map is necessarily a white square, a space where the infinite imagination lays, a common starting point for those who *travel through themselves* in their writing (Michaux, 2012), and for those who invent spaces out of a design process. As a matter of fact, for both the writer who tries to define what space is and the designer who traditionally works with it, the blank page represents the first place they have to manage. With a – perhaps unconscious – designerly attitude, the author affirms that a space begins with some marks on a blank page (Perec, 1974/1989, p. 19). Obviously, those marks assume different meanings in Perec’s work and for the designer. The former identifies *words* as ordinating tools, while the same purpose is conveyed by drawings for the latter. Though, the similarities that put writing and designing, words and space, in contact are the trigger for the following dissertation.

In literature like in design, the whiteness of the page – the first indistinct matter – is the blank to be filled with one’s creativity. It is a place with plenty of possibility, to express even the same concept or narrative. Indeed, another eminent source of inspiration for the development of a design approach based on direct experimentation, trial and error, is Raymond Queneau’s *Exercices de Style* (Queneau, 1947/2007): a collection of 99 narratives of the same short story, each time written with a different linguistic strategy. Other similar exercises have been conducted by other writers, such as Perec with his lipograms (texts in which a particular letter is avoided) (Perec, 1969/2007) or Umberto Eco in *Il secondo diario minimo* (1992), in which he rewrites the same poem, each time excluding a different vocal. A strong characteristic, shared by all the previous examples, is the definition of a method which starts from a constraint, may this be difficult and apparently absurd. From this, imagination needs to be freed from conventions in order to find new solutions, hence conveying surprising results.

A similar approach, drawn from this exploratory literature, has already been experimented in the design field, searching for innovation. For instance, Martino Gamper designed *100 chairs in 100 days*, created by the recovery and hybridisation of discarded ones; while the master, Bruno Munari, adopted some principles translated from writing...
methods into his own work, to investigate new forms of communication. His booklets, as Contanti Affettuosissimi Auguri (1994/2016), Libri Illeggibili (1984/2017), or Prelibri (1980/2018) basically shift the focus from the content – of a book, of education, of design – to the modalities of creating knowledge or products, thus transferring great importance to physicality from the point of view of the experience (echoing the Chinese proverb according to which we learn by doing), and to fantasy (as an essential element of the design process). Actually, from his experimentations, Munari summarises a design method (1981/2013) that insists on lateral thinking and tries to detach the designer from mere function and feasibility, letting fantasy imagine even the more absurd, incredible and impossible solution (Munari, 1977/1998).

Once again, in the attempt to reach freedom and stimulate creativity, rules are needed. Munari depicts them in his work Fantasia (1977/1998), while another master of Italian Design, Enzo Mari, aims at reversing them by questioning the role of the designer, of the consumer and of the designed product itself. In fact, in Proposta per un’autoprogettazione (Mari, 1974/2010), he offers the user a manual to self-create his/her own furniture, destabilising the mutual designer-customer relationship and the market mechanics. Similarly, a contemporary (ex-) designer can be regarded as a rule-challenger: Martí Guixé is not enslaved by the traditional design logics. He seems to embrace Munari’s fantasy. He brings it to the real world, realizing destabilizing yet brilliant objects, such as Football Tape, adhesive tape with a football pattern that allows to create an actual football when it is balled up; or Blank, a wall clock made of whiteboard that inverts the definition of time: it is no longer the object yet the user who defines his/her time.

As these last examples testify, whether it is starting from a rule or a pure concept, if the design process has no cultural constraints and includes fantasy, then the results will be unpredictable, and even out of the designer’s complete control. In a way, it reminds serendipitous surrealists’ games. Serendipity lays on the exploitation of chance while something different from the final result was being searched for. Through ludic components as a human common language (Huizinga, 1938), techniques of surprise and methodologies of the fantastic, surrealists undermined the certainties of the reasonable and respectable (Brotchie, 1995). In particular, they recurred to well-defined procedures, like Automatism, to set the beginning of their creative activities (from writing to visual arts). From strict rules they encouraged spontaneity to produce unexpected material which they used as the basis for further composition.

To sum up, from surrealists’ approach, from games and rules, from challenges and serendipity, from physical experimentation and conceptual investigation, a provocatively prototype-based design approach has been developed. It attempts to translate all of these elements in a unique recipe, as they appear to be of paramount importance for triggering original results. In particular, the influence of the experimentations in the literary and artistic fields is reflected in the premises of the design approach. The cited writers and surrealists base their reasonings on the foundations of the matter they have to express themselves: language and composition. They question the principles of their disciplines, putting unnecessary limits on their use. Similarly, the proposed approach takes root in predefined rules limiting the designer’s possibilities through the materials on which design is founded. According to the experimental nature of the described literary and artistic experiences, it is not a rigorous approach, yet it sets some fixed points, some ingredients to discover unknown and unpredictable paths, hopefully the recipe of creativity.

2.2 Designing Through the Prototype: Between Rules and Chance

To better understand the impact of the proposed approach, it is necessary to consider the environment in which it has been generated. Current Italian design education gives great importance to speculation and abstract thinking in the development of the project. Specifically, it is the prevalent tendency in Politecnico di Milano – department of Interior Design. At the beginning, a substantial work looking for theoretical and cultural references, original parallelisms, evocative images, and developing a concept is conducted. Then, the idea materializes and evolves mainly through conceptual and functional diagrams, in-plan space organisation and digital 3D visualisations. The physical model only comes at the end of the design practice and with a mere representative function. It is a communicative item among many others. In addition, Interior Design students approaching space planning for the first time are conditioned by common practices and misconceptions about this activity. They need to free their minds from preconceptions and leave space for creativity, or, in Munari’s terms, for fantasy. These are the moving reasons for the development of a prototype-based design approach, assessed in a first-year Project Foundations Studio at Politecnico di Milano and addressed to a class of about 50 students.

The objective of Bundles of Spatial Ingredients, an assignment intended to educate future open-minded designers, is to design a minimal living-space – 110 m³ – for a single person, that has to include another specific public function. Here, the conception of space reflects Perec’s definition of it (1974/1989): just from its delimitation (the blank square or, in this case, a metrical surface) students will discover how space can be incrementally expanded (into a universe of
qualities or, in the author's work, an actual one). The residential topic, instead, has been chosen as it is something they all can easily refer to according to their own personal experiences, and can assimilate in a common yet differentiated background.

For the development of their projects, students are divided in groups from two to three people and they are guided by bundle of cards portraying all the fundamental ingredients to take into account during the design of interiors. A ludic approach is at the basis of the experimentation. In fact, the form of game has proven to be effective in terms of setting rules that people are inclined to favourably accept (Bertolo & Mariani, 2013), as they enter in a parallel dimension where they free themselves from cultural and social expectations (Csikszentmihalyi, 1990). During a four-weeks period, students are called to undertake a progressive and practical design process. They primarily need to identify and meticulously describe their target user – in order to have a very rich source of inspiration for their interior characteristics and functions – and then, once a week, they have a bundle of cards to pick up, which determines the unpredictable and serendipitous final result. The first one defines the typology of space, and the relationship between private and public into the residential space; the second week, they will receive information about space exits (according to an introverted point of view), natural and artificial lighting affecting their interior area; while their third and last pick reveals materials, colours and furniture they must use to characterise their space. To add more game dynamics and unpredictability some limiting and wild cards are provided. By the way, the fundamental and peculiar aspect of this approach lies in the modality students are required to develop their project. As a matter of fact, after an aesthetic research about the ingredients they have been casually assigned, the only mean students have to visualise, test and explain their ideas is the prototype. From the very beginning, they are not allowed to use drawings or computer programs to express themselves. On the contrary, they are forced into a practical step-by-step construction of a physical temporary model that needs to be implemented, revolutionized, set aside and perhaps taken back, to finally get to the final solution. Whether it may seem an easy task to fulfil, this approach is actually in opposition to the conventional bidimensional definition of spaces but, thanks to its physicality, it provides richer and more immediate information in the representation of choices. Moreover, the central focus throughout the entire design phase is the action, the tangible experience and the overall method through which they understand how to investigate, set and select different design solutions. Refined materials are not required (students can use paper, recycled cardboard, or whatever facilitates their creation process). In this way, they actually learn how to manage space by physically manipulating it in a reduced scale.

During the development of the assignment, students have a weekly revision of their work – which has to be implemented with the freshly-picked new ingredients. It is useful to help them overcome the obstacles represented by the often-challenging combinations of ingredients; better interiorize the method; leave all of their preconceptions and eventually dare to explore unconventional paths. Revisions are also essential to closely monitor and assess the validity of the approach and its outcomes, in terms of the evolution of students' attitude towards the design process and their improvements in handling spaces. Lastly, the final project is presented by the research outputs, technical drawings and the ultimate model, which comes back to its representative role.

3 Reflections on the Prototype as an Active Educational Tool

Directly working with a prototype, without moving from a preconditioned theory, makes failure a key moment in the design process. Then, the prototype the opportunity to begin again, and more intelligently, as Henry Ford used to say (Ford & Crowther, 1922). Revision after revision, card after card, students are called to build, dismantle, rethink, reconstruct, shape and refine the model, which is an actual and active tool, and not just an exhibition object, as it is usual in our context. The evolving prototype, therefore, represents a source of continuous inspiration and a moment of constant research. In particular, four main reasons resulted to be relevant for students' education, and they are about the prototype being in-progress, introverted, subversive and de-contextualized.

3.1 The In-Progress Prototype

As it has already been explained, the proposed approach is characterised by a step-by-step development of a prototype, which can be assimilated to a travelling companion in the design process, not just its final result. The great challenge is to encourage the students to deal with weekly added, unpredictable, new ingredients that are able to corroborate or even subvert their previous assumptions. Design requests are always different, progressively turning down the scale while augmenting the detail level and continuously questioning past, present and future directions. From the second card pick, students clearly realize how temporary and ephemeral their reasoning and propositions may be. In opposition to the human tendency of assuming guidelines that seem unchangeable and deeply rooted in the design process, in this case, students necessarily have to learn to quickly adapt and to be open to changes. They have to accept failure as part of the process, and inferring new stimuli and unexpected opportunities from it.
Handiwork, the direct manipulation of materials and the creation of actual spaces allow future designers to gain an increased awareness from a greater experience, attention and – in Ford’s words – intelligence towards the project. The weekly challenge, trains the students’ dynamic and lateral thinking. As a matter of fact, while the second card pick may represent an insurmountable problem, already the third one is accepted in a more positive and constructive way, even if, at that time of the process, the students have comprehensibly maturated preferences towards the directions of their project. Nevertheless, this kind of consciousness and ability to manage the space are exclusively derived from the hands-on experience, in a way that a traditional, bidimensional attitude cannot pursue.

3.2 The Introverted Prototype
This prototype-centred approach also allows to develop another fundamental skill: the ability to imagine and generate spaces uniquely from an interior, three-dimensional point of view. In fact, students do not have to take care of the external sides of the architecture, nor perspective drawings are required. Their only aim is to learn the foundations of interior design, as the name of the course already depicts. Even if the process begins with the shaping of volumes, the spatial distribution and characterisation are to be figured out from the interior living dimension. The provided materials are also defined to favour this attitude (entrances are referred to as exits, openings are described in relation to the types of lighting they allow, etc.) but still, as the revisions pointed out, it does not seem to be a very intuitive approach. That represents an additional reason to encourage students to actively use their prototype and project themselves inside the space they are designing.

Ultimately, the external façades are not specifically designed, yet they are configured as the result of the choices operated according to interior necessities. Thus, on the threshold in-between inside and out, they attest a precise design will. The indifference towards the exteriors does not stand as a didactic lack, on the contrary, it underlines the effectiveness of a good interior design that reflects on a valid and qualitative appreciable outside perspective.

3.3 The Subversive Prototype
Throughout the entire experimentation, students are asked to approach the design of a space with a diametrically opposed point view in relation to what their academic experience will teach them. Instead of starting from the preconception of a fixed, bidimensional space to fill in and then translate it into three-dimensional views; they are required to shape the space according to the necessities dictated by the cards and by their own preferences. Only at the end, they will transpose their project into technical drawings and sketches. This attitude not only reverses the design perspective, configuring it from inside-out as it was previously discussed, but it also defines the prototype as a subversive component of the design process. Therefore, simultaneously, students have to manage functions, requirements, spatial constrains, aesthetics, and personal values. All of this, while directly reasoning in terms of generation of a space. Especially at the beginning of the experimentation – when they firstly have to delineate their requirements, spatial constrains, aesthetics, and personal values. Only at the end, they will transpose their project into technical drawings and sketches. This attitude not only reverses the design perspective, configuring it from inside-out as it was previously discussed, but it also defines the prototype as a subversive component of the design process. Therefore, simultaneously, students have to manage functions, requirements, spatial constrains, aesthetics, and personal values. All of this, while directly reasoning in terms of generation of a space.

3.4 The De-Contextualized Prototype
As a reflection of a de-contextualized approach, the (future) designers practically understand that they do not need to be submitted to space, yet they are empowered to manipulate it to their own will (Figure 1). A deficit of this attitude is that this statement may be too strong and not always feasible in the professional experience. By the way, the aim of the experimentation, in an educational context, is to free student’s minds from conventions and let them free to explore the most creative and even absurd paths to better comprehend their role and purpose in the design process. This has been demonstrated by the following exercise they had to develop. For the final exam, in fact, students had to deal with a complete interior design project, redesigning the functional organization and aesthetic connotation of an existing minimal living-space. The task could be fulfilled with a more traditional approach – according to the Polytechnic tendency previously described – but in light of what they apprehended during the experimentation, they changed their approach. First, they still used prototypes as tools of the process, in addition, they were more confident at handling the space, they were able to better detect the space characteristics and potentialities and manage them according to their needs; and eventually they explored and evaluated their solutions in a more conscious way as compared to their first intuitive approach. The space was no longer a box to be filled with objects and functions, nor a blank square to be filled with abstract words and ideas. Through a scaled version of it, the space was actually recognised as a resource to exploit to express a clear and even bold concept. Thanks to a de-contextualized
environment, with no auto-imposed restrictions deriving from the context, students felt free to dare in the manipulation of space, with absolute creative freedom. They used Munari’s fantasy as an ingredient for their recipe, and the prototype as an active tool. They developed their ideas, demonstrating their awareness of space.

Figure 1. Final prototype of the experimentation - Project Foundations Studio, professors: Luciana Crespi, Barbara Di Prete, Emilio Isgrò (Brusoni, Nunziata, Pronzati, A.Y. 2017/2018).

4 Discussion

Academic institutions have to be places for experimentation, where theories are formulated, skills are developed and innovation is pursued. They are the perfect sites where to dedicate time to exercises in style and games as forms of higher and unrestricted learning. Therefore, tools and methods provided to students should necessarily respond to such a dynamic context. That is the reason why prototypes, having an innate versatile nature, are to be exploited for the meaningful experience they can provide and must not stand as merely representative tools. Hartmann et al. (2006, p. 299) efficaciously state that “[...] prototyping is the pivotal activity that structures innovation, collaboration, and creativity in design.” Still, to reach that point, values traditionally related to models have to change. A prototype may not be just an accurate depiction of a design, a portrait of functionality or a concept mediator between designers and users (Scaletsky et al., 2014, p. 3085). As the illustrated on-field research outlined, models may become:

- **Brainstorming triggers**, tools to generate ideas, discussions and suggestions more rapidly as they are already reflected in a three-dimensional space;
- **Provocative devices**, as they give occasion to encourage students to break new ground, to explore personal and unpathed directions;
- **Experimental tools**, which allow investigations in-between fantasy and concreteness, freedom of expression and liberation from past heritage, innovation and balance;
- **Sensemaking prototypes**, objects that are not only representative and informational, but that also generate meaning;
- **Playful artefacts**, as the ludic characterisation has proved to be one of the most effective qualities of the assessed approach. If doing is associated with playing, then the resulting activity will be more positively connotated and involving a more open-minded attitude, despitess all the encountered difficulties and obstacles.

Perhaps, the best picture of a maquette can be illustrated by a secant, underlining its cross-value between the creative process and its complex results. In fact, if in the design-oriented research “[...] the resulting artefact is considered more a mean than an end” (Fallman, 2003, p. 21), in this case, the prototype assumes a double meaning which becomes clear both in the procedure and in the outcome.
Certainly, the method portrayed in this paper does not aim at perfection, as it mostly refers to an exercise in style and may not seem grounded on real-life problems. On the contrary, it makes of imperfection, unpredictability and margins of error its strength points. In fact, the exercise may represent the beginning for further implementation, like automatic surrealist games were. In this sense, formal precision, standardised functionalities and uniform representations are a prelude to monotony and homologated thinking, while intended inaccuracy and possibly unproductive impositions may be the openers for a divergent thinking with results inspired by creativity and adaptive spirit.

Finally, this approach, as successfully experimented in small working groups of interior design students and teachers, may be further investigated and implemented in different fields, and even include a wider plurality of actors (intended as end-users, managers, engineers, etc.). In fact, its provocative nature and generative role can insert it among some unusual forms of participatory prototyping (Youn-Kyung, Stolterman & Tenenberg, 2008).

References


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Why Design Students Need Application Programming Interfaces (APIs)

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Abstract: One of the perennial questions faced by designers, researchers, and students of design is to what extent they should develop a prototype in order to learn the most from it. In some cases, a simple paper sketch is sufficient. In others, a fully functional version is necessary in order to adequately convey the core concept. In this paper, we focus on the latter end of the spectrum, and propose that one way to quickly and efficiently create these kinds of prototypes is to identify and use one of the publicly-available application programming interfaces (APIs) that can be quickly found in API databases. In short, we seek to simplify prototyping in the field of Interaction Design that appears complex and multidisciplinary with a lot of moving pieces and formulate a way to streamline rapid prototyping. We argue that proper choice and use of an API allows designers with minimal knowledge in information technology to skip the complexities associated with multidisciplinary ideas and enables them instead to traverse different regions of the design space. This helps prototyping, even in this fully-functional space, to take on additional roles such as a generator of design ideas, stimulus for reflection, and influence on behaviors in order to discover and refine design ideas. We ground our discussion in a case study focusing on design process of a language learning prototype that accesses half a dozen APIs to analyze uttered speech and visualize lexical stress in real-time.

Keywords: application programming interface; API; prototype; interaction design; design space

1 Introduction

Design of digital artifacts, things built around information technology, is becoming increasingly complex in the field of Interaction Design (Löwgren & Stolterman, 2004). Advent of new technologies coupled with evolving user needs has resulted in messy situations in many design problems where there are ambiguous boundaries and unlimited degrees of freedom for designers. Design researchers have introduced plenty of theoretical methods, frameworks and approaches to help practitioners navigate complexity but studies show that designers, although familiar with these methods, rarely use them (Stolterman, 2008; Rogers, 2004). Design practitioners have tended to employ tools that prepare them for action than frameworks that guide them in action because it is often difficult to tailor a theoretical method to a specific design context (Stolterman, 2008).
One of the concepts that has proven to have stood the test of time is thoughtful design (Löwgren, 2004). Thoughtful interaction designers have reflective minds that enable them to solve problems, think critically, and prepare for action in complex situations. They examine the purpose, outcomes, and benefits of design which leads to “good” design (Stolterman, 2008). As another key ingredient of a successful design, we highlight the influence of behavior in prototyping (Kolko, 2010). Kolko et al. see design as a natural dialog between the user and the artifact rooted in reaction and anticipation. Therefore, the role of designers is to assist users in experiencing a particular emotion and understanding the context which goes beyond usability in interaction design.

Lim, Stolterman and Tenenberg (2008) view prototypes not only as a means for evaluating design but also as a generative entity that enables designers to reflect on their design and analyze behavior. Given the distinction discussed by Lim et al. (2008) and further elaborations by (Camburn, Viswanathan, Linsey, Anderson, Jensen & Crawford, 2017), we can identify two types of prototypes widely used in interaction design practice and education:

1) The prototype is created to evaluate ideas and hypotheses by designers through an iterative trial-and-error process. It is commonly applied in the design process in Human-Computer-Interaction (HCI) research. In this category, prototyping helps in conducting usability testing and market research and follows distinct steps: design, build, test, and analyze (Von Hippel, 2005) (Anderl, Mecke & Klug, 2007). Design is primarily focused on developing specification-oriented prototypes rather than prototype-oriented specifications (Schrage, 1993).

2) The prototype is used to explore, generate, and brainstorm design ideas. Lim et al and others conceptualized this new definition of prototyping as a means for a holistic discovery of the design space. Scaletsky et al. (2014) described the design space as a tinkering space where designers understand users’ behavior (Bogers & Horst, 2014), generate ideas (Hess & Summers, 2013), and communicate the creative ideas (Barbieri, Angilica, Bruno & Muzzupappa, 2013). In this category, prototyping falls under the research through design rather than research for design (Scaletsky, 2014, p. 4). Such prototypes are effective tools in a designer’s arsenal to reflect and understand user behavior in complex digital artifact design.

2 Prototypes as Generative Agents

Designers often use sketches as a quick and handy way to reflect and evaluate their design without employing multidisciplinary teams and investing significant time and effort upfront to build a semi-functional prototype. Sketches, while often useful as a first step, fall short of creating a real and comprehensive interactive experience particularly in complex design problems. As further explored in our case study, modern design problems arise where sketches are poor articulations of design because they are incapable of encompassing important design concepts such as reflection and behavior-based communication that is the core of thoughtful interaction design.

A functional or at least a semi-functional prototype seems necessary to immerse both the designer and the user for reflection and behavior respectively. Nevertheless, functional prototypes of modern digital artifact often prove prohibitively expensive and time consuming to build. Moreover, modern digital artifacts that involve complex activities such as emulating human response need multidisciplinary skills. Such functionalities are typical use cases of features built using machine learning which take long and expensive development cycles to build.

The challenge is how to reach a point where the prototype affords sufficient functionality to enable the designer to be reflective without investing significant time and capital. In this article, we argue that Application Programming Interfaces (APIs) offer a solution that can help interaction designers create effective prototypes that have the aforementioned merits.

The goal of this paper is primarily to advocate for the use of APIs as a form of design support aimed at improving design process in interaction design practice and education. We show that APIs can help designers and students traverse the design space in a holistic way through developing prototypes which leads to a thorough understanding of design, concepts and meanings (Stolterman, 2008). Furthermore, through prototyping with APIs, designers can understand behavior and track behavior-based changes over time (Kolko, 2010). The design space in our study has two principal dimensions for developing prototypes: 1) the level of fidelity, and 2) the number of features that shows how complete the prototype is (see Figure 1). Selecting the level of fidelity and the number of features in prototyping influences users’ perception and reaction to the prototype which leads to different understanding of a design space (Lim, 2008). As a result of this implementation, designers are able to navigate different regions of the design space optimally with minimal cost and complexity. This helps prototyping meet its principle role as generator of design ideas, stimulus for reflection, and influence on behaviors in order to discover and refine design ideas. Using APIs also
allows designers to advance from the very early stage of ideation to a semi-functional prototype with higher breadth of features at a faster pace compared to the situation where APIs are not used.

3 Application Programming Interfaces (APIs)

APIs have greatly benefited software development by compartmentalizing various disciplines of software design and creating boundaries around different features to enable standardized and straightforward communication among different functionalities without the need to fully understand the details of their implementations. During the software development cycles, designers can embed features from other applications through APIs and gain access to knowledge to leverage in their design. APIs provide designers with flexibility and efficiency in innovating and bringing new ideas to fruition while simultaneously reducing complexity and saving time and resources (Red Hat, 2018).

In the literature, APIs have historically been leveraged by designers in the field of Human-Computer Interaction as a means to provide quick access to knowledge and data (e.g., Twitter, Google Maps) (Ruecker, Hodges, Lokhadwala, Ching, Windsor, Hudson & Rodriguez, 2015) that is otherwise time-consuming and expensive or even impossible to come by. With the growth of Artificial Intelligence in recent years, APIs can now take a very different role and perform intelligent activities on behalf of a human agent such as face recognition, object detection in images, transcribing speech (Schalkwyk, Beeferman, Beaufays, Byrne & Chelba, 2010) and converting text to speech. Availability of such functionalities via APIs make it possible to build functional multidisciplinary prototypes that were prohibitively expensive to build just a few years ago. Moreover, with the emergence of advanced mobile devices and powerful server-side infrastructure (cloud computing), many APIs are now built to be compatible with mobile programming and facilitate 24/7 accessibility to API functionalities from virtually anywhere at any time.

Our case study focuses on the design process for a language learning prototype that analyzes uttered speech and visualizes lexical stress in real-time. We will show that it proves difficult to evaluate design ideas and generate new ideas when the early prototype does not actually respond to the user’s voice (a low fidelity prototype), because voice inherently has a complex and dynamic nature. The prototype makes extensive use of various APIs both in the form of accessing a knowledge base as well as emulating a human teacher in terms of real time feedback. The study serves as an anecdote that shows the importance of APIs in simplifying, streamlining and refining a seemingly complex design idea and building a semi-functional prototype with minimal time and effort. We have subsequently conducted user research with 20 language learner students and made design iterations that introduced additional features.

![Figure 1. Using APIs could enable designers to traverse a design space from point A to Point C at a faster pace. This enables us to conduct extensive user studies at an early stage. Selecting the level of fidelity and the number of features influences users’ perception and reaction which leads to different understanding of a design space.](image)
4 Case Study

Language learning has significant potential for innovation for several reasons: sparse access to human teachers, advent of advanced mobile devices and innovations around human-computer interface (Godwin-Jones, 2011). Although self-learning language tools are commonplace these days, there are certain aspects of language learning that still require a human instructor for real-time feedback, such as pronunciations, correct placement of lexical stress on the right syllables in some languages (such as English) as well as tonality (Celce-Murcia, Brinton & Goodwin, 1996). The idea was to design a digital artifact that makes it possible for a learner to utter an expression and receive visual feedback on the location of lexical stress as shown in Figure 2. The final design would employ machine learning to analyze speech, find lexical stress, recognize speech and display the recognized speech with the stressed syllable enlarged or emphasized.

Although a low-fidelity prototype (sketch) might seem useful as a first step, it proved tedious to familiarize the learner with the idea during user studies. This was specially the case for learners whose native languages do not employ a lexical stress mechanism to communicate meaning. For instance, native speakers of French or Farsi had no concept of lexical stress in mind and were confused by the whole idea.

Building a functional prototype seemed prohibitively difficult at first sight because of all the complex tasks that it needs to perform. It would have required multiple teams with various technical capabilities, a multi-cycle development project, a significant amount of time as well as significant capital expenditure to build. However, as detailed below, freely available APIs made it possible to build a functional prototype leveraging a minimal team of designers with little knowledge in machine learning and computer science in a short amount of time, conduct user studies and perform design iterations.

Another benefit of employing APIs is that they make it possible to use them without having complex and expensive hardware on the user side. The machine Learning algorithms conduct live, complex analysis of user speech on servers at the API provider’s premises and users can access them through a simple web connection from a handheld device such as a smartphone – which creates the perfect platform for a self-learning language tool.

![Figure 2. The uttered word is “geography” that has 4 syllables and the primary stress is located on the second syllable. The pitch curve shows a peak value in this syllable (the pitch and the intensity were illustrated from Praat Software (Boersma, 2002)).](image)

Our experimental prototype conducts the following tasks (see Figure 3 that shows the workflows):

1) **The user/learner utters speech in the target language. The smartphone captures the speech and sends it to Google’s speech-to-text API:** Both Android and iOS operating systems provide easy access to device microphones through software libraries and make it possible to collect, package and transfer speech data to Google’s speech-to-text API via the web.

2) **Google’s Speech-To-Text API transcribes the audio in the target language and returns text to the user:** Google’s Speech-to-text API (Google Cloud Speech-to-Text, 2018) accepts voice data in many languages. It is capable of transcribing speech with high confidence even in noisy environments. It will then return the
transcribed speech to the device in JSON format along with a confidence level. It can also provide alternatives for the transcriptions with lower confidence levels. The longer the speech the higher the confidence for the transcription because longer speech provides context and increases the confidence level. Transcription is performed simultaneously with speech utterance. Therefore, the user can experience real-time response even with modest internet connection speed.

3) **The prototype sends transcribed speech to a syllable detection API (words API):** Once the prototype receives the transcription from Google’s speech-to-text API, it sends it to a syllable detection API. In order to identify the stressed syllable, we need to segment the uttered word into its syllables. There is a freely available API for this purpose as well. A quick search in RapidAPI (2018) which collects, hosts and manages millions of APIs, led us to WordsAPI (2018) which is capable of receiving a word and returning its syllables. Now, we not only know what the user has uttered but also have segmented the uttered word into its syllables. In the next step, we will determine which syllable has been stressed by the user.

4) **The prototype sends speech to a pitch detection API (built in-house):** A considerable amount of research has gone into techniques to detect lexical stress in speech. Many have identified pitch as an indicator of stress (Tepperman & Narayanan, 2005). When a speaker places stress on a vowel, that vowel is uttered at a higher pitch than the rest of the utterance (see Figure. 2). Open source software tools such as Praat (Boersma, 2002) have implemented algorithms that determine and plot the utterance pitch. In order to use it in our prototype, we have created an API, in house, that implements the same method (De Cheveigné & Kawahara, 2002) used in Praat as an API with the addition of being compatible for use in a mobile application, Figure 4 (Left).

Simultaneous with the above steps, the prototype sends the speech data to a pitch detection API which returns a plot of pitch variation during speech utterance.

5) **The prototype overlays the detected pitch over the transcribed word and its syllables and finds the syllable that is stressed:** In this step, we overlay the pitch variation on the transcribed speech to detect which syllable is stressed by the speaker. Now we know what the user has said, its syllables and the syllable that is stressed by the speaker.

6) **The prototype uses uppercase letters in a larger size for the detected stressed syllables and displays the transcribed text to the user:** During the ideation of this prototype, one aspect of the idea was to help users visualize the stressed syllable. In general, for language teachers, it is difficult to teach concepts related to speaking as they are quite cumbersome to communicate. Therefore, we decided to show lexical stress which is an audio property via modified typography i.e. using large uppercase letters for the stressed syllable.

It is not exactly novel to express lexical stress using indicators such as uppercase letters for the stressed syllables. What is novel about this is providing real-time feedback for uttered speech in this fashion. Now we have displayed the user’s uttered speech with the stressed syllable in uppercase. In the next step, we display the correct way to speak the same word next to the user’s version.

7) **The prototype also shows the same text with the correct syllable to the users:** WordsAPI discussed in step 3 not only gives us the syllables of a word but also returns the syllable that needs to be stressed. Using this information, the prototype can display the correct version of the utterance along with the user’s version so that the user can compare and correct themselves with practice.

8) **Using a text-to-speech API to let the user hear the correct pronunciation:** This step was originally absent from our prototype but was added at a later iteration after user studies. While users enjoyed seeing how they have placed lexical stress, most of them wanted to hear the correct version of the speech as well. APIs came to help one last time as Google also provides a text to speech API (Google Cloud-Text-To-Speech, 2018) which can receive text and return spoken words as an audio file. Therefore, invoking this API, the prototype not only shows where the user has placed lexical stress and where it was supposed to be but also speaks the word correctly in the end.
5 User Research

We conducted user studies on 20 English language learners in the age range of 18 to 40 with various native languages such as Korean, Chinese, Farsi, Arabic, Hindi, Spanish, and Portuguese. We originally tried to conduct user research using simple sketches. A human English language expert played the role of the machine and presented the learner with sketches similar to Figure 4 (right) once the user uttered the requested expression. The first problem that arose as a result of using sketches was that some native speakers of languages such as French and Farsi, who had no concept of lexical stress in their native language, found the purpose of the design confusing. Verbal explanations seemed to do little to describe the true meaning of lexical stress. Although a human expert was present to represent the machine and simulate what the ultimate design would do, learners had a hard time understanding the design. Using a human expert to represent the machine also seemed counterproductive since the main design idea was to use machines to imitate a human teacher. As it immediately became apparent that a fully functional prototype was inevitable to best articulate the design concept for user studies, APIs seemed to offer a quick way to build a functional prototype without expensive development cycles. A functional prototype as detailed in previous section was built in less than two months and user studies were resumed. Users now received instant responses from the prototype.

Think-aloud cognitive interviews (Given, 2008) showed that almost all users understood the intent of the design. Repeated exposure of the learners to the prototype showed that the users could retrieve their previous responses and gradually improve their responses over time. This was not possible to assess with original sketches. Some learners’ judgements were incorrect in their first responses in the sense that they took some time to realize that a combination of loudness and higher pitch would best represent a stressed syllable but repeat exposure resulted in quick improvements. During the Think-aloud sessions as well as verbal probes, users expressed interest in hearing the correct version of the expression after every utterance. The good news was that there was an API for that as well. A text-to-speech conversion was quickly added to the prototype and as predicted by learners, it significantly improved users’ speed in improving their utterance. It was quickly demonstrated that APIs offered the possibility of quick design iterations. Additional observations are listed below:

- Users were intrigued by the idea of visual feedback on their pronunciations as it related to lexical stress – particularly language learners who were preparing for standardized tests for foreign language fluency (TOEFL) since the only available alternative for them to seek feedback was a human teacher.
- Some users did not initially believe that they were mispronouncing the words in terms of lexical stress. For most users, once they witnessed a visual representation of their utterance and compared it to the correct visual, they became more interested in repeating the exercise and eventually getting it right.
- Many users were interested to see the pitch curve itself as shown in Figure 2. In a separate prototype, we made it possible for the users to see the pitch curve if they elected to see it.
Why Design Students Need Application Programming Interfaces (APIs)

- Users’ native language had a significant impact on their learning speed as well as their familiarity with lexical stress. This was expected as lexical stress and tonality has no significance in some languages while it is extremely important in other languages.
- In order to visualize the lexical stress, we prepared many mini-prototypes as seen in Figure 4(right). We then conducted separate user studies to choose which visual representation was most desirable and felt most natural to users. Users overwhelmingly chose prototype #1 as it also appears in some language learning books and material. This choice was likely related to learners’ familiarity with this visualization from such material. Investigating other parameters in visualization such as color and typeface will be examined in our future prototyping.

![Figure 4](image)

**Figure 4.** (Left) The functional prototype was built for iPhone iOS. (Right) mini-prototypes for finding the most desirable visual representation for the users. The visualizations are listed in the order of users’ preference.

6 Conclusion

We have demonstrated a new role for modern APIs as entities that perform intelligent actions in prototypes beyond their historical role as sources of data/knowledge. Such design ideas are difficult to communicate with users when implemented as low-fidelity prototypes. We have also shown that using APIs in this context can help build multidisciplinary and high-fidelity prototypes that seem prohibitively expensive and time-consuming to build in the absence of APIs. Our case study successfully implements a real-time feedback system for language learners which visualizes speech properties such as lexical stress to help users identify inaccuracies in their stress placement and improve upon them with practice. Furthermore, we have shown that using modern APIs can simplify subsequent design tweaks during user research and significantly reduce time to solution and save designers time, cost and design complexity.

References


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Game-Design-Driven Knowledge: When Prototypes Unpack and Reframe Conventions

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Abstract: This paper explores the implications of conceiving, designing and prototyping location-based mobile games (LBMGs) that bridge the real and the digital into fascinating and unexpected hybrid worlds. The distinguishing traits of these games make them pop up as a compelling contemporary field for design research and practices, where design knowledge is informed in multiple ways: from posing the questions of relating to/embedding technology, to addressing design issues, from ruminating and dealing with UX and UI, to assessing communicative aspects. Moreover, being situated in a specific context and addressing unpleasant topics in the meanwhile, these games prove to be further challenging. The result from our study is that especially when the design activity pushes the line beyond playing within a formal structure, becoming a way to play with structures and a way to celebrate experimentation, prototyping has a crucial role in nurturing awareness and knowledge. In the light of this reasoning, designing, prototyping and testing of LBMGs are framed from a design perspective, exploring their potential in terms of design education.

Keywords: location-based mobile games; prototyping; learning; meaning-making; hands-on experimentation

1 Introducing LBMGs: A Controlled, Complex Space for Design Experimentation

The topics of design research and education, as well as their methodological framework are still open matters of investigation at the centre of many discussions. Nevertheless, contemporary literature agrees on the necessity to encourage innovative learning/educational environments able to nurture knowledge about learning or/and teaching (Edelson, 2002; Cobb, Confrey, di Sessa, Lehrer & Schauble, 2003; Sandoval 2014). In the light of this reasoning, we identified games as a meaningful and inclusive context where design students can experiment and apply the design process in its entirety. Hence, we approached location-based mobile games (LBMGs) because of their interdisciplinary nature. Their being comprehensive of different degrees of complexity make them an ideal space for exploring the various stages and multiple challenges of design education. LBMGs are popular and flourishing typology of games that, in addition to be recognised as means of entertainment, prove to be an interesting and rather challenging field for investigation (De Souza e Silva & Sutko, 2009; De Souza e Silva & Hjorth, 2009; Montola et al., 2009; Ackermann, 2014;
Ilaria MARIANI, Davide SPALLAZZO

Leorke, 2015). Allowing informal situated learning and favouriting hands-on learning and practices, they provide a powerful space where exploratory processes can be tested, analysed and implemented (Spallazzo & Mariani, 2018).

We ruminate on games as structured systems of interactions that imply a dialogue with the game system, but also with other players, and spaces. The latter in particular can be seen as environments as well as social contexts, where physical objects can be spread in order to activate interactions. Bridging the real and the digital into fascinating and unexpected hybrid worlds, such games require certain abilities that surf from sense to sensibility. Acknowledging the state of the art in the field, and the potentialities coming from mobile technology, we decided to deal with a confined but complete design process, that of designing LBMGs, which quite nimbly allows to go from conceiving the idea to its prototyping and testing. We started our study as an empirical research conducted in the Politecnico di Milano, School of Design educational context, analysing the design processes that led to create 44 LBMGs, outcome of the elective BSc course Augmented Reality and Mobile Experience.

The distinguishing and peculiar traits of LBMGs make their creation a compelling contemporary field for design research and practices, where design knowledge is informed in multiple ways. Design issues are addressed in a broad sense: from understanding the relation with the environment – and hence problematizing the interaction with the surroundings – to the potential engaging uses of mobile technologies; from examining and dealing with UX and UI, to assessing communicative aspects. Indeed, they can include meaningful persuasive aspects that stem either from a significant narrative dimension and/or from informed, considerate, attentive uses of procedural rhetorics (Bogost, 2007; Sicart, 2011a). Narratives and mechanics can indeed nurture engaging and captivating experiences that prompt into critical reasonings (Mariani, 2016). From covering uncommon topics to employing unusual gameplays, a growing amount of games and play practices questions and sometimes even breaks our ordinary conventions to trigger different novel perspectives. As a result, it is key to focus on the meanings and implications that lie on the ground of designing games that frequently prompt unusual experiences leading to unexpected and meaningful play activities.

Echoing and expanding Sicart’s reasoning on procedurality (Bogost, 2007; Sicart, 2011a), we challenged our students to design LBMGs exploring transgressive topics and gameplays, from unconventional matters to taboos and subjects that none would like to talk (or play) about (Mariani & Spallazzo, 2016).

This design brief presents several implications that go transversally to the design fields, as the designer interprets complex topics while dealing with games that are situated in the space. In consequence, for those who design such games, meaning-making as well as the definition of significant interactions are far from being second-order problems. To handle such a complexity, prototypes are needed. That said, in the following, we open the reasoning about how prototypes can play a key role in triggering learning at different levels and design moments.

Prototypes are clearly a way to empower designers, even more when the discourse implies playing with meanings and meaning-making. It follows that the design activity at the basis of such games pushes the line from playing within a formal structure to a way of playing with structures (Zimmerman, 2008), turning the game design activity itself into a way to celebrate experimentation. In so doing, prototyping is far beyond from being in service to knowledge. It is rather key, since it plays a first-line role in advancing understanding and awareness. Our educational aim was to challenge students to follow the entire design process when designing LBMGs, from their conception to their testing; a process that relied on early prototyping and hands-on experimentation aimed at activating a virtuous circle of iterations that goes through progressive implementation and improvement. Here, prototypes serve both as a way to materialize and test concepts, and as a moment of discussion with peers. The course was indeed structured to exploit prototyping at different stages: depending on the design phases, they allowed designers to discuss about topics, or to enable a collective critical discussion within the classroom triggered by feedback from peers.

In the light of this reasoning, this paper frames location-based mobile games from a design perspective, exploring prototypes potentiality in terms of both design and design education.

**LBMGs in the Educational Context**


Discussing the potentials of LBMGs in an informal or formal education context means touching diversified and broad fields of research such as mobile learning (m-learning), situated learning, and game-based learning (GBL), since
games—and LBMGs in particular—are sophisticated communication systems that establish multidimensional relationships between players, the game context, technology and other players.

Intending LBMGs as mobile-supported systems means referring to the field of mobile learning. The potentials of mobile devices in terms of learning have been addressed by several authors who list the main characteristics that make these devices compelling tools for learning: social interactivity and individuality (Klopfer, Squire & Jenkins, 2002); context, mobility, learning overtime, informality and ownership (Naismith, Lonsdale, Vavoula & Sharpleys, 2004). Therefore, mobile learning appears as a process of knowledge acquisition, experience and awareness while in mobility, enhanced by personal and public technology (Kukulska-Hulme et al., 2009).

Looking at LBMGs as games, we can highlight how they are progressively emerging as educational media (Squire, 2006; Paraskeva et al., 2010; Girard et al., 2013; De Freitas, 2018) that find their strengths in the ability to involve players utterly and completely, sometimes also taking particular advantage of the space in which they are situated. Learning by playing digital games could signify acquiring specific skills (Gee, 2003; 2004) but also being educated about the topics the games deal with (Bogost, 2007; 2011). LBMGs in particular, for their ability to foster playfulness (Sicart, 2014; Mariani & Ackermann, 2016) and mix an engaging play activity with the richness of the contingent world, can be seen as valuable tools to trigger both active engagement and situated learning (Lave & Wenger, 1991). LMBGs, indeed, may embed learning in authentic environments thanks to the mobile technologies ability to locate players and provide contextual contents (Huizenga, Admiraal, Akkerman & Dam, 2009). A potential that has been highlighted also by Klopfer (2008) as essential to augment the learning experience, be it in a formal or informal context.

Learning and engagement are seen by Avouris and Yannoutsou (2012) as inherent to LBMGs and the balance between these two poles is at the basis of the classification of educative LBMGs they propose, structured in three categories: (i) ludic which includes games aimed to enjoy players; (ii) pedagogic that regards LBMGs specifically developed for players’ learning and (iii) hybrid that looks for a balance between the aforementioned aims. Therefore, mixing interactive entertainment with learning is at the very core of game-based learning and a novel way of dealing with contemporary learners both in formal and informal education settings (Prensky, 2001; Papastergiou, 2009).

The experience we ran for three consecutive years took place in a formal education setting and focused on sensitive topics, looking at LBMGs as means to look at our society, both from player’s and designer’s point of view. Students were asked to realize working prototypes of LBMGs, games as media to communicate meaning, ways to translate multifaceted perspectives, controversial themes and wicked issues into gaming experiences. In so doing, games also emerge as tools of enquiry. Not only the games designed, but already the considerations and reflections that led to the prototyping—as well as the prototyping itself—have been source of knowledge, emerging as fundamental moments of learning. Indeed, addressing sensitive topics frequently involves seeking for transgressive ways—gameplays—of dealing with moral arguments. In particular, we focused on topics of questionable playful interest, usually steeped in negative value and avoided in daily conversations (Kaufman, Flanagan & Seidman, 2016): we asked our students to explore the game and its dark side (Mortensen, Linderoth & Brown, 2015), deliberately investigating morally defensible choices and giving rise to negative emotions and feelings (Juul, 2013). Designing, prototyping and testing these games prompted rumination between meanings shared and transferred through the gameplay and the experience they trigger (Sicart, 2011a). Meanings that reflect the message that students, in the role of game designers and senders, intend to convey but emerge as a result of the player’s interpretation and understanding.

Our academic interest was in the analysis of the relevance of LBMGs prototypes, on the one side as activators of reflection and on the other as triggers of learning experiences in a formal educational context. The discussion here proposed aims at framing LBMGs prototypes as valuable tools to stimulate through-design learning for students, where learning is multi-layered and rely on how early prototyping and an iterative process of test and correction resulted in terms of educational outcomes.

2 Methodology

Thanks to direct (participant) observation of the design (first) and play activity (later), we dug into the learning dynamics and processes activated by designing LBMGs. The enquiry has been supported by post-game questionnaires and informal interviews aimed at grasping knowledge about how players received the game, its mechanics and message (Mariani, 2016). While recognizing that the understanding of the message in itself is not the core of this article, it plays a key role in providing students clear feedback on what they prototyped. Acknowledging that game-playing and game-designing can work as relevant models for learning, becoming powerful calls for action and reflection in the real world (echoing Mezirow’s (1996) transformative learning), the education results have been
analysed and unpacked examining how learning can be informed by hands-on experience. As a matter of fact, subjective understanding is nurtured through design practice (Frayling, 1993). Thus, this is both a review and a critical discussion about how prototyping games can serve for constructing design knowledge. The approach framed as “design as research” (Schön, 1983; Laurel, 2003; Cross, 2006) lays on the ground of a study that sees (game) design as a way to conduct enquire and encourage reflective insight about the creative process. That said, in a through-design perspective (Frayling, 1993), conceiving, designing and prototyping LBMGs become ways to gain expertise and awareness.

The analysis has been conducted on 180 students, informed since the beginning of the course that their design activity as well as results would be subject of analysis. The study focuses on the outcomes of three assessments in the BS course “Augmented Reality and Mobile Experience” that ran in the academic years 2013/2014, 2014/2015 and 2015/2016, and employs a mixed approach based on a triangulation of different research methods aiming at lessening intrinsic biases and weaknesses (Denzin, 1978). To cross-validate the study, participant observation has been combined with interpretative ethnography and questionnaires. In particular, questionnaires were built to assess the play(ier) experience and some of its aspects as the feelings elicited, the ability to understand the message conveyed and the perceived overall quality. The data gleaned from the questionnaires and the ones of the ethnography provided important insights into the way the game answered the initial aims and expectations as well as on the role played by prototypes in allowing designers to grasp such knowledge through a hands-on activity.

The ethnographic study covered the entire design process over a six-months span for each academic year, while the questionnaires were handed out at the end of each playtest cycle. When students cross-played and cross-evaluated their working prototypes they were asked to provide feedback about the games’ playability to their peers, assessing the relevance and pleasantness of the interaction with the game and its elements, as well as their ability to convey meanings.

3 Unpacking Learning Through LBMGs Design and Play

The formal educational setting wherein the experimentation here described took place is that of a School of Design and the main goal of the didactic activity was therefore to teach students how to design for mobile experiences, taking into account not only the mere interaction with mobile devices but also its development over time, the context in which it occurs and, above all, its meaning. Furthermore, the course aimed to shift future designers’ attention from the implementation of new technologies to the design of the resulting experience (Hassenzahl et al., 2013). Based on such premises, we examined how designing LBMGs—that are known for being engaging tools—can transform a higher education class into a space where knowledge is gained by conducting iterative on-field experimentations.

Therefore, learning is mainly intended as the result of a formal didactic activity that mixes theoretical knowledge with hands-on experimentation, ranging from creating proof-of-concepts and low fidelity prototypes to deploying working prototypes then tested and evaluated in a peer activity. Nevertheless, our study revealed that learning emerged as multi-layered across the entire course for the three consecutive years. Students, indeed, learned to design for meaningful and engaging mobile gaming experiences, but at the same time, by designing games on specific topics and by playing those games, they could gain knowledge about the argument covered.

Consequently, we may highlight three learning forms: (L1) learning to design for mobile experiences (formal learning within design practice); (L2) learning by designing games (formal learning about the design objective of the course and informal learning about specific topics covered by each game); (L3) learning by playing games (informal learning about specific topics) (Figure 1).

The first layer (L1) considers LBMGs as significant mobile experiences, whose design is subject of the course during which the mobile games have been conceived and tested. This level portrays the expected outcomes of a formal educational activity in the design field. As stated above, it is the result of a teaching activity that relies on theoretical lectures as well as on hands-on activities and looks at prototyping and testing phases as the main means to gain skills, competences and knowledge (L1). Therefore, learning to design LBMGs can be considered, first of all, a formal educational activity (L1) that can be targeted as learning to design, since students acquire skills to conceive meaningful mobile experiences by taking part to the course. Eventually, another level (L2) is necessarily intertwined, since the didactic activity passes through the actual design of LBMGs and an iterative design process intended as an on-field practice for advancing understanding.
Students were asked to develop functioning systems in an operational environment—working LBMG prototypes ready to be tested—going through a set of given steps: definition of the game narrative and of the game mechanics, user experience design, low-fidelity and, finally, hi-fidelity prototyping. It is evident that prototyping acquires here a key role in the iteration that usually characterizes the design process, and Interaction Design in particular (Saffer, 2009). Rather than incurring in the common translation of theoretical principles into concrete design, learning to design (L1) and by designing (L2) induced students to derive such principles from the experimentation, allowing to develop direct, experiential knowledge. Moreover, the assessment of the games designed via mutual playtest encouraged to gain awareness. By feeding learning, although in different ways, these activities can produce evident benefits in terms of design curriculum. Through trials and errors, students directly experienced the entire process of conceiving, developing, testing and releasing of a LBMG, getting continuous feedback on several issues connected to their games: mechanics, graphics and user interface, narrative, usability, user experience, involvement, just to name a few.

Designing a game requires specific knowledge in the discipline of game studies and game design, that we provided to students in the form of short lectures. Therefore, the act of designing games also became a means of formal education about the gaming field and its fundamentals, since students were asked to master the basics of the discipline to design coherent, working and engaging games. Learning by designing (L2) is therefore the second level of formal learning achieved by "getting the hands dirty" with prototypes, being them rough or refined. But designing a game necessarily involves a good command of the subject matter of the game, in order to create a meaningful fictional world, relevant tasks and consistent game mechanics. Hence, learning by designing means learning how to design—learning by doing—but also having both a wide and narrow knowledge about the topic. In other words, it means also an informal acquisition of notions about specific topics covered by each game, a kind of learning (L2) that affects mainly the design team. It uses design skills to pass on knowledge gained in the form of gaming experience to players who, hopefully, will learn by playing (L3).

If the use of prototyping skill is helpful to learn how to design for meaningful interactive experiences, it is also true that the need to create a working and complete prototype forced students to deepen the subject matter of the game, in order to create a coherent fictional words, quests and game mechanics. Gaining this knowledge can be considered as a productive side effect of the formal activity and triggered by the task of creating an operative prototype. An example is the game The Lost Papyrus (Benedetti, De Marco, Franco Conesa & Piatti, 2015), which deals with Alzheimer’s disease, aiming to inform players about its effects and implications, on the daily activities of patients and those who live with them (Figure 2). This complex and delicate topic is addressed through a metaphoric narration, and through the transposition of the disease symptoms into game mechanics in order to create awareness and provide information. The metaphor is the Ancient Egypt of the first heroic archaeological expeditions. The four players are dropped in the early 20th century wearing the roles of an expert archaeologist of Egyptian culture and his three assistants. Their objective is to explore a still undiscovered tomb to find a renowned papyrus. The relevant number of documents read and discussed, and information filtered by the students, resulted in an unintentional but thoughtful knowledge of the disease, and the continuous confrontation within the design team led to an emotional involvement towards ill people and their relatives.

Therefore, informal learning can happen while designing LBMGs but the working prototypes of LBMGs are at the basis of the third level of learning we identified in our study, defined learning by playing (L3). Each game underwent an iterative process consisting of several testing by peers, namely by classroom mates as players who are in the meanwhile designers of other games. In this case, the focus is on the ability of games to transfer the embedded
meaning and raise awareness about delicate topics, affect some mindsets and affect the position of designers/players about the represented issues.

The translation of information, processes, concepts and knowledge into a story, the definition of a fictional world and of game mechanics are evidences of the informal learning process that happened within the design team. However, quantifying the learning outcome of a mobile-supported experience is not an easy task, since the employed methodology cannot account on real transformation of players’ attitude towards the subject. Nevertheless, we observed that frequently players, during the play activity, were led to think and act according to the role they were assigned, and, in so doing, to discuss the point of view proposed by the design team. Often, players reported that the game experiences triggered reflection on their morality and ethics and acted as a stimulus to discuss and question delicate issues.

An indicative case of this attitude, as well as sharp example of how the three typologies of learning unfold during the prototyping process and inform the game design is The 10 Commandments (Culla, Di Filippo, Frisia & Golan, 2014), a game conceived to dive players into the daily life routines of a person struggling with anorexia (Figure 3). To design its
narrative and mechanics students conducted a significant desk research, identifying some real online blogs that openly sustain and promote Pro-Ana behaviours, and the renowned Ana’s 10 commandments, that means seeing anorexia as a philosophy of life to be followed in order to have a “perfect slim body”. Such resources and testimonies (L1 and L2), were exploited to drive the game design. The story goes that players are in the shoes of a young girl who has to face nine stages to successfully attend a photographic shooting. Players are asked to go through different moments of the day, coping with a series of dilemmas that are indirect references (Kaufman & Flanagan, 2015) to the commandments. However, this game has been structured in order to make the player fail. Indeed, whatever the choice, the result is a game over. By respecting the commandments, players lose energy and cannot make it to the end, while by disobeying their sense of guiltiness increases, preventing them from reaching the final stage. In this case study, the informal learning that happens through playing (L3) is singular and noteworthy. The gameplay is indeed thought to make players feel progressively more doubtful and suspicious about the validity of their in-game behaviours. By following a linear, distributed narrative, players are indeed led to question the logic and soundness of Ana’s 10 commandments as rules to trustfully follow. Dealing with the topic addressed (L2), students decided to structure The 10 Commandments as an unwinnable game (Ruggiero & Becker, 2015). No player can reach the eagerly awaited shooting, since they will not have enough energy to open the ultimate door that brings to the photo studio, or they will be lacking the self-esteem needed to participate in the casting. Struggling with anorexia, the player is led to play from the losing side, experiencing failure and frustration. As a matter of fact, these feelings, gathered through participant observation, informal interviews and questionnaire, are the eventual objective of those who designed the game. As to mirror the dynamics of the disease, the game is not giving any chance of winning, stressing the fact that this eating disorder cannot be solved by continuing to follow harmful practices and behaviours. According to the interviews conducted, the final disclosure was rarely perceived as a total epiphany. During the game, players frequently started to debate about the inconsistency of the Pro-Ana behaviours.

This case study represents in an explanatory way the learning processes object of this article. It is already recognized that games are constructive systems able to encourage transformative learning (Mezirow, 1996; Mitgutsch, 2011). However, the topic is generally covered from the players’ perspective, drawing attention on how design patterns can challenge players and lead them to rethink their expectations, but also reframe their positions and knowledge by making them conscious of their own bias and prejudgments. Instead, the point we intend to stress is how creating games, and the stages of prototyping and testing, in particular, are sources of significant knowledge. The initial stages of research and analysis that bring to the idea and its prototype are the first trigger for consideration and reflections. However, deeper pondering, awareness and consciousness can only come afterwards, from the very fact of prototyping and conducting on-field experimentation as fundamental moments of learning. Collecting information about how their own game shaped as completely working prototypes were played by others created awareness about the effectiveness or flaws of certain game mechanics, as well as of the storytelling (narrative part) of the game. The moment of comparison between designers and player is key since it offers a unique perspective with those who made a direct experience of the game. By playing games designed by peers, the students were also encouraged to assess their own games through comparison, and the gained insights were then enforced by the feedback of those who tested the game. This happens at a design stage when designers are prepared to question their work, as variations and implementations do not require a total revision of the system, but of progressive improvements and adjustments. In this sense, learning by playing (L3) can be intended also as a way to test the design skills acquired during the class activities (L1 and L2). The working prototypes were therefore key to activate the levels of learning here discussed since they allowed to: directly verify how the designed system was used and perceived (L1); improve the design skills by actually realizing a working system (L2); get a wide and narrow view on the topics addressed by the games (L2) and, finally, to be sensitized about those topics by playing the LBMGs (L3).

4 Reframing Knowledge via Prototyping: Discussion and Conclusions

The course clearly had multiple objectives. Designers were asked to author arguments and topics through processes (L1), with the given objective of turning them (L1+L2) into a kind of knowledge that players could grasp by playing thanks to working prototypes (L3). Relying on Bogost’s (2007) and Sicart’s (2011a) reasonings, through their procedural rhetoric, these games have been conceived and developed aiming at becoming a way to show or expose how the represented systems and topics work. In this sense prototyping played a paramount role since the very early stages. The early prototyping phases of the game provided hands-on knowledge of the topic and about how to translate it into game mechanics and narrative. This required students to face several levels of complexity. First it comes the fact of identifying a controversial, problematic topic of social interest to conscientiously address through a game. Hence the research and strategic articulation of this topic into a narrative (with its fictional world) and game processes showed how games can be used persuasively, namely as ways to provide a first-hand experimentation by including persuasive contents. From a design perspective, learning to conceive entertaining games and master
persuasive communication means able to impact on players—changing their opinion or even affecting their behaviours—has several implications. Indeed, designing and prototyping artefacts able to both engage and induce change through experience and interpretation requires iterated tests and validations to assess the artefacts’ usability as well as their communicative-persuasive effectiveness on players.

The aim of designing games that trigger learning processes on players is not new, and the virtuous circle of learning by (L2) designing and (L3) playing games has been a matter of analysis for several researchers. In particular, Flanagan and the colleagues involved in the Tiltfactor team look at digital games as a medium to express and incorporate moral and political values. During formal educational activities such as workshops, Flanagan and Nissenbaum (2014) investigated how game-based systems can communicate ideas and integrate human values. We extended this educational approach to LBMGs and their design process, further challenging our students to cope with the constraints of mobile technology and the real world. In this articulated and challenging process, the role of prototyping covers a pivotal role, and both designing and playing games acquire a twofold role and function, as ways to question and understand design knowledge and practices given for granted (L1+L2), and as sources of broader understanding (L3). Cycles of prototyping and assessment lead to recognize the presence of repeated issues attributable to the difficulty of transmitting concepts and soliciting critical reflection, as well as to deal with a game situated in the real space where the gameplay is located, and the narrative is often distributed. In addition, substantial benefits derive from interacting with a prototype since the early stages of the game design, allowing progressive implementations.

A large proportion of our students approached the design with clear and definite ideas about what kind of gameplay they wanted to create. However, until the prototype was tested, we noticed that students struggled to envision the players’ experience as a design outcome, and in particular to frame how players would have grasped and interpreted the topic addressed by the game. In this sense, we encouraged them to reconsider their starting assumptions in order to adopt a more personal perspective. A perspective that was less predictable and subject to conventions, but rather based on fresh or unexpected narratives and game mechanics, striving for experiences that can stimulate significant reflections on the subject (L2). Only through direct experience and especially testing, designers understood that the best way to trigger reflections and support arguments goes far beyond the construction of rules of behaviours that emerges from the game experience. On the contrary, they realize that comprehension and knowledge rely on more complex dynamic models, which include coherent and consistent narratives (Wolf, 2012), as well as unexpected gameplays (Mortensen et al., 2015). As a result, most of the time failure and narrative turning points started to play a central role in the gameplay, becoming in-game sources of meaning-making.

To further point out the contribution of this research in our communities of reference, we want to underline that this study regards on the one hand an enquiry on the role of prototyping, applying design methods and practices to a limited but complex context, that of designing LBMGs, wherein multiple design issues and levels of complexity are entailed (L1); from this perspective, prototyping also pops up as a way to test and question practices, enquire processes and gain consequent knowledge (L2). On the other hand, it refers to the way in which the playtest phase via prototyping informed designers. They benefit from investigating how players have reacted to the experience of the game as a source of understanding and activator of change (L3).

Acknowledging that just going through prototyping and assessment students can learn that what has been designed on a theoretical level can encounter failure when translated into practice, we decided to exploit the trial-and-error process as an educational method. Designing games has become an opportunity for experimentation in which students had the opportunity to test themselves and fail, as a planned part of their learning activities and outcomes. A situation made even more sensitive because of the arguments addressed: social issues. This led students to think conscientiously through the practice of designing, prototyping and playing on topics as delicate as they are complicated. Ultimately, this design activity gave them the opportunity to reframe their own conventions in terms of topic covered, while providing novel insights on the overall design process.

References


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Abstract: It is conceivable that capitalism and the new market economy as it currently operates is unsustainable despite the bullish opinions of businessmen and entrepreneurs. There are many obvious concerns surrounding an economy without money the most basic of which is the accounting of productivity. However, if we are seriously engaged in this thought experiment, we must also consider two operations of the current system that seem to be most detrimental to societal and more recently, political constructs which are the accumulation, and transfer of money. Moderate restrictions have been placed on both operations but considering the involvement of business in government countless examples evidence the lack of enthusiasm to restrict them further. If we consider life without money, we need to substitute some values that would take the place of cash in order to reshape societal values by placing an importance on things that have greater return than the construct of money can provide. In this study we developed a series of prototypes to learn how a game might be designed in order to emulate a new economic system using time and choice as important values. This study extends students’ understanding of the prototyping process through participation in both development and usability. The students who have a basic understanding of economics provide the feedback loop in order to establish rules, playability, and begin to understand how the game can be rigged in their favour.

Keywords: prototyping; game design; capitalism; human behaviour

1 Introduction

Project problems for design students often have parameters that are well defined. Professors or the problems themselves impose constraints that determine the scope of the project within the skills and cognitive capabilities of the student. In this paper, we describe a project and process that goes beyond most any design students’ capability in part to push students to ask the question “what if?”. We asked them to consider an economy that moves away from using money. The problem requires them to shift their thoughts from commodities and services to concepts like...
incentives, and what new set of values could bring to bear for a new economy. Incentives and values brought conceptual similarities from the game design space, which opened up the possibility for prototyping an economic simulation. We imagined a game environment where time and choice are the highest valued possessions of a player. In this game, a player suspends disbelief and sets aside the concept of money in lieu of activities that provide more free time and choice to motivate players to participate and actively play the game. The goal of this study was to demonstrate an economy that holds the benefits of money, such as incentive, without the downside of money - the power to corrupt. The study also allowed for distortions and deviations from social norms in order to benefit one's self and to see how self-governing in a game environment would call out those deviations when using the prototypes. Preliminary discussions with students informed us of the ingrained power of money, how we limit our imagination when dealing with problem complexity. The students could hardly fathom any other form of economy.

2 Background

Typical collaborative design processes use prototypes as a tool for development and communication to create a space to exchange ideas. Multiple stakeholders collaborate when prototyping such as designers, users, consultants, for example in a variety of capacities. Role organization is an important part of collaborative design to differentiate communication around the object such as inputs and outputs, or criticism and evaluation. Supporting communications using what has been defined as boundary objects should happen at different levels of discussion between individuals or groups in reference to the project (Chiu, 2002). A boundary between users and designers helps transform knowledge in a manageable and organizible way limiting scattered conversation because of their focused attention on the object (Bogers, 2014). Prototypes help users to discover their needs and add or change some attributes to the characteristic of the new product through objects (Terwiesch & Loch, 2004) that are seen as tangible or unfinished. The role of the designer in collaborative design changes focus from user centred to co-designing (Sanders, 2008) where users are active participants.

### 2.1 The Purpose of Prototyping

Prototyping has more recently become a central element in corporate innovation processes (Leonard & Rayport, 1997; Mascitelli, 2000; Schrage, 2000). Creating early versions of the design have an effect at all stages of the process from definition of the problem, to problem solving, and through manufacturing after customers provide feedback in order to improve the design, prototypes [should] always improve, until the last prototype, (Bogers, 2014). Refining products for manufacturing is not the only purpose of prototyping. Designs that modify behaviour by forming a relationship between designed objects and their user is also an important aspect. The process for creating prototypes and collecting user feedback requires the designer to understand the nuance of the user’s environment. Looking at the process of co-design where users transform into designer limits the input from those roles to concepts and functionality of the object. These roles fluctuate between the emphasis of designer and user (Fischer, 2002) however, they often favour the expertise of the participant. In the area of co-design little has been written about the roles of participants when user and designer are one in the same that requires any transformation is required.

Coughlan offers three objectives related to the purpose of prototyping: “building to think, learning faster by failing early, and giving permission to explore new behaviour” (Coughlan, 2007, p. 122). Prototypes also help researchers and designers empathize and communicate with people they hope to serve. (Scaletsky & Ruecker, 2014). In a similar way Scaletsky and Ruecker argue prototypes generate, communicate, test ideas and even build theory about ideas within three categories; developmental, experimental and provocative prototypes. To rephrase these purposes in terms of thinking, learning, and exploring we can identify the breadth of their function. To what degree then do we understand the reactions users provide or the depth they feel about the prototype?

### 2.2 Collaboration in Design Education through Prototyping

Teaching students to solve complex problems is one of the responsibilities of design education. Quick prototyping helps to build and test the initial ideas (Snyder, 2003) and break the complex problems to smaller ones. One of the features of collaboration in design education is prototyping. Exchanging information and communication through prototype helps to change design pedagogy. Collaboration between students and teachers in problem solving improves critical thinking and understand design process. Each individual participant shares the information and ideas to solve the problem (Chiu, 2002). Prototyping is a tool for communication between students and teachers to learn the process and express their ideas. Through collaboration both student and teacher build the prototype, then test it, changing the structure, function and material. If any of the prototypes fail make new ones and test them again until they fit the characteristic of the potential solution. This method is an Interactive iterative method with the possibility of quick fails and emerged the ideas by building and failing quickly.
Donald Schön in 1987 said, the main key of design collaboration is effective communication (Schön, 1987). An effective communication is a clear, accurate to the objective, proper response or feedback, understanding each other by knowing the main purpose of the message and easily express the ideas (Thompson, 2018). As we know prototyping use to express ideas (Cross, 1989), to interact designer and users (Warfel, 2009) through verbal and non-verbal communication, to exchange their ideas and feedback about a design problem and potential solutions (Derksen & Shafieyoun, 2018). Therefore, prototyping is a useful tool to create effective communication in design collaboration and it would be useful Constructivist approach in design education. Schön defines design as a contemplative conversation to use the constructivist view of human perception in design process (Schön, 1987). Collaborative design needs to share experience and understand the design restriction to develop the relevant solution.

3 Methods: Design Prototypes in Our Game - Co-design

The process for developing the Money Game emerged from iterative versions of prototypes. Four successive classes were dedicated to building a new prototype through playing the game and making changes to the game board, rules and the physical materials as needed. Each iteration was improved upon in the following class and following rounds of play. Our strategy for creating prototypes in this way was to build quickly but also to explore methods of participatory design where users closely collaborate with each other to design solutions. Participatory Design has been defined as, “a strong commitment to understanding practice, guided by the recognition that designing the technologies people use in their everyday activities shapes, in crucial ways, how those activities might be done” (Robertson and Simonsen, 2012, p. 05). The design classroom is uniquely suited in that students may fit the demographic profile of the game audience and at the same time has the advantage of understanding design principles. The professor’s role is facilitator of a process that encourages users/design student to ask the necessary questions of their ideas.

3.1 Levels of Engagement in Games

Chunking is a phenomenon in cognitive theory that suggests humans engage with the world at different levels and is something we do continually. The chunks transition across three level of brain function: the first level is conscious thought, then a level of integration, intuition and association, followed by the third level of adventure (Koster, 2013). Koster believes games or puzzles prompt the same problem-solving skills similar to learning to drive a car. New drivers are hyper aware of the car when they start, then form habits as they integrate an understanding of the physical world, followed by a confidence that motivates us to explore. Students learn to build prototypes in a similar way; initial interactions with the physical world and humans who use the prototype transforms into an intuition around how prototypes need to function.

At the second level of integration, intuition and association a dissonance is created by the students own understanding of games in general and their conscious thoughts of how an economics game should be played. Playing a game requires players to consciously think about their current standing in the game, their strategy for playing and the other players in the game to ensure they are playing by the rules, for example. Designing a game that currently does not have rules or physical structure engages our conscious attention to be focused on our preferences for chunked information rather than force new processes into established patterns. By reducing the cognitive effort from game logistics to defining simple motivations for playing was necessary to move students from their focused attention on logistics and trust their own game experience and intuition. Reminding students to create a game that did not reward acquisition and transference of values (trading acquired things) was enough of a guiding principle for them to begin.

The adventure level of chunking defined by Koster is exploration and probing motivated by the unknown. This level directly relates to prototyping from the design perspective of creating that which does not exist. A designer’s interest in discovering how users will interact with their ideas is central to the purpose of prototyping. However, we intentionally stalled this stage so that students would continue to think through game play for an economy game that used new values of choice and time. The differences between the game prototypes were large which also delayed reaching the third level of cognitive understanding and as a result the last level of exploration that required engagement from players we did not observe.

Game theory suggests that competition between players is the incentive and mechanism to keep the players engaged. Competitors make optimal choices so that the advantage is greater for themselves than their opponent even though cooperative play can advantage both players described by Merrill Flood and Melvin Dresher in the game strategy, prisoner’s dilemma (Dixit & Nalebuff, 2008). Incentives are bound to the notion that we can outsmart or outperform our opponents rather than cooperate to beat the game. In free market types of games cooperation is imperative, players find ways to become valuable to other players and join teams or contract to cooperate. It allows players to set
the value of objects based on a market rate instead of setting values provided by the game developers. For these reasons substituting values such as time and choice become less significant in the game scenario. The reward for playing is more appropriately determined by players.

### 3.2 Prototyping through Play

The role of designer as user violates basic tenets of usability according to Neilson/Norman Group (Neilson, 2008). It is possible however, to distinguish between user as designer and designing prototypes for users in recognizing the expert user profile. (Barcellini, Prost & Cerf, 2015). In this study the users should be considered novice even though they participate in the consumption of goods and services daily. The expert user would be someone who understands the concerns of the greater economy including supply and demand exchanges, inflation, and economic growth trends. The roles of the users in participatory design methods engage in the development at the conceptual stages of a project where input is organized by expertise and deep understanding among the complexity of a problem (Barcellini et al., 2015). Therefore, we would identify the students who designed the game as designers first, who understand many aspects of the user condition.

Students in this study collaborated in the design of the game, playing the role of co-designer as the game was being developed. Through discussion and consensus on the format of board game was determined among the students facilitated by the professors of the class. Objectives for playing emerged from game play that was guided by the economy without money concept and the use of time and choice as substitute values. Measuring time using a stopwatch was immediately adopted, which instigated discussions around urgency and decision making and the logistics of keeping time. Resulting paths on the game board were varied in length to delay or quicken one’s arrival to a point to make a choice.

Decision making and support for making the right decision reflected the students’ current choices. Because they were in school, decisions to take a path going to school seemed to confirm their real-life choices, as a type of public declaration that they made the right real-life decision. Rules as the function of the prototype created and tested the same time as testing the structure of the game. Knowing functionality of a rule was a reason to change it to another rule and test it again. Rules not only made based on the objective of the game but also to make the game more fun. Student and teacher created the game and play it at the same time and surprisingly they were excited to play the game and be the winner. Rules were created in different level of the game, the beginning, in the middle of the game and when they feel they learned the skills. It seems rules gave them some challenges and each step they tried to keep them balanced between challenges and skills.

### 4 Case Study

We proposed the idea of a world without money and replacing it with the values of choice and time. This type of world supported an economy that was not as tangible for the participants who struggled with a concept so abstract. The prototypes created during a collaboration between student and teacher. The first prototype was a simply drawn ellipse of cells, where each player will count off as they move around the board. The second prototype is a set of circles with different radii, cells sat on each radius to count from the roll of a dice. The game started at the centre and players selected any path to move along. The third prototype was similar to the second but included three circles and the fourth prototype increased in detail adding more objects to win in the circles. Improvements made from the quick hand drawn prototypes provoked more input from players in the structure and function of the game. Where later versions focused more on function and material content.

Eight senior and two junior students in Design at the University of Illinois at Urbana-Champaign participated in this study. They learned about prototyping through readings and discussion of 20 papers ranging in length. We discuss the structure of the alternative-to-money game as a group. Some of the students believed it would be a boring world without the motivation of money yet others found it impossible to conceive. We sketched the structure as we discussed the game to make it more tangible to see the potential using the prototype, even if all the details of the game had not been made clear. The result of the discussions gave the participants/players confidence that smaller aspects of the game could be tested using this method.

#### 4.1 First Prototype - Creating and Playing the Preliminary Game

All the prototypes had the same set of goals, which were developed in the first game. The first game also instigated many of the rules that were used in subsequent games (Figure 1). Players rolled one dice to move their piece around the board, landing on spaces that requested them to make choices usually implying lengths of time. Objects that were
simply acquired when landing on the square were later changed to be manufactured. The materials of the first prototype were limited to cars, homes, computers and cell phones, which split out as follows: cars (small, mid, large), house (1 bedroom, 2 bedrooms, 3 bedrooms), computer (tablet, desktop, laptop) and cell phones (bar, slide, smart). Item selection stops were created in a variety of cells on the board, and some of the cells stayed empty. Players seemed to change their cell phones and computers more than their cars and houses, which may be indicative of the participant’s age. Manufacturing included production and trade of commodities, but also added the unwanted behaviour of stockpiling goods. One player who had a number of cell phones could trade them for something else but if they did not make a trade, they could continue to produce more of them. A participant requested that cheating be an option in the game, they posed the scenario, “if I pretend my cell phone was lost or broken, I would have to produce another one”. Cheating was allowed in this way only to see what the effect would be on the game and no rules were added to disallow it.

Students seemed more excited about the world without money during prototype testing than before the game began. In the first prototype, players continued to perceive monetary value in their choices. For instance, they chose a 3-bedroom house because it has higher dollar value in their mind rather than a changed value based on need, for example. Changes in the rules of the game required a pre-written lifestyle to shift choices toward players’ needs. For example, if they decided to be homeless a house would not be one of their choices or options to trade.

**4.2 Second Prototype - New Choices in Harry Potter Game**

The second prototype focused on function and was based on the Harry Potter books to avoid the perceived dollar value of the first game (Figure 2). Material, the content of the game in this prototype was abstract or fantastical which was a harder valuation leading to a better result. In Harry Potter world they could choose their players characteristics such as ambitious, witty, brave, loyal. Some of the choices of commodities were books, brooms, familiars, robes, and cauldrons. Each player had a score sheet and when they reached five items of the same type they could manufacture or trade it. Discussion of the game created new rules during the play just as the first game. Objects were awarded by rolling a dice and landing on a cell with that object. Other than the main goals of the game players showed less excitement during the game than before play began. Without the perceived value of objects participants needed more motivation such as pre-planned goals or smaller achievements to make the game more fun. During the second prototype participants were merely collecting objects.
4.3 Third Prototype - Life Scenario

This prototype was more refined in its production, which changed the type of input from users (Figure 3). The focus shifted to strategy and brought back a more real-life scenario of acquiring cars and homes to observe the functional behaviour of rule constraints and strategy. Participants drew their player piece and selected a name for themselves. Goals such as, what type of job, education, car and house they wanted were documented before the start of the game. Similar to previous prototypes, the game rules emerged as it was played.

Additional materials such as furniture, types of relationships, pets etc were also winnable options. Participants started play by rolling a dice, some participants could reach their pre-planned goals where others gained more objects than they need, while others acquired less. Excitement the game was higher in this prototype but still needed more fun elements beyond acquiring objects. Levels of occupation varied in the number of cells for example to emulate real world scenarios of spending more time in college versus getting a job immediately after high school.

5 Conclusion

In this paper we discuss some options for substituting values for money as a basis for a new economy. The characteristics required for shifting values from money to anything else would take a catastrophic event however, prototyping an economy within a game environment helps to conceptualize such a world and identify the difficulties if implemented. Iterating through a number of prototypes during the conceptual stages of the game with designers who are also users of the economy provides immediate feedback and a unique opportunity to make changes as the game is played.

The process of designing and developing a game for users who are designers has the benefit of making changes while the game is evolving. The designer makes changes based on their understanding of roles and human behaviour. As a user, their focus is on the logistics and strategy of play within the constructs of incentives to find value. Time and choice in a sense, have values that are portable because they are ubiquitous and we would argue universally understood. The study does hint at the expert players interest to be adventurous and even distort and deviate from social norms similar to our current economic system.

The participants in this study formed strategies that still clung to the idea of accumulation of objects and signs of wealth or perceived need. Players expressed little interest in the games that provided little challenge to acquiring objects but at the same time were motivated to cheat just to acquire more objects to obtain more. These are early findings for our economic game prototype but they indicate how deeply ingrained our attachment to the economic system is but also indicates the possibilities for substituting values through the use of prototypes.

References

Prototyping a New Economy


Bibliography


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Teaching Wearables

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Abstract: Wearables is a novel area in education, products and production. This cross-domain field is interesting from a teaching point of view. Students must learn and succeed in different areas such as jewellery design, programming and prototyping. In this paper we present our planning and teaching of Wearables classes since 2014. The paper reveals some failures which we have learned from. However, the focus of the paper is on the success of wearables teaching. We reveal our recipe to teach this very versatile, novel and challenging subject. The spark we get from teaching wearables derives from its multidisciplinary qualities. Wearables does not necessarily fit any established domain, yet it has touchpoints in many. We have a mix of students from Jewellery Design and Computer Science in our classes. However, in this intersection lie many vital domains as jewellery, fashion, crafts, design, programming and electronics. Students with knowledge from these different domains worked in teams in our Wearables classes. In addition to having learned about their own domains, the students learned about user involvement in the design process, prototyping and pitching the concept.

Keywords: wearables; jewellery design; multidisciplinary teaching; intrinsic and extrinsic motivation; prototyping

1 Introduction

In this paper we explain our experiences in teaching wearables at Copenhagen School of Design and Technology (KEA), Denmark, since 2014. We also explain how teaching a class became the Wearables Lab, and to elaborate on our teaching methods, we illustrate our experiences with company collaboration cases which we applied in the classes.

Wearables is a novel multi-domain field which incorporates electronics embedded into objects worn on the body. They can be anything from jewellery to clothing. The term wearables derive from wearable technologies. On investigation of the semantics of the word technology, we found a definition of technology as anything man-made which helps humans in reaching their goals in everyday life. With this definition, any tool represents a piece of technology. If we match this term with wearability and body, we could claim that wearable technologies include well-established product categories such as glasses, watches, pocket watches, clothing and portable compasses. However, within the past few years, the term wearables have become established as specifically meaning electronics embedded in what we wear. Examples of products on the wearables market include fitness trackers, headsets and smart
Scholars have defined wearables in many ways. For example, Wallace (2007) discusses digital jewellery, Carpenter (2018) mentions smart meaningful jewellery devices, and also wearable health technology has been developed and discussed by many scholars, among them Møller (Møller, 2018). Koulidou studies (2018) digital jewellery augmenting intimacy, whereas Ahde (2008) discusses enhancing friendships or altering physical spaces with wearables (Ahde, 2009). Wearables can also be considered as extensions of the human body (Ugur, 2013). According to Ugur (2013), we can find a possible future for wearables as virtual extensions and implanted extensions, in addition to what wearables are now. Ugur (2013) argues that wearables can provide embodied emotional communication and that the physical limits of the human body have become more abstract with the incorporation of technology.

As currently most products on the wearables market have distinct gadgety design aesthetics, one aim of the Wearables class has been to encourage students to broaden the design space in this field. In our programme, we believe wearables design could have connotations closer to jewellery and fashion, as there are fundamental similarities between the electronics and jewellery domains. Both deal with extreme detailing, high precision, size constraints and precious conductive metals. Consequently, combining these similarities with wearability and the body seems apt. We have conducted four Wearables classes since 2014. The classes had slightly different settings with a lot of similarities. All Wearables classes discussed in this paper were taught at KEA. Most classes were taught to a mix of students from two domains, Jewellery, Technology and Business (JTB) and Computer Science (CS). In our opinion and experience, mixing students from different disciplines provides a good basis for innovative designs. However, teaching multidisciplinary classes can be challenging.

2 Background

While being unique, the JTB programme at KEA runs parallel to education in jewellery provided by other institutions. Historically in Scandinavia, a jewellers’ education was an apprenticeship complying with the apprentice-journeyman-master system. Later, traditional crafts or fine arts schools began providing jewellery education. Following this tradition of vocational education, some institutions started to offer curricula in jewellery as part of fashion education. This tradition is still dominant. Our programme was established at KEA in 2013 as a full-time study and has three main focus areas, jewellery design, technology and business. We are pioneers in providing jewellery education with this combination of subjects, as especially business did not previously play any large role in jewellery education. We distinct ourselves in combining all three main domains needed for succeeding in this field.

Considering the impact of new generations of younger and more tech-savvy jewellery wearers, and the potentials of near-term technological innovation, wearables cannot be disregarded as a future domain within the jewellery field. As an educational institution it is vital to anticipate this development and provide the students with skills matching the needs of the future labour market.

2.1 Wearables Teaching

We have been developing the Wearables class since 2014. The first three Wearable Technology classes in 2014-2016 were interdisciplinary collaborations in teams with a combination of JTB students and students from CS. The classes were the last module of 4th semester (15 ECTS points) and obligatory for the JTB students, but an elective module for the CS students. Wearables was the only class the JTB students had in these modules. In 2017 we did not teach the Wearable Technologies class due to curriculum development. We organised the class again in 2018 with alterations. This time taught at the 6th semester, the class was still obligatory, but took a full semester and was only for jewellery students. In teams, the students had a technical tutor, who was a professional helping them with practical electronics issues.

All classes culminated in a Jewellery of Tomorrow event arranged by the students themselves introducing their concepts to the public and the media. The 2015-2018 classes took place in collaboration with private companies. In 2015, the students collaborated with the Finnish extreme sports wearables brand, Suunto, in 2016, with the Danish high-tech development company, DELTA, and in 2018, with the Russian classical jewellery brand, Sokolov.

In the Wearables classes the teaching has been focused on the design process. In our experience, learning how to manage the design process itself has a greater impact on student learning than reaching for the perfect outcome of the product. In many cases students learn more from failure than from success. In our teaching approach, failure is seen partly as a success, as prototyping and iteration are important in the process of learning as well as in designing. It is a core aim to encourage the students to make use of iterative techniques – and if they fail to recognise opportunities for iteration, we guide them. In our Wearables classes we emphasize motivation, empathy, and multidisciplinary group work.
2.2 The Setting

Our teaching developed over the course of the classes. However, there are some similarities in all the classes, and teaching aspects that worked well were not changed: First, learning by doing was the main driver for the students to learn about electronics. Second, the wearables industry is developing so fast that teachers and students were learning at the same time. Collaboratively, we were all building new knowledge together. The new knowledge did not only flow from teacher to students but was generated on parallel levels. So, we have all been creating something special and new in the class.

Table 1. Content and outcome of the Wearable Technologies classes.

<table>
<thead>
<tr>
<th>Class</th>
<th>Topic of the class</th>
<th>Learning Goals</th>
<th>New areas in teaching</th>
<th>Design competition rewards</th>
<th>Outcomes of the class</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014 4th sem 10 weeks</td>
<td>The evolution of Interactive Jewellery</td>
<td>To learn how to run and handle an interdisciplinary project. To learn iterative design process (a-z). To learn to understand users and find their unrevealed needs. From idea to promotion. Two learn to combine jewellery and technology. To learn to produce and pitch a concept with a prototype.</td>
<td>The iterative design process was introduced for the first time to the students. User involvement in the design process. Using electronics in jewellery.</td>
<td>No competition</td>
<td>Working on high-end prototype of the design solution, Log Book (study diary) and Presentation Catalogue.</td>
</tr>
<tr>
<td>2015 4th sem 10 weeks</td>
<td>New magical jewellery concepts for the new target group.</td>
<td>To learn interdisciplinary teamwork. To learn to combine jewellery and technology. To understand a possible future of jewellery. To learn to produce and pitch a concept with a prototype.</td>
<td>3D printing in plastic and wax as well as using precision welding technology as part of prototyping and production. Using electronics in jewellery.</td>
<td>Products from Suunto for the winning team.</td>
<td>Working on high-end prototype of the design solution, Log Book (study diary) and Presentation Catalogue.</td>
</tr>
<tr>
<td>2016 4th sem 10 weeks</td>
<td>Meaningful jewellery devices without displays.</td>
<td>To learn interdisciplinary teamwork. To learn to combine jewellery and technology. To understand a possible future of jewellery. To learn to produce and pitch a concept with a prototype.</td>
<td>Using electronics in jewellery.</td>
<td>Consultation time with IdemoLab, DELTA, to get the project into commercial business.</td>
<td>Working on high-end prototype of the design solution, Log Book (study diary) and Presentation Catalogue.</td>
</tr>
</tbody>
</table>
Although the Wearables classes were successful, it was no smooth journey. In the wearables field we imagine products and product categories that do not yet exist on the market or, in some cases, not even conceptually. Teaching, learning, and indeed understanding something in a constant flow of change has been a challenge, for the teachers as well as the students. We managed to succeed in this by following the Design Thinking process (Brown, 2011). Since we were very open to failure, we learned a lot together with the students.

2.3 Introduction to wearables class
To create a development of learning for the JTB students we began wearable technology as a one-day introduction class in 2015. This formed part of the students’ Basic Materials course on their first semester. The students were given a brief history of wearables together with an introduction to electronic sketching with LittleBits or IdemoBits. By introducing wearables on the first semester the aim is to make the students ready to use electronics in their designs already before their main wearable technology class. This early introduction made it easier to motivate the students about the subject again on their 4th or 6th semester. Between their first semester and their own upcoming Wearable Technology class they watched the older students’ success with the Jewellery of Tomorrow event and the accompanying media exposure, which helped build anticipation.

The aim of our wearables teaching is to make the students view the products as pieces of jewellery rather than gadgets. This approach had an impact on the whole class from its planning to its execution. Typically, wearables are produced of plastics and silicone. In our class, however, we experimented with precious metals and other traditional jewellery materials. We also encouraged the use of traditional motifs, ornamentation, design, jewellery and body placement in the wearables design. Hence, we combined traditional jewellery with electronic components, to merge the jewellery into wearables.

![Figure 2. First semester students’ prototypes from introduction classes 2016 and 2018.](image-url)
On the one-day course on the first semester, the students fashioned a playful jewellery prototype with LED lights. They shared this on Facebook. Sharing their results on the social media created additional motivation. In many cases they did not only share the results with the class’ Facebook group but also with their friends. They were quite willing to expose their achievements in public. The playfulness of the experimental prototypes created in the introduction class is key for the students to get curious and interested in continuing in the field. The students used the prototypes to frame and discover possibilities in a new design space (Lim, Stolterman & Tenenberg, 2008).

3 Intrinsic Motivation vs Extrinsic Motivation

In this chapter, we illustrate pedagogical theories’ ideas for motivation and our application of them. First, we discuss intrinsic and extrinsic motivation, next, how the students’ various disciplinary backgrounds influenced their learning as part of their motivation. The discussion about intrinsic and extrinsic motivation follows Ryan and Deci’s approach (2000). Our experiences with the learning and motivation by students with various disciplinary backgrounds have been illuminated by Christiansen and Olsen (2006). In adherence with Prince and Felder (2006), we take the autonomy of our studies into consideration in the discourse of motivation and versatility of students’ disciplinary backgrounds.

3.1 Why and How to Motivate Students?

According to Ryan Deci, two types of motivation can be identified: intrinsic motivation and extrinsic motivation (2000). Intrinsic motivation refers to students wanting to do and accomplish something simply out of enjoyment, whereas extrinsic motivation refers to the motivation from desirable outcomes (financial gain, status, etc.). The process and the enjoyment of it are main factors in intrinsic motivation, and noticeable outcomes, like degree or grades, are the main factors in extrinsic motivation. Intrinsic motivation supports autonomy in the students’ own work. In this orientation, too many or too strict rules are not recommended, and the ownership of the project should lie with the students. They may feel pressured in accomplishing the project, but they also feel much more rewarded afterwards when having succeeded.

3.1.1 Intrinsic Motivation

Curiosity, positive experiences, exploration, having fun and playfulness are the thriving forces when intrinsically motivated students are to tackle challenges (Ryan & Deci, 2000). However, this behaviour doesn’t naturally arise in connection with every challenge the students have during their education. Therefore, we strive to create intrinsic motivation in the class. Sometimes, we see true extrinsic motivation with regard to topics the students find less interesting. In these cases, students participate in class just to get the needed ECTS points to be admitted to the semester exams. However, students can shift from extrinsic into intrinsic orientation. This can happen during a class when they gradually understand the relevance of the topic.

According to Ryan and Deci (2000), the task sometimes summons up the intrinsic motivation. In these cases, the student finds the task so interesting that the personal need for success makes the student enjoy tackling the assignment and solving the problem. Sometimes the satisfaction gained from doing the task drives the student’s motivation towards the intrinsic. So, according to Ryan and Deci (2000), the task must be either interesting enough to the students or their commitment to solve the task strong enough. However, the students’ focus lies on satisfying an innate psychological need to be motivated intrinsically (Ryan & Deci, 2000). In our study, we mixed these two approaches, satisfying the innate psychological needs and designing interesting tasks for students on the right level. This, quite often, requires tasks that are a little beyond their level of knowledge and ability to ensue. In our experience, tasks that are too easy may be boring to accomplish, and tasks that are too difficult will keep the students in the extrinsic orientation. So, it is important to find the middle way.

3.1.2 Case Suunto

Overall, the Wearables classes were beyond the basic knowledge level and were therefore not too easy for our students. In the 2015 class we collaborated with Suunto, a company producing high-end wearable extreme sports devices. Their current customer base was men doing extreme sports, but they wanted to investigate magical everyday concepts and products for the average woman. This shift in target groups, together with working with an inspiring company and having a novel subject of wearables triggered the students’ intrinsic motivation. The project also involved all three domains of the programme: designing jewellery, doing brand research to create concepts for a new target group and producing prototypes with craft skills and 3D technologies.
3.1.3 Case Sokolov
Another example is the 2018 class collaboration with Sokolov, a Russian jewellery company looking for opportunities in the wearables market. They wanted concepts and products for women using technology in their everyday life. For their final presentations of Sokolov, all groups produced 1) a functional, but large, rough prototype, 2) a non-functional prototype in true size and materials, and 3) complete branding and storytelling material.

![Image of hearing aids designed by Team Auris](image)

*Figure 3. Team Auris built their design idea on hearing aids. They redesigned the function and looked for women needing to control sound in their everyday life. (Winner of the 2018 project).*

On their 6th semester, the students have just returned from their internship period, and have already started specialising in the direction they want to go, so some of our students did not have much motivation to design wearables. For some groups, the burden of working with electronics and programming posed too great a challenge, restricting them in their approach to brainstorming and prototyping. Other groups were demoralised after their first encounters with the target group, who didn’t seem to want any more technology gadgets, and became focused on the negative aspects of technology, thus demotivating themselves in the design process. Their negative outlook made it difficult for them to work with their technical tutor, and they were less open to learn about technology. However, several groups’ motivation grew towards designing wearables after they had had talks with the tutors and been on a field trip to Technological Institute of Denmark, where they experimented with electronic prototyping and got feedback from experts.

The project was most successful for the students with intrinsic motivation, who got along with the way their expert taught them electronics. It was especially successful for those who based their idea on already existing technology. Building on existing technology made them freer in their brainstorming and prototyping, which motivated them to experiment with all aspects of ideation and wearables.

3.1.4 Autonomy vs. Control
We have been keen on applying discovery learning in teaching (Prince & Felder, 2006). In this approach, students get a problem to solve and they work independently to find suitable solutions. According to our experience this is the most suitable approach when students work with iterative processes. As Prince & Felder emphasize: “In the purest form of this method, teachers set the problems and provide feedback on the students efforts but do not direct or guide those efforts.” (Prince & Felder, 2006, p. 89). The main add-on for Prince and Felder’s approach is that in teaching wearables the tasks, i.e. design challenges, are developed in collaboration with the company. Thus, it is not just the school providing the design challenge.

In many cases, the projects are also done in a competitive setting and the collaborating company will reward the winning team. The involvement of an actual professional network inspires students to perform with higher ambition.
Also, the competitive setting encourages team members to collaborate, resulting in more independent teams. All this enables the discovery teaching. Students are ready to work with getting feedback in coherent teams and they strive to discover. According to our experience with wearables teaching, teams compete in their ability for discovery.

Ryan and Deci (2000) discuss autonomy versus control in the learning process. They argue that overly controlled students lose their initiative to learn, especially in complex, conceptual and creative assignments. They also consider the greater intrinsic motivation, curiosity and desire for higher education: the challenge appearing when students have autonomy in their work (Ryan & Deci, 2000). We have found it a very gratifying approach to give the autonomy of the progress to the students in these complex, very conceptually creative classes. Likewise, the students have expressed their enjoyment of the autonomy given to them in the class.

The greatest benefit of the autonomy approach in teaching is that the feedback the students get is truly personal for each team, and they can also receive support in the issues they are tackling at each stage when they occur. Nevertheless, it is best for this approach that the teacher can provide direct constructive feedback. The teacher can also express curiosity towards each project without harming the other teams. If a team needs further challenges or assistance, the teacher can adjust their level of expectation. We use this to push the students to break their own boundaries. As students also learn from each other’s feedback, they have common presentation days of the progress for the entire class. During these sessions, each team gets feedback from the teacher and from the rest of the students in the class. On the last presentation day, they get feedback from a company representative. These presentation days work as touch down points for the whole structure of the classes.

### 3.2 Design Thinking

The Design Thinking process is a six-phase iterative design process where user involvement plays an important role (Brown, 2011). The first three phases are learning phases and the last three phases are the designing phases.

Each wearables project on the 4th and 6th semesters is based on the human-centred design process and substantial user studies to find the unmet needs of the users. This is an interesting part of the learning since the students are often tackling products and product categories that are completely new to the users who may have no previous experience with the type of solutions that the students are creating. Therefore, user involvement is crucial throughout the entire process. Each project starts with understanding the users and ends with testing the prototypes with the users. In the 4th semester classes we introduced Design Probes (Mattelmäki, 2006), where the students send tasks to chosen focus group members to complete individually and send back to the students. Already familiar with Design Probes, the 6th semester students were introduced to Say, Do and Make tool sessions (Sanders & Stappers, 2013) where the students use focus groups as co-designers. Both methods were implemented in the early stages of their prototyping.

We start the wearables classes with explaining what wearables and electronics are, and then we introduce the Design Brief which is formulated together with the company we collaborate with. The students start with user observation and research. When they have ideas of concepts early, they start electronic sketching with LittleBits or IdemoBits which they later use for testing their ideas with the users. The sketching and testing phases are iterated with quick

![Figure 4. Testing the idea with electronic sketching in 2018.](image-url)
prototypes and user testing until the students find the right solution. In the last phase, they produce the final design and present a prototype together with supporting materials, such as presentation catalogues and displays.

We have learned that once students have a tangible idea of the concept, they should start sketching it. We encourage electronic sketching instead of prototyping in the early phases, since we have experienced that the sooner the students have an even semi-functional sketch of the idea they are testing, the better results they get. Having a functioning model also makes it easier for the students to explain their idea to their research participants and for the team to discuss and develop the concept further. This is especially important in a field where the focus is on innovative and novel product categories. The more concrete the presentation of the idea is, the easier it is to progress for the students. Since the way we teach wearables follows the Design Thinking process, most of the teaching is guidance and feedback. The students themselves have the responsibility of conducting relevant background research and delivering the results. This approach to teaching emphasizes the importance of student autonomy. Consequently, the more project autonomy the team has, the better are their chances of success.

3.3 User Research within Teaching Wearables
We have learned that it is not useful to ask the potential users what kind of wearables they would like to have in the future. The students posed this question in the 2018 class and found that there was no need for wearables. The users felt that they were already too busy with their existing technology (mainly SoMe on smartphone). We see that asking such a straight question raises a paradox. Users are likely to get confused and in denial because they cannot imagine a need for something they do not yet know about.

Instead of asking what kind of wearables people would like to have in the future, we should focus on observing their need in a holistic view and analyse the findings with technology and wearables in mind. Also, we have learned that it is particularly important to believe in the designer’s instinct and start the production of electronic sketches of the ideas as soon as possible (Cross, 1982). With tangible presentations of the concepts we can go back to the users and ask how they would see themselves interacting with such a new idea, technology, or piece of wearables. We used this approach in the first classes, but in 2018 we expected that wearables would already be familiar enough as a product for the students to conduct more straight forward user inquiries. However, we learned that the users did not yet possess the readiness.

<table>
<thead>
<tr>
<th>Class</th>
<th>Topic of the Class</th>
<th>Design Thinking</th>
<th>Motivation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014 4th sem (10 weeks)</td>
<td>Evolution of Interactive Jewellery</td>
<td>- Observations - Probe Kits - Experimental and developmental prototyping – both digital and analogue.</td>
<td>Intrinsic: - Discovering a new market where they can use their existing knowledge. - Playful and experimental aspects of electronic prototyping. - Interdisciplinary collaborations Extrinsic: - Obligatory course ECTS points</td>
</tr>
<tr>
<td>2015 4th sem (10 weeks)</td>
<td>New magical jewellery concepts for new target group. (Suunto)</td>
<td>- Observations - Probe Kits - Provocative, experimental and developmental prototyping – both electronic and analogue.</td>
<td>Intrinsic: - Discovering a new market where they can use their existing knowledge. - Playful and experimental aspects of electronic prototyping. - Interdisciplinary collaborations - Competition Extrinsic: - Obligatory course ECTS points</td>
</tr>
<tr>
<td>2016 4th sem (10 weeks)</td>
<td>Meaningful jewellery devices without displays. (DELTA)</td>
<td>- Observations - Probe Kits - Provocative, experimental and developmental prototyping – both digital and analogue.</td>
<td>Intrinsic: - Discovering a new market where they can use their existing knowledge. - Playful and experimental aspects of electronic prototyping. - Interdisciplinary collaborations - Competition Extrinsic: - Obligatory course ECTS points</td>
</tr>
</tbody>
</table>
Everyday You - wearables for the tech savvy woman. (Sokolov)

- Observation
  - Say, Do, Make Tools
  - Provocative, experimental and developmental prototyping – both digital and analogue.

- Intrinsic:
  - Discovering a new market where they can use their existing knowledge.
  - Playful and experimental aspects of electronic prototyping.
  - Support from, and lectures by technological tutors.
  - Feedback from digital experts.
  - Competition

- Extrinsic:
  - Obligatory course
  - ECTS points
  - Obligatory to write an article about wearables.

4 Analysis

Our experience is that Bachelor level students are quite mature and independent learners. However, there is a need for a clear structure and instructions from the educators. We have learned that the more mixed the student group is, the more innovative results they can achieve, given a suitably challenging problem. When everyone in the team is outside their comfort zone, they can perform on a level where no-one is afraid of failure, and success to innovate is the only option. This requires a lot of guidance and support from the teacher.

A cross-domain collaboration can provide vast opportunities for both students and teachers as all parties can learn from each other. They do not only gain actual skills and professional knowledge, but also benefit from the experience of different styles of learning and teaching, as well as learning from each other’s working routines and practices. We can create a fruitful base for innovation with teams of students on different backgrounds, skills, and knowledge. Also, according to our experience, better results can be expected when the students have the surroundings to work and contribute equally.

There are differences in the readiness of the students in the different domains (JTB and CS). The differences within the student groups should be taken into consideration when planning and running close collaboration with students with different learning styles and backgrounds. Due to the cross-domain issues faced in the three first classes we decided to try a new setting. In the 2018 class we provided a tutor with knowledge of electronics for each group. These experts were teachers and assistants from other domains at our school. They took the responsibility to help the groups find the possibilities of the electronics, and they helped building the electronics part in their final prototypes. The extrinsically motivated teams with low interest in wearables and electronics had some difficulties in communicating with their expert, as they had a different view of wearables. It worked better for the intrinsically motivated teams, who were excited about the wearables project, and they were able to communicate well with their expert. However, the next class will again be planned for cross-domain student groups, as this creates valuable learning for all the students.

5 Conclusion

The main purpose of teaching wearables is to provide the students with readiness to succeed in the wearables field, which is expected to employ 1.5 million people (in the US) within the next few years (Adecco, 2016). This will also change the prospects of future job descriptions, both within jewellery and fashion. This is one of the fastest growing technology markets right now. With wearables teaching we are acting on the future demand on the labour market.

We established a Wearables Lab after the first three years of pilot classes in wearables teaching. We wanted to provide the students with opportunities and easier access to applying knowledge of how to produce and implement wearables. The 2018 class was provided by the lab.

We have learned to learn in situations, and to learn from the students when teaching wearables. Consequently, for us teaching is not only giving and sharing knowledge, but also receiving knowledge and insight. It is also about experimenting with electronic sketches quickly, so both students and users can grasp the vast possibilities of the wearable technology. It has been a great learning process to manage and develop the classes over the years. The classes were somewhat similar, but pedagogically they were built differently. We tested different teaching styles and settings and took the learning further. We ascertained that motivation is a key factor when students are learning about wearables, regardless of the programme they are studying or their background. The main learning however, has
been for us to understand that this constantly evolving domain will require continuous learning for teachers as well as for students. Teachers obtain fruitful learning together with the students when exploring new opportunities.

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References


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A Gestalt Approach to Teaching and Learning by Prototyping

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Abstract: This paper describes a teaching approach used at both Politecnico di Milano, Department of Design and the University of Cincinnati, College of Design, Architecture, Art, and Planning. In this teaching approach, students learn about furniture and product design by prototyping a full-size working prototype, in tandem and with the integration of other design methods, in order to better see and learn - underscoring the Gestalt idea: The whole is greater than the sum of its parts. Different kinds of prototypes are used throughout the design process to verify, as touchstones, every step of the product’s development, providing feedback and suggestions according to shape, function and usability. The paper intends to underline the importance of the prototype in the process of creating artifacts as a practical feasibility of the concept, along with a palette of designers’ tools including sketching, drawing, 3D modelling and 3D printing.

Keywords: learning by prototyping; furniture design; product design; design method; making

1 Introduction

Practice is, first and foremost, a process by which we can experience the world and our engagement with it as meaningful. (Wenger, 1998, p. 51)

Since ancient times, we get to know things surrounding us through engaged actions and practical experiences that bond us together. As Heidegger pointed out, these interactions cause the uncovering of meaning in the world (Dourish, 2001, pp. 129, 177). Then, it can be stated that human sense-making, understanding and learning are not ideal processes based on self-contained structures –the Platonic Hyperuranion– yet, they are defined in a strict relationship with actional contexts (Hanks, 1991, p. 15). As a matter of fact, from a gnoseological point of view, physicality is fundamental in our lives. Through our body we touch, feel, and ultimately know objects and spaces in the physical world (Hornecker, 2011, p. 21). Moreover, referring to bodily experiences does not imply focusing only on sight. On the contrary, we are made of “eyes in the head on the shoulders of a body that gets about” (Gibson, 1979, p. 222), which means that we perceive our surroundings through all of our senses that, in turn, trigger multiple insights.
For instance, “touching something fires a whole battery of sensors and nerves; we feel resistance, temperature, surface quality, softness, weight, and more” (Hornecker, 2011, p. 21) and all the pieces of information deriving from our different senses finally merge into the whole, providing meaning, awareness, experience, performance, pleasure, affect, emotion, persuasion, etc. (Kaptelinin & Nardi, 2009, p. 253).

In the contemporary scenario, action and embodiment seem to lead Human-Centered Design and UX research in a holistic way (Forlizzi & Battarbee, 2004; Hassenzahl & Tractinsky, 2006; Väänänen-Vainio-Mattila, Roto, & Hassenzahl, 2008; Hassenzahl, 2008, 2011). Therefore, education should be informed by these notions and students need to acquire their skills by actually engaging in a concrete process, no more being provided with exclusively abstract knowledge, for them to reapply in later and also intangible contexts (Hanks, 1991, p. 14). As Dourish outlined in the context of HCI – but in a way that can be transposed to any field of design – building active representations can induce learning, facilitating the exploration of abstract ideas and relationships through a physical procedure (Dourish, 2001, p. 163), which, in design disciplines, is represented by prototyping, here intended as the activity of building physical full-size models throughout the design process.

The on-line Merriam-Webster Dictionary defines the word prototype as: “a first full-scale and usually functional form of a new type or design of a construction” and, additionally, “a prototype is something that serves as a model or inspiration for those that come later” (“Prototype | Definition of Prototype by Merriam-Webster,” n.d.). Thus, making a prototype is a way to foresee, to perceive, to study, and to learn about an object or space (typically at full size). But also, as a verb, it implies the idea of projecting (hurling forward) concepts and enabling discourse by seeing, experiencing, and reflecting – enhancing one’s understanding about interaction, presence, characteristics, and quality of the object and/or space. According to Scaletsky et al., (2014) the act of designing represents a projection in time, throwing the designer forward, to build something that did not exist. It is a way of generating knowledge through a process of learning by experiencing and by doing. From prototyping, designers can get information to “empathize with the people and their living conditions” (Scaletsky et al., 2014, p. 3084).

Then, prototyping allows one to uncover issues in the design (Dourish, 2001, p. 145), as it happens directly in the physical world (Dourish, 2001, p. 153). Consequently, it is central to design, and learning to work within this venue, early in the process, is critically important to a design-based education, as it may serve well as a pedagogical tool. During the iterative process that characterizes prototyping, it is already possible to assess the final design qualities, thus problematic issues can be exploited to explore new paths towards new solution directions. In particular, with its incompleteness, prototypes reveal parts of the final ideas and, therefore, only parts of their qualities. For this reason, the competence involved in prototyping is the skill to build prototypes that are able to filter the qualities the designer wants to examine and explore. (Lim, Stolterman & Tenenberg, 2008)

Nonetheless, currently, if students in studios, labs or seminars are called to design a furniture piece (or system), they typically spend a great amount of time in drawing and digital modelling, while they often prototype their ideas at full-size only at the end of the creative process, to affirm and present solutions rather than explore or refine design-inquiry. Usually, that happens because of the efforts, related costs, and time involved.

The advent of computer graphics, 3D software, and rapid prototyping has completely changed the concept of modelling. In professional practice, models used to be made in wood or resin with a long and very difficult process, they were finished by hand, or redone when the result was not satisfying. Nowadays, the whole process has taken a different path, making the waste-time and the discontinuity in the design process disappear. The possibility of personally managing the entire process eliminates the pause-time between the realization of the design and the delivery of the prototype to the companies: that mandatory suspension and sedimentation of the idea is now spread in the flow of a non-stop design process, which proceeds for continuous revisions, corrections, and adjustments. Certainly today, having the possibility to send files directly to the prototyping laboratory, time is better managed and there is little downtime. Moreover, with modelling software, every slightest variation can be assessed, which was actually impossible in the traditional resin or wooden model method. Three-dimensional digital forms lead to a reversed working approach: designers now see, evaluate, discuss, compare, and choose defining and subsequently refining the result. Undoubtedly, there is less room for questions and explorations – that the obligatory time of waiting entailed – and it seems that answers almost come before questions.

Yet, real and correct perception begins with what is experienced, and not just expected (Dourish, 2001, p. 21), may it be from a drawing or digital 3D model. As the Compasso d’Oro-awarded Makio Hasuike affirms, most of his work as a designer is defined out of this (Ceconello, 2015, p. 60) and, in general, it is only through a direct interaction with artifacts that one can create, manipulate, and share meaning (Dourish, 2001, p. 126). As categorized by Lim et al.
(2008), the reasons why prototypes are used cover: (i) evaluation and testing; (ii) the understanding of user experience, needs, and values; (iii) idea generation; and (iv) communication among designers.

Starting from these premises, the contribution aims at proposing a Gestalt, phenomenology-based approach for furniture design, to be applied in an academic context. In particular, it refers to the course of Furniture Design (Prototyping Furniture Seminar) ARCH7036-004, University of Cincinnati (2018-19), which shares the same principles of Final Synthesis Design Studio, Product Design, Politecnico di Milano (2017-2018) and Smart and Interaction Design Seminar, Politecnico di Milano (2017-2018). According to Gestalt principles, learning is efficiently encouraged when the instruction is related to real life experiences (David, 2015), therefore, the purpose of the courses is to introduce prototyping from the beginning of the design process, then integrating a study-through-making approach with complementary activities (such as sketching, drawing, detailing, and analysing). The process results in a broad spectrum of linear and integrated assignments designed to nurture and strengthen the output. Such a teaching method, more often than not, results in whole project solutions that, on a number of levels, are greater than the sum of their parts. Students firstly need to manage the project in its entirety, rather than broken up into parts (Ehrenfels, 1937, p. 521). The alignment of specific design assignments, occurring in tandem with making an array of prototypes, results in clarification and refinement of the design intent through the process of integrating theory, utility, aesthetics, materiality, careful detailing, fabrication methods, resource allocation, human use and interaction, text descriptions, the delineation of plan, elevation and section, computer modelling, social and spatial context definition, etc.

A broad range of ideas will fuel the process of designing and fabricating a working prototype of a furniture or product. Initial studies that generally involve sketching, might also involve the study-through-making process (i.e., a model or fabricating a rough full-size working-prototype of a furniture piece or furniture system) in order to explore and test initial design ideas. Following efforts can involve developing a set of drawings for the project, in order to see and understand details of the design.

2 Methodology

It is often too great a challenge to begin with a complete and comprehensive picture of a resolved design idea already set in mind. Rather, a better approach is to begin with a partial view and work inductively to generate an integrated whole out of the sum of the parts. Yet, in the proposed approach, a series of working prototypes is the preferred pedagogy to the course, and specific assignments give focus and resolution to the different parts of the entire project.

In order to introduce a hands-on approach as a common design practice that helps furniture or product design students to always have a contact with an integrated whole –comprehending more information than the same object divided into separated pieces– an academic methodology has been developed. The Furniture Design Seminar at the University of Cincinnati, in fact, presents a prototype-based learning approach, which focus is to make students understand the value of physical experimentations on the entirety of their projected items, instead of considering them in a multi-faceted way, e.g. through sketches. It develops on a 15-week semester and its final result is the design of a piece of furniture or product, as stated, utilizing a phenomenological approach. Throughout the design process, students are free in decisional aspects and time management, while they are guided in following a precise methodology –highlighting the importance of early building of prototypes– through precise indications and assignments, as well as with a theoretical support.

Firstly, students are asked to define the object of their design exploration. They have no constraints in that, and they can get inspiration from anywhere: precedents, life-style uses, trend forecasting, or personal intuition. As the initial stages of the design process can be daunting and dispersive, students are supported by readings and lecture presentations, introducing a wide-ranging body of knowledge on the subject of furniture design. This body of knowledge helps them to open their minds and comprehend a broad range of furniture designers’ works and working methods; processes for designing furniture; taxonomies and typologies; anthropometries and ergonomic theories; interrelations between disciplines and companies; regional and global trends; professional practice considerations, marketing, branding, and promotion; materials and fabrication procedures involved in making (manufacturing and production); regional, national and international venues for furniture design, including, exhibits, tradeshows and museums. Moreover, since students tend to point at general-use situations, leaving their field of enquiry too wide, some activities are planned in this phase to help them find a direction towards a more punctual specificity of their projects. For instance, they are introduced to theories and practical examples in class as well as through field trips. At the beginning, the course is intended to encourage the limitation of the scope of the initial concept to something relatively simple, so that later students can (i) keep the design, material palette, and fabrication effort focused as they
develop complexity into the furniture design, and (ii) concentrate on prototyping as a central part of the design process and the final outcome.

As a matter of fact, what is fundamental in this educational method, is to rapidly build upon ideas, focusing on pre-production prototyping. On that purpose, five assignments are subsequently required. In the first assignment, the prototype is akin to a thought-experiment, an idea-generator, or a vehicle for testing design-ideas. Only after an initial and rough prototype is made—usually by the third week of class—a full-size, working prototype of the furniture design piece has to be fabricated (assignment B) working closely with one another, faculty and staff in the workshop and prototype lab. Throughout those phases, students must make important early decisions, considering utility, social-use and spatial context, along with performance, and fabrication of the furniture or product, until they get to a few carefully articulate ideas that should govern the project development to its completion. Then, to increasingly implement their reasoning about the items, they also have to take in consideration the bodily dimension (assignment C). Finally, students begin to work through simultaneous phased assignments, including sketching, drawing, writing and defining specifics about the furniture project, to return, at the end, to the finalization of their prototype (assignments D-E). From these assignments, which are better defined in the following paragraphs, it emerges that the direct embodiment of concepts into prototypes denotes a form of participative status for students in the design process. In fact, things are embedded in the world and reality depends on their being embedded (Dourish, 2001, p. 18).

3 Assignments & Descriptions

As previously explained, full scale or scaled model studies, made early in the process, should serve to explore and test design ideas rather than solely presenting design solutions. That is the reason why students are supported in their practical investigation by a series of assignments that, at once, give perspective and enrich designing operations.

3.1 Assignment A: Prototyping

Simultaneous with clarifying the design intent and considering issues of utility, social, and spatial context, students are invited to build rough prototypes, in order to initially explore size and form parameters for their project. This initial work should be made using a limited material palette (i.e., wood, cardboard, foam, metal, fabric, plastic, etc.). Then, through a series of follow-up assignments and in-class lessons, students should develop and resolve the design, the material palette, functionality, joinery, and workmanship to a schematic-level resolution. At the end of this initial phase, the first-pass prototype (Figure 1) will be presented to the class for discussion, encouraging others to see it, experience it, and critique it. At this stage, students have to understand the importance of seeking inputs and reactions from everyone.

![Figure 1. Prototype as ideas tester and generator (Fourth year student in the Furniture Program, DIS, 2005).](image)

3.2 Assignment B: Modelling the Idea at Scale

Following the initial effort to develop a rough working prototype, students will increase their effort by completing a second prototype iteration (Figure 2), improving the initial working-prototype at every level possible. They will focus on a particular aspect of the piece (detail inquiry) or may consider making a scaled model to further their investigation and design direction (scale 1:4). This phase is particularly important to experiment with materials and intentionally
integrate the materials into the piece to affect its performance, durability, or interactive qualities. Material suggestions may include lumber, veneer or ply material, metal rod, tube or sheet, plastic, or anything else.

Figure 2. Second prototype iteration: testing the plasticity of an edge profile - Furniture Seminar, University of Miami (Dickerson, 2009).

3.3 Assignment C: Anthropometric Studies

Our body affects our experience of things, changing our viewpoint on them, in terms of what they allow, suggest or prohibit (Hornecker, 2011, p. 22). This is the main topic of the assignment C. Assignment C is designed to guide efforts in observing and documenting people’s interactions and use of furniture/products at full scale, underlining that material objects are often described by the enactment of a particular human activity (Kaptelinin & Nardi, 2009, pp. 240-241). Using white Kraft, corrugated cardboard, or bond paper taped together and any media to draw with, students shall produce a drawing of their product: plan and elevation – aligned and composed on one sheet, with appropriate line quality and weight– integrating as many body postures as they can think about, to provide a wide scenario of possible utilizations of their project (Figure 3). The aim is to communicate spatial and physical dimensions, behaviours and use in 1:1 scale reconstruction. For further realism, the plan shall be viewed directly on the floor and the elevation on a vertical surface, so that the sheet has to be folded along the seam where the floor meets the vertical partition.

This phase is particularly important, since we are accustomed to interpret spatial qualities in relation to our own body, and that attains psychological meaning (Hornecker, 2011, p. 21). Therefore, evaluating one’s project in relationship with human body and behaviours also informs the product sense-making.

Figure 3. Human body integrated in an object plan and elevation - Anthropometric Study (Sambuco, 2017).
3.4 Assignment D: Design Documentation – Drawings and Text

While students are working on fabricating a final working-prototype outside of class-time, they are asked to produce a finely delineated set of materials to document their design graphically (Figure 4). Indeed, design is about communication, it has to persuade audiences of its utility and social value. From this, the designer’s argumentative ability is measured (Buchanan, 1989, p. 111; Kolko, 2011, p. 53). Additionally, describing a piece can have enormous benefit in a generative perspective. For instance, giving a title can serve to bind and underscore the content within the piece. It is also the case that most furniture pieces, like books, have titles.

Assignment D is composed of—at least—a five-sheet document including: the title of the furniture design and other basic information; a reference image (this may be a sketch or photograph); a text describing the general background description, functional information of the design, its intended purpose, cultural considerations and context—which is indeed essential as artifacts are the product of cultural needs and they are transformed by culture and society providing incentives, guidance and constraints (Kaptelinin & Nardi, 2009, pp. 61, 248); technical information (weight, material(s), finish, production process, dimensions, cost, and formal description); a constructive critique; measured scaled drawings in plan, elevation, and section carefully rendered (by either hand or computer); one exploded axonometric showing all significant components of the furniture; and a final rendering of the situated furniture piece showing both use and spatial context. The idea is to create a single image that communicates the spatial context (time and place), use, purpose, and design qualities of the piece: we are spatial beings, therefore, while presenting a design, we cannot escape spatiality (Hornecker, 2011, p. 21).

4 Results

The most tangible outcome of the presented approach is that the idea immediately acquires a physical dimension. This path highlights several aspects that cannot be seen on paper, thus requiring an early 3D, physical materialization
is not only a constraint, but also a stimulus for the design process. In addition, early materialization enables one to better consider weight, lateral forces, and human scale relations in the design process.

Then, directly working with the prototype forces students to keep the design simple versus simplistic and strive to make the design complex rather than complicated, focusing the inquiry on one primary idea, or point of departure, as a place to begin and refer to during the project development. Subsequently, some considerations may follow. What components and variables should be present in the next iteration? And how might the organization of the parts contribute to the understanding of the whole? What ideas can result when considering use, comfort, surfaces, construction specifications, materials, finishes, and details? These are only some examples of the natural questioning approach that affect students dealing with direct prototyping in person, hence stimulating their reasoning and problem-solving skills. In addition, interesting conclusions or correlations can become relatively easy to detect when design ideas are experienced. But, in order to result in something that others can experience, students will need to focus and work within strict limitations of their resources, knowledge of various technologies, and time.

Below, results more strictly related to each assignment are highlighted.

**4.1 Assignment A**

In assignment A, students begin designing and fabricating a rough furniture prototype, and explore initial design ideas at full scale. Making a full-size working prototype helps students consider form, size, scale, structure, use, and the reality of their design. They can rapidly visualize ways a person can sit, ways things can be displayed or organized, ways activities can be supported, or ways materials can be joined. Requiring a rough, working prototypes throws students into the practice of furniture design, to engage theory, fabrication, workmanship issues, structure, and utility. The process generates a body of knowledge that designers need to consider in designing furniture. In addition, as initial fabrication efforts need not be of high craft or workmanship, but rather produced out of a relatively simple and easy-to-work media (corrugated cardboard, reclaimed wood or scrap metal) from which, the results can be useful in provoking further development or individual inquiry and class discussion on several aspects of furniture design. In this way, assignment A stimulates a formal direction of inquiry for the furniture piece.

**4.2 Assignment B**

In order to create a worthwhile working prototype, several factors must be taken in consideration. This is the utmost relevance of this assignment. While developing their prototype, students strongly increase their awareness and skills about different design issues. For instance: if the product has to support the human body, one can think about ways to sit in or on it, or rather, lean into it. If it is to organize or display things, those things should be included with the prototype. If the piece is to support an activity or use – then the necessary equipment or components – such as a chair with a desk or a place setting with a dining table might be included within the prototype. At the same time, issues of durability, comfort, sustainability, fabrication, joinery, and many more aspects should be considered in the early stages of the design process as well.

**4.3 Assignment C**

Forcing students to confront their product with the human body quite in the middle of the design process has double consequences. On the one hand, they can set their design up, free from common practices and expectations –a risk that Norman and Verganti (2014) warn about in the field of User Centred Interaction, as it can get designers stuck into present solutions– on the other hand, it does not bring them too far from physical reality, in a parallel dimension only made of aesthetics and abstract functions. Furthermore, 1:1 scaled drawings and –especially– prototypes facilitate the reasoning and elaboration of alternatives in human behaviour, as students do not have to make almost any effort of imagination.

**4.4 Assignment D**

This assignment, which demands the most usual materials of design documentation, is the proof that the physical model serves to better understand the drawing. Prototypes in cardboard or polystyrene or other materials, support better comprehension and reflections on a product, and this has a significant impact on the quality of drawings. Moreover, the three-dimensionality of objects may foster additional characteristics that 2-dimensional design methods may ignore, like shadows and perspectives. Finally, it highlights the importance of products communication: an object can provide information about sitting behaviours, modalities, movements and at the same time it can be considered for its colour, shape, line weight, material deflection, support, joinery and more, along with other design elements that will affect the experience and degree of success of the design.
5 Discussion

Seeing, touching and making mistakes are the fundamental components of a correct design practice, as Isao Hosoe stated, and they all are experienced in design by prototyping. (Ceconello, 2015, p. 57).

Prototypes are intricately intertwined with the evolution of design ideas throughout the design process. [They are useful for the designer to] evaluate and reflect on the values of what they design—if those designs are socially responsible, economically viable, experientially pleasing, culturally sound, operationally usable, technologically compatible, and functionally error-free. These are some of the important values that designers try to satisfy. Throughout the design process, prototypes are what manifest the design thinking process to reach such design outcomes (Lim et al., 2008, p. 8).

A designer obviously has a strong propensity to experiment with the project, contemplating aspects that go beyond its dimensions (which are always, and in any case, infused by the drawing) letting himself be guided by a sensory nature. Touch, textures, smells, etc. enrich his/her work and this type of sensory response only increases the number of elements at stake when (s)he has to grasp the right moment and the right way to connect them together. In addition, prototypes (especially in Product Design) communicate several perceptual aspects, like size, weight, shape, texture, etc. In this way, also functions can be envisioned. Thus, taking into account also the context of use of the future product, “nearly every feature related to embodiment” (Scaletsky et al., 2014, p. 3089). Yet, just referring to a bidimensional or virtual reality —as common practices (based on sketches and 3D models) require— may be deceiving, while dealing with something physical and situated in the same dimension actually facilitate the creative process as a pedagogical tool. The use of scaled or full-size study models help in an immediate and unmediated way in the understanding of the formal and visual characteristics of an object or space, training the mind to be in connection with the hands and verifying through the prototype the sensitivity to shape and proportions. The continuous comparison between the two dimensions and the three dimensions enriches the awareness and sharpens the receptivity on objects and spaces (Piardi, 2011, p. 8).

Common within one’s design teaching experience, the model is primarily a tool for the final presentation of the project while, during the design and concept development phase, students use only 3D sketches or computer modelling software. Yet, the use of the model is fundamental —though often overlooked— and it is a powerful and, at the same time, pleasant tool in a design approach. It can generate points of departure and verification, but also stimulate creativity. Hands are often the basis of the first formal elaborations of a design product: hands can gesture, hands can draw and hands can model. Despite the introduction of digital technologies and virtual mock-ups, physical modelling remains an irreplaceable tool for the dimensional definition of the project and for the immediate verification of hypotheses. On the other side, as pointed out by Lim et al. (2008), designing and constructing prototypes is a time and resources consuming process, which makes it difficult for students to really evaluate the importance of this tool in relation to the efforts it requires.

Though, collectively, the assignments, and the constraints built into each of them, enable students to learn core-content and knowledge about furniture design and fabrication methods. In designing and realizing a furniture prototype, students gain a substantial level of understanding about design, production, and physical implications. Through the furniture assignments, students learn about ergonomics, part-to-whole relationships, human use, structure, detail, and materials. While, through traditional representational assignments, they acquire awareness of the role that each method has in relationship with the product itself, and of the importance of different means of communication.

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From Observing Beans to Serving the Elderly: Prototyping Medication Administration for the Elderly in Hong Kong

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Abstract: Ageing has become an important social issue and the concept of age-friendly city is increasingly advocated around the world, as we attempt to design information and social services that are accessible and comprehensible for the elderly. On the contrary to this trend, there is a design-related problem in Hong Kong’s medicine services that have long led to poor performance in medication administration for the elderly. In response to this issue, our design students were required to develop a series of prototypes from the users’ perspectives that centred around redesigning medicine labels and enhancing positive experience in medication administration for the elderly. However, it becomes challenging for design students who have a developed designer-centric mind-set but little experience in designing for older people. In this project, students need to be taught to reach beyond an emphasis on beautifying design and to bring end-users to the centre of the design development process. With no prior experience in user-centred design or training in observation skills, students were first motivated to raise their level of curiosity and sensitivity towards objects and people around, through the simple, easy and intriguing observational exercise of documenting the lifespan of beans. Throughout the 13-week course period, they conducted user tests with the elderly users and have learned how to pay close attention to their subtle gestures and expressions. Students finally verified the optimal medicine label designs and developed final prototypes with compelling solutions towards medication administration for senior citizens.

Keywords: ageing; observation; prototyping; medication administration; user-centred design

1 Background

The ageing population is drastically growing and has become a global issue in the 21st century. In response to the challenges of growing ageing population, the World Health Organization (WHO, 2007) advocated the concept of ‘age-friendly city’, which aims to provide facilities and social services that are accessible and comprehensible for the elderly. However, WHO states that one of the common challenges in communicating with senior citizens lies in the visual presentation of information. In Hong Kong, it has been observed that a major field in which related issues are commonly experienced in the daily life of senior citizens is that of health and medical services.
1.1 On Medicine Label Regulations in Hong Kong

Medicine labels in Hong Kong, as they are in many advanced cities, are controlled by government regulations. Starting 1st January 1995, the prescription of medicine and relevant information must be presented on the respective drug bags or medicine bottles distributed to patients, who can find on the label medicinal information, including: name of the medicine, regimen, dose, patient name, date of dispensing, clinic or hospital name, special instructions and so on. The aim of the presentation of information is to instruct patients on taking each medicine appropriately.

According to Provision No. 22 (5) of the chapter 138A Pharmacy and Poisons Ordinance in Hong Kong, “the medicine shall be clearly labelled with instructions for use in English and in Chinese”; Provision No. 38A (1) states that “no person shall sell or supply any medicine unless it is labelled with particulars printed so as to be clearly legible in English and Chinese, as to dosage and the route and frequency of administration”. However, the ordinance does not provide further elaboration on how to achieve satisfactory levels of legibility and accessibility. Such lack of detailed guidelines in the ordinance, in relation to the fact that poor legibility and accessibility can lead to preventable medication errors such as overdosing, incorrect drug use, and overlooking of side effects, forms the basis for this inquiry into medication administration in Hong Kong.

1.2 Problems in Medication Administration

A study titled Preventing Medication Errors (Aspden, Wolcott, Bootman & Cronenwett, 2007), issued by the Institute of Medicine of the National Academics in the United States, indicates that preventable medication errors cause harm to 1.5 million people every year and amount to at least $3.5 billion in extra medical costs for the treatment of drug error-related injuries. In addition, the Journal of American Medical Association (Lucian et al., 1995) states that 39% of medication errors occur during the prescription process; 12% during transcription at the pharmacy; 11% during compounding at the pharmacy, and 39% during the administration process on the patient’s part. It can therefore be suggested that by bringing improvement to the communicating of instructions for medication administration, service providers should be able to reduce preventable medication errors caused by patients by a considerable extent.

In fact, the potential of harmful impact linked to problematic medicine labels has been well documented. A local periodic bulletin about medication incidents released by the Hospital Authority—the Medication Incidents Reporting Programme Bulletin (MIRPB)—issued a Medication Errors Index in 2009 that put wrong label information at top place amongst the Top 3 Most Common Dispensing Errors, at 26%. This was followed by wrong strength dosage (21%) and wrong drug (19%) (Hospital Authority, 2010). According to data from the MIRPB’s 2004 issue, the number of recorded medication incidents in the Bulletin had increased dramatically from 8,106 in 1994 to 18,349 in years 2003/04. In between 1998 and 2003, 71 mislabelling incidents were recorded, along with 240 similar drug name/appearance and 913 failure in communication incidents (Hospital Authority, 2004).

While official data linking label or otherwise medication-related design to medication errors is still quite limited as of the present, the above data carries certain conceivable implications, possibly including illegibility in prescription, inadequacy in communication, incorrect/confusing dosage or drug information, among others. These problems, largely centred around the presentation and understanding of crucial information, might be indirectly connected with usability and accessibility issues arising from medication-related design. Given the amount and variety of medication elderly patients often have to deal with on daily basis, there is little doubt that mistakes and inappropriate intake of medicine would be a prevalent phenomenon among senior users. Studying such issues from a design perspective—in relation to realistic user behaviour—is therefore a much-needed initiative that could bring valuable impact to a prominent aspect of elderly living, as well as a fitting learning opportunity for students being trained to be socially conscious designers. The following sections present in detail the two courses that have been developed with a focus on the above matters, and elaborate on examples of student work created in response to the project brief.

2 The Course and Project Brief

2.1 User Study Seminar and Information Studio

Both User Study Seminar and Information Studio are level-three core subjects in the undergraduate programme offered for third-year Communication Design students at the School of Design of The Hong Kong Polytechnic University. No similar subjects are offered in the first two years relating to user-centred design and the context of healthcare. Courses taught in the first two foundation years put an emphasis on communication design principles and two-dimensional related visual presentation, with topics such as poster design, publication design, and typography. In other words, students at the target level have no prior experience in conducting user tests and developing series of prototypes based on observation and feedback from intended users.
About twenty design students attended both courses, User Study Seminar and Information Studio, and were given the objective to develop a design solution in healthcare for the elderly. In the first class, students formed groups of four or three. The relevant issues of medication errors were addressed in class, and students were able to recognize current problems in medication administration for the elderly. They were aware that instead of simply fulfilling requirements in a school assignment, their design would respond to social concerns as well as improve the ways in which medicine information is presented, read, and understood, in a meaningful manner. Students would be expected to learn to take usability and accessibility into consideration for all users, particularly for the elderly.

2.2 The Project Brief

It is established that design-related problems found in Hong Kong’s medicine services have long led to poor performances in medication administration. The project created in response to such phenomena was aimed at raising public awareness of ageing-related problems in Hong Kong, and promoting an ageing-friendly community in the city that would embrace an accessible and enjoyable lifestyle for senior citizens. The project also provided a solid, hands-on experience for students to learn about user-centred design and observation within a genuine social context, the needs in which are an essential and expanding part of design in today’s healthcare and wellbeing services. While students in a more conventional training course would have developed design solutions from personal points-of-view, the intended users in this case (elderly users of medical service) were invited to join in the user test processes as participants, they provided valuable feedback and evaluation for the iterative prototypes that students developed throughout the entire process. Armed with 13-week experience of user studies and observation sessions, students successfully generated novel concepts to examine and better the currently prevalent user experience in medication administration for elderly service users.

2.3 Eligible Elderly Group

The project objective was to meet the needs of elderly users of medical services. Students were required to present prototypes to, and generate feedback from, a group of eligible intended users. The Hong Kong Census and Statistics Department classifies people aged 65 and above as elderly; for the purpose of the project, eligible participants were not only within the specified age group, but also possessed basic literacy. This was to ensure that they all had a base level of ability to read and process information presented on the prototypes. Eligible participants could wear glasses when necessary, but had to have no visual impairment otherwise.

3 Methods

To build up a skill foundation and appropriate mind-set for user-centred design, students were trained in conducting basic qualitative research, using methods such as observation, home visits, interviews, and card sorting. Such methods enabled students to understand user perspectives in a more comprehensive manner, and to develop and evaluate design solutions accordingly.

3.1 Observation

Observation is an ethnographic method which requires attentive looking and deep understanding of what the intended audiences are doing, what tools they are using, and how they make sense of their world (Kuniavsky, 2003; Crabtree, Rouncefield & Tolmie, 2012; Hanington & Martin, 2012). Although observation is a basic research tool, it is quite powerful in the sense that it enables design students to see beyond their preconceptions and immerse themselves in the world of others. Being able to identify people’s needs gives students the capacity to translate them into meaningful design opportunities.

In order for students to recognize observation as an important research tool, and to practice observation skills with clear objectives, the course instructed students to plant more than 10 beans at home as part of their first assignment. This observational task required students to document the lifespan of their beans throughout the 13-week course period. The growth of beans would change over time according to a number of factors, thus the documentation was divided into two parts: internal changes and external interferences. The former recorded data such as the growth of beans, number of leaves, size of leaves, changes in colour and directions of plant growth, etc. The latter documented any interference from external or environmental factors such as weather, sunlight, and insects, etc. Students were asked to carefully observe the beans on a daily basis and present a weekly report on social media regarding the observation results (Figure 1). This assignment was useful in nurturing students to develop observational curiosity and to pay close attention to elderly users’ subtle gestures and expressions as they conducted user tests with design prototypes.
3.2 Home Visits

Home is a private place where is seen by ethnographers as a key research site where daily mundane activities people are lived out (Pink, Mackley & Moroşanu, 2017). In contrast to do observation in laboratory, people perform naturally at their familiar home. Since errors in medication administration are known to be more likely to occur at users’ living spaces, for example at home or at elderly care facilities, students in the course were encouraged to carry out home visits and observation sessions on-site. Visiting the homes of intended users provided an opportunity for students to observe medicine-related behaviour of elderly patients in a context that is natural and familiar to them (Figure 2). For instance, it was possible for students to observe minute environmental details such as whether medicine would be placed in the kitchen or on the dining table.

By observing realistic user behaviour on-site, students also developed an understanding of the overall transformative process that translates medicine information into user actions (Figure 3). Throughout the observation sessions, students came to understand more closely and realise the specific needs of the senior group. They also learned to rigorously investigate each step of the medication administration process in order to identify and analyse existing problems. As the design development progressed, prototype tests were carried out in centres for local senior citizens operating in different districts.
3.3 Testing Materials

All students were given a detailed tutorial on conducting usability tests combined with user research. One of the major research methods explored during the course was card-sorting, which provided students with a framework to understand how (and whether) elderly users made sense of groups of information, as well as which categories of information presented on medicine labels is being received first. Taking accumulated data from the card-sorting exercise, students then organised it using a tabular format for detailed analysis. One of the groups, for instance, came to the suggestion that certain types of information, such as that about hospital names and durations of intake, were not as important or relevant for senior users; in contrast, they found that instructions for dosage and names of patients should be displayed to stand out against other information. The prototypes proposed by students at this stage had the objective of inviting further and deeper discussion surrounding specific needs and actions. They also provided test participants with clear variations that could be compared easily, based on their impressions of how accessible, satisfactory, effective, and efficient each prototype appeared to be. It should be noted that each participant was presented with prototypes in individual sessions, so that they could react naturally without potentially influencing one another in a group setting. Each elderly participant was required to rate various prototypes on a Likert scale from 5 (strongly agree) to 1 (strongly disagree). Students also recorded their response times of each of the assigned tasks completed. After collecting data, students input all data into spreadsheet for further analysis and synthesis. The initial findings were employed for the improvement of prototypes in the next round of user tests.

By the conclusion of the course, each group of students had to complete no less than three different usability tests, and in each case prototypes needed to be tested individually with six to eight elderly participants. Participants were invited to react to the prototypes and perform intake of medication (by pretending to use the device or product for their daily medicine). In follow-up segments, students gathered user feedback and ask specific questions to gauge the participants’ reception and understanding of the presented information. For example, they would ask which part of the label showed dosage, or how many pills were meant to be taken according to the instructions. During this process, participant responses of all types relevant to the search, reading, usage, memorization, and comprehension of medicinal information were coded into material for analysis; students’ subsequent modifications would be informed by the participants’ accurate and inaccurate responses. After receiving feedback, students would further iterate the prototypes, document them, and present them in the following usability test session.

4 Students’ Prototypes of Medication Administration

Following a series of observation and prototype testing sessions over the course period of 13 weeks, students were required to submit by the end a proposed final prototype which would respond to the intended users’ analysed needs. A variety of positive design attributes essential to the medication administration experience— including security, safety, reliability, respectability, and enjoyment— had to be considered and factored into the final solution. The design of these prototypes was not restricted in any particular manner, meaning that students were free to propose any varied means of administering medicine, provided they were solidly developed from participant feedback and from usability test-generated insights.
Furthermore, the students’ design decisions were informed by a deliberate consideration of context, which created a range of valuable impact to their prototypes and presentation of information. Through on-site observation in home visits and usability tests, students were able to gather supplemental insights into the way seniors are used to managing routine medicine intake, usually on their own at home and without assistance. Such contextual insights guided students towards design decisions with a focus on presenting information to minimize user anxiety over self-caused medicinal mistakes. The following sections show a selection of student prototypes developed for this project.

4.1 Medicine Label Prototypes with High Legibility

In this example, one of the student groups examined a range of differently sized and shaped medicine containers (from bottles to ointment cases) with a focus on spatial arrangement. Working with the different sizes in mind, they attempted to pick out the most important information and rearrange its structure in order to achieve maximum clarity, developing a system that would work consistently throughout the set of varied and limited surfaces. As they received user feedback from the usability test sessions, the students made further developments accordingly, displaying the medicine names more prominently and applying a yellow background to the section for a spotlight effect. After iteration, patients’ names were purposefully displayed with a relatively small font, which allowed the design to direct user attention to more relevant information (Figure 4).

![Figure 4](image)

Figure 4. Students finalized and applied typographic settings and cueing across a range of different-sized medicine containers. Even on a surface as small as an ointment container, the label could still be read clearly by the seniors. Students: Matthew Yung, Sinyi Lau and Charlotte Li

4.2 MediReminder

Another group of students even developed a more far-reaching prototype based on insights generated from their home visit observations, proposing a re-invented experience of medication administration for the elderly population. Their concept of the MediReminder was to combine a water bottle with a medicine container (Figure 5). During the home visits, students made the observation that many seniors would perform regular activities outside of their homes, such as doctor appointments, visits to their children, yoga sessions at the Folk Centre, or jogs at the park, etc.; they often needed to bring an assortment of medicine along with other personal belongings when going out.

Regarding their concept of introducing this new experience of medication administration, the students explained that Based on the findings from observation, the elderly cannot take their medicines on time because of two main reasons: they are either simply being forgetful or they sometimes have not brought the medicine with them when being outside from home. Thus, a set of reminders, MediReminder, is designed to facilitate the elderly’s medicine-taking practices in both cases [sic].

In this MediReminder prototype, both the water bottle and the medicine container lid work as a set of reminders for users to administer medicine on time. The design attempted to integrate the intake of water with that of medicine—since drinking water is usually an essential step of taking medicine—thusly creating a convenient routine experience
From Observing Beans to Serving the Elderly: Prototyping Medication Administration for the Elderly in Hong Kong

that is integrated into users' existing lifestyles. In terms of design context, the compact water bottle in the prototype was designed for outdoor activities; the small yet sufficient capacity for medicine storage within the bottle was also created to minimize carrying burden for elderly users. The top lid was designed for daily use; it includes a medicine container and instructions that could remind the users to take medicine on time when they pick up the bottle to drink water.

Figure 5. The concept of the MediReminder design presents an all-in-one medication administration experience, with a product that senior users can bring along during outdoor or social activities throughout the day, wherever they might go. Students: Chung Ka Yin, Chau Tsz Wai, Mak Chun Hin and Ho Sze Wai Joyce.

4.3 MediUtensils

Based on findings from a series of user tests and observation, this group found that it was an extremely common phenomenon for elderly patients to easily forget about taking medicine and treatments on time, due to deterioration of memory in old age. The students stated that “their forgetfulness even makes them frustration [sic]”. Through close observation of the intended users’ behaviour in taking medicine, the group also identified other sources of frustration. For example, they realized that the elderly often found it difficult to cut their pills in half, as was necessary in certain cases, or to measure out precise dosage or portions, as they did not have standardized medicinal spoons with indication marks at home.

The concept of MediUtensils was to integrate design for medicine administration with a positive experience, through solving the common problem of users failing to take their medicine on time. A set of tableware prototypes were designed based on the Chinese-style or traditional-style eating utensils widely used in homes of the elderly (Figure 6). In the new design, a pill pictogram is pre-printed on the bottom of the bowl, which reveals itself once the bowl is emptied, serving the function of reminding the user to take medicine after a meal is finished, as is required in most
cases. The spoon was designed with an indicator of liquid level to signify an appropriate measurement of dosage; the indicator is coloured for increased clarity and visibility. The tops of the chopsticks were designed to assist users in halving pills effectively. As an experience-centred design solution, this set of tableware design serves both as a reminder and supporting device for elderly users’ daily medicine intake, by making use of objects that are already familiar and essential in their lifestyle, all integrated into a natural and comfortable setting at home.

Figure 6. MediUtensils is a set of traditional Chinese style tableware designed to assist the elderly in using correct dosages of medicine, as well as to remind users to take their medication on time. Students: Fan Shui Lun, To Kam Chi, Yeung Yan Yi and Shuen Po Chi.

5 Conclusion

Instead of having students experience only learning by listening, as the popular expression goes, the notion of learning by prototyping delivers even more in design education. Such pedagogical strategy could contribute considerably towards the promotion of a curious and motivated mind-set, as well as the facilities for self-discovery and self-initiated learning. Through entering and becoming immersed in their target users’ actual lives, in this case even in their living spaces, students gain crucial perspective that in turn helps them experience the power of empathy.

Norman (1988) proclaimed in his acclaimed The Design of Everyday Things that, in order for designers to make something or some information more accessible and understandable, there is a need to minimize the rift between the models of the design and the user.

In the User Study Seminar and Information Studio project, in which students worked with the Hospital Authority’s medicine label design, we find the example of learning by prototyping that involved close collaboration with the target audience, in this case, a group of elderly users of medical services that had genuine and significant concerns. Through the course of design development in the project, students had experienced and realised gradually the indispensability of observation as a research tool. Thorough and systematic observation has the power of piercing through presumptions and guiding students towards identifying shared patterns throughout human needs and behaviour; student-generated insights stemming from such shared needs could in turn be transformed into meaningful and impactful design opportunities.

Apart from observation and user tests, students had also learned through extensive experience more about research methods, interview skills, usability testing, documentation, and data analysis, throughout the 13-week project. As a
result, students in this course not only emerged with an improved user experience for elderly-oriented medication administration, but had also come to understand the correlations between knowing-thy-audience, contexts of use, and form and content, all of which contribute to the enhanced legibility and accessibility of information and design for the target audience.

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References


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Progressive Prototyping for the Design of Spatial-Number Sense Tools

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Abstract: While several design studies have used prototypes as test-instruments to validate the success or failure of design outcomes, only a few have touched upon the role of prototypes as learning agents for a designer during the design process. Prototypes, according to these latter studies, are considered more than mere evaluation tools; they are the means by which designers organically and evolutionarily learn, discover, generate, refine, and communicate their design ideas. This study attempts to enumerate such roles of prototypes during an iterative prototyping process adopted for the design of spatial-based learning tools to fostering number sense in young children. The designer has employed the process of prototyping as a vehicle for inquiry during the design of these tools. The study revealed that the features of a prototype that designers decide to retain or filter during each iteration cycle, enable them to traverse the design space, besides acting as a decisive factor for the success of the prototype. The study also illustrated the pivotal role of both the users and the prototypes in shaping the designer’s thinking process. Based on this, some of the known models of prototypes are also revisited to be more inclusive of users.

Keywords: prototyping; filtering dimensions; action research; number sense; spatial visualization

1 Introduction

Prototypes and the process of prototyping are crucial pillars of any design process. They are vehicles for communicating a designer’s ideas, instruments for refining existing ideas, and a catalyst for novel ones (Lim, Stolterman & Tenenberg, 2008; Matthews & Wensveen, 2015). In the field of design research and practice, they have played a spectrum of roles including—testing a concept or design, gathering stakeholder’s needs, identifying design issues (Camburn, Viswanathan, Linsey, Anderson, Jensen, Crawford, Otto & Wood, 2017), and problem definition and ideation (Deininger, Daly, Sienko & Lee, 2017). According to Gero (1990), a design prototype is a conceptual schema for representing a class of generalized heterogeneous grouping of elements derived from similar design cases that initiate and maintain continuity in a design. Prototypes are also proposed to be ‘filters that traverse a design space’ and ‘manifestations of design ideas that concretize and externalize conceptual ideas’ (Lim et al., 2008).
Noting their significant contribution, several design researchers have focused on the taxonomy of prototypes based on their fidelity (Lim, Pangam, Periyasami & Aneja, 2006), uses in design or developmental process (Lichter et al., 1994), or on representations and manifestations of design ideas (Lim et al., 2008). Houde and Hill (1997) proposed to triangulate the dimensions of a prototype (Figure 1) into Role, Look and Feel, and Implementation, at the intersection of which Integration emerges. Role prototypes refer to the purpose or function of an artefact, Look and feel prototypes denote the visceral aspects of the representation, Implementation prototypes connote the techniques and components required to achieve the function, and Integration prototypes reflect the complete user experience of an artifact (Houde & Hill, 1997). Houde and Hill deliberately drew the triangle askew to emphasize that all dimensions are equally significant in a prototype as well as in prototyping.

Matthews and Wensveen (2015), have further categorized prototypes as an experimental component, a means of inquiry, a research archetype, and as a vehicle for inquiry. In the first three cases, research is driven by or conducted through the prototype, and in the fourth, the process of prototyping is the vehicle for inquiry. While a number of studies have focused on research-driven by or conducted through the prototype, only a few have illustrated the process of prototyping as the vehicle for inquiry (Matthews & Wensveen, 2015), or illustrated the designer’s action of designing (Camburn et al., 2017) or the iterative construction of the artefact (Matthews & Wensveen, 2015; Lim et al., 2008). After all, prototypes are more than mere evaluation tools- they are the means by which designers organically and evolutionarily learn, discover, generate, and refine designs (Lim et al., 2008). Arguably, even though the practice of prototyping, as a means of inquiry often receives the least attention as a research contribution, often in design practice and research, prototyping plays a significant role in directing the exploration and development of the solution (Matthews & Wensveen, 2015). Hence, this study sought to contribute to the existing knowledge in the field of research by considering prototypes as vehicles of research; that is, the possibility of examining the prototyping process as both the method and the object of research (Matthews & Wensveen, 2015).

This study was conducted in the context of an educational design project in which the designer (in this case the authors) explored the design of learning manipulatives to enhance the Number Sense (from here on, NS) of young students. It is only a part of a much larger doctoral study (of the first author) on designing spatial tools for scaffolding NS. The presentation of this work is a somewhat refined version of the otherwise messy process that occurs behind the scenes. This paper is an interim juncture within the scope of the larger doctoral inquiry and has its own failings; nevertheless, it allows the authors to critically inquire into their own journey of prototyping.

2 The Design Project- Designing of Spatial Manipulatives for Scaffolding NS

Before elaborating upon the prototypes and the process of prototyping, it is essential to briefly introduce the design problem on which the research inquiry is based.

Number Sense development is considered the foundation for all higher-level mathematics, and a lack of it has been stated as the cause for student’s poor performance in higher mathematics (Jordan, Glutting & Ramineni, 2010; Boaler, 2015). The literature of Mathematical cognition and mathematics education defines NS in myriad ways (Berch, 2005). However, this study interprets NS as an ability to be fluent with numbers as defined by Twomey Fosnot and Dolk (2001). That is, knowing how a number can be composed and decomposed and using that information to be flexible and efficient with solving problems (Boaler, 2015). For example, knowing 25 is composed of 20 and 5 or two 10s and a 5.
Studies have established that the ability of Spatial Visualisation (from here on SV) is closely linked to the improvement of early NS (Nes, 2009; Cheng, 2012). It is the skill of building and manipulating mental representations of two- and three-dimensional objects and perceiving an object from different perspectives (NCTM, 2000, p. 41). It primarily consists of the mental rotation (MR) which is the ability to visualize how an object might look like when rotated in 2D or 3D space (NCTM, 2000).

While SV can be enhanced in several ways, symmetry-based training has shown to immensely improve the SV of young students (Davis, 2015). However, despite these theoretical evidences and established facts that use of manipulatives improves the math performance of students (Ahmed, Jeavons & Oldknow, 2004), there is a dearth of explicit teaching instructions and educational aids that are consciously designed based on the correlation of these specific spatial and math abilities (Ontario Ministry of Education, 2014; Davis, 2015). While the literature does display spatial tools such as Hundreds board systems, base 10 blocks, Number rods, etc., and activities with Dot cards, Dominos, Hundred squares (Swan & White, 2006; Bobis, 2008), etc., these primarily focus on building of mental representations and not so much on their mental manipulation. On the other hand, tools such as tangrams and construction blocks like Legos (Nes & Eerde, 2010), do foster mental manipulation, but it is not linked to NS. Moreover, most existing tools spatialize only the ‘numerical magnitude’ aspect of numbers while maintaining the ‘visual number form’ (Kadosh & Dowker, 2015), i.e., the numeral representation of a number. For example, a number rod for the number 2, represents its magnitude aspect by its length, and visual aspect by the numeral 2 itself, printed on the rod as shown in Figure 2 (Montessori Primary Guide, 2019).

![Figure 2. Number rods](image)

Therefore, this study proposed to explore the prototyping process as a vehicle for inquiry through the design of spatial visualization-based learning tools for fostering NS. This was done by

- Spatializing numbers in terms of both quantity and the visual number form through geometric shapes, and
- Stimulating mental manipulation (particularly mental rotation) of students through the designed tool.

3 The Research Method

The systematic, iterative prototyping process was documented, analyzed, and reflected upon through the action research method (Kemmis & McTaggart, 2005). The research contribution of the study was not tied not to the artefact itself as much as to how the artefact was crafted (Matthews & Wensveen, 2015).

The study was conducted with eight preschool students aged between (4-4.5-year-old) at the Redbird Kindergarten School, Nankari village, Kanpur, Uttar Pradesh in India. The students here hailed from a lower socio-economic stratum with little or no possibility of gaining knowledge through additional tuitions. The school is based on an experimental ideology and adopts unconventional pedagogy. Hence, the Principal, teachers, as well as the parents, were willingly open to try the use of novel manipulatives in the curriculum. As described by the school Principal and teachers, the students had recently learned numbers up till forty, by mostly counting and numeral identification. However, the concept of quantity was still not clear, and number composition and decomposition were completely unfamiliar. This proved fertile ground to introduce numbers as spatial entities to the students before they were trained in a different worldview of numbers.

Requisite permissions from the Principal as well as the parents were taken in a parent-teacher meeting, where the author was a special invite. To maintain the privacy of the subjects, names have been altered and faces masked in the photographs.
4 The Prototyping Process

4.1 Action-Cycle 1: The Number-Strip Prototype

4.1.1 Plan
In the lack of any specific and definite leads towards the problem solution, Action-Cycle 1 began with no particular direction and resulted into a prototype of just about any idea that correlated the two main variables of the design problem- numbers and spatial comprehension. The authors hoped that the failure or success of the prototype would indicate a direction to the problem-solving. This action cycle was a gamble, however, planning, and later making of the prototypes assisted the authors to simply bind the overwhelming and inconsistent concept generation phase into something concrete. The early phases of prototyping were unstructured, free-flowing, inconsistent, and stretching towards multiple directions. Everything seemed a possibility; however, the authors had no clue of its feasibility or its impact on the users. Hence, the authors began the exploration of integrating numbers with spatial competency, with the simplest possible concept of representing each number by a geometric shape, say a square. That is a 1 can be equivalent to a single square; consequently, a 2, which is nothing but 1+1, can then be represented by composing (constituting) two squares.

Consequently, in this concept, the quantity of a number is equivalent to the number of squares, and the visual number form, that is, the numeral of a number is represented by the rectangular shape formed by the unique composition of these squares. Numbers can then be composed or decomposed by each set of square-shapes in relation with other square shapes.

4.1.2 Action
The authors created colorful number stripes out of paper to externalize the above plan. Easily printable and simple to cut at right-angles, these number stripes were uncomplicated to print and replicate. The stripes were colour-coded for each number, with a 2mm gap between two squares. For instance,

1= a single square of red colour

2= a blue rectangle formed by two squares

3= a yellow rectangle formed by three squares

Therefore, the quantity of number 3 was equivalent to three yellow squares in the spatial domain. More importantly, 3 could be composed of in terms of various other smaller number strip combinations. For instance,

3 = 1+1+1 is equivalent to 3 single squares

3=2+1 is equivalent to two blue squares and a single red square

‘3’ can also be represented as a single yellow rectangle to represent three as a whole

This way, the authors were able to compose various numbers with combinations of other number stripes, as shown in Figure 3.
4.1.3 Reflect
The designer created these coloured stripes for numbers 1-15. However, while constructing various numbers, recall of numbers through colours and size proved difficult and confusing. The prototype worked well when the stripes were visually and tangibly available for manipulations; however, in the absence of the physical product, mental recall of the spatial numbers did not succeed as holding the mental image of the number was difficult. The tool also lacked in providing affordance for mental rotation plausibly because, with every increase in numerical value, the shape or orientation of the prototype remained unaffected. A new number was nothing but another rectangle only with an increased length. Thus, the stripe prototype successfully exemplified a numerical value but not the spatial character of the value. Therefore, the designer sought to explore more ideas which correlated the visual number form of a number with a shape instead of colour.

4.2 Action-Cycle 2: The Tree Fractal Prototype

4.2.1 Plan
The previous prototype was incomplete and interim. Nevertheless, it gave a cue to the designer to shift focus from colours onto shapes. Diversifying concept generation within the same category, that is Mathematics, the designer explored several spatial concepts such as fractals, geometry, and trigonometry. Unlike the previous cycle, Action-Cycle 2 was more goal-oriented and structured. Upon exploration, the designer learned that fractals are self-similar patterns created by repeating a simple pattern over and over again (Barnsley, 2014). That is, a simple pattern can be considered as the fundamental building block of the entire fractal. This is analogous to considering the number 1, as the building block of the infinite number system. Fractals also give rise to new patterns after every level, opening up the possibility of creating diverse shapes for every new number, which the previous Number-strip prototype lacked.

4.2.2 Action
While investigating different kinds of fractals, the designer stumbled upon the Tree fractal. Similar to the deconstruction of a number into its smaller number constituents, a Tree fractal contained a repeating pattern of tree branches splitting into smaller ones. The designer explored this analogy by experimenting with the decomposition of the number 100 (represented by the rectangular shape) in the form of a Tree-fractal, as shown in Figure 4.

Figure 4. The Tree fractal prototype- decomposition of hundred

While using the analogy, the designer could not use the source of the analogy as-is but had to transform it a little to fit design problems. The branching at every stage was supposed to occur with the branches splitting into two smaller
Ekta SURENDER, Koumudi PATIL

ones of equal areas. However, the designer split the areas unequally to enable to show decomposition in terms of all possible smaller number combinations.

The designer constructed several combinations of numbers, composed and decomposed in terms of other smaller numbers. For instance, Figure 5 shows a few of the possible compositions of 8.

![Figure 5. Various numerical and spatial compositions of eight](image)

4.2.3 Reflect

The Tree fractals represented numbers as nested, interconnected, and composing or decomposing of other numbers. They are flat and easy to replicate through 2D colour printing in any school. Despite several efforts, while constructing numbers with the Tree-fractal prototype, the same problem of unique visual number form as in Action-Cycle 1 resurfaced. The same number could be perceived in different shapes in a Tree-fractal, but the similarity between some spatial visualizations was very close. For instance, the two combinations- 5+3 and 4+3 for 8 and 7, respectively, were visually similar because the rectangles of 4 and 5 differed negligibly in their areas, as shown in Figure 6. This again increased the dependency on colour instead of shape to identify a number.

![Figure 6. Tree fractal representation for 5+3=8 and 4+3=7](image)

The fractals spatialized numbers better than the Number-strips prototype. However, they were still unable to construct a unique visual number form to facilitate identification and recall of a numerical value.

4.3 Action-Cycle 3: The Tessellation Prototype

4.3.1 Plan

As Fractals provided some degree of success in Action-Cycle 2, the designer explored similar geometry-based solutions in disciplines other than Mathematics and stumbled upon Islamic tessellations. Islamic tessellations are similar to fractals with infinitely repeating patterns. They are geometric designs which are created by fitting polygonal shapes together, without any gaps. These polygons are drawn on either a square or an equilateral triangle-based grid, as shown in Figure 7 (IAGD, 2004).

The tessellation grids provide ample affordance for construction of symmetric patterns, a trait which was most welcome in this study because symmetry-based training has proven to positively affect student’s spatial visualization ability (Nes, 2009; SRIEY, 2015, p. 92). Moreover, the same tessellation enabled viewing of multiple patterns in it. For example, the tessellation in Figure 8, can be seen as a pattern of repeated flowers as well as that of repeating diamonds. This can be considered analogous to the viewing of the same number in terms of various smaller number compositions. The tessellation concept was further explored in detail.
4.3.2 Action
The designer selected a square grid for exploring the construction of symmetric shapes. A 1 was represented by any single right-angled triangle in the grid, as shown in Figure 9. The subsequent numbers were then formed inside a single grid element (Figure 9) with the following constraints:

- A number $x$ can be formed with $x$ number of right-angled triangles, thus spatializing the quantity of a number
- These triangles must be arranged in the grid such that the sides or the vertex of any two triangles should touch each other, so as to create a symmetrical pattern, thus spatializing the visual number form of the number

Based on the above self-imposed design constraints, the designer created all the possible tessellations (Number-Shapes from hereon), from 1 to 10. These Number-Shapes for numbers 1-5 are shown in Figure 9.

Thus, a number is spatialized as follows- the quantity aspect of a number, say, 3 is equivalent to three connected right-angled triangles in the spatial domain, and the numeral aspect of 3 is equivalent to the unique symmetric patterns created by the triangles as shown in Figure 9.
4.3.3 Reflect

The designer explored these tessellations for days, composing, and decomposing Numbers-Shapes. For example, the Number-Shape for 4 (Figure 10.a) was constructed with various number compositions—four 1s (Figure 10.b), a 3 and a 1 (Figure 10.c), and two 2s (Figure 10.d).

More interestingly, in some instances, the Number-Shape also rotated. For example, the Number-Shape of 4 in Figure 10.d, consists of two 2s. The upper green square, representing the Number-Shape 2, is rotated by 45 degrees to fit the shape of 4, thus indicating the inherent ability of this concept for aiding mental rotation.

As the Number-Shapes were unique, the designer was also able to easily remember and recall them after some familiarization. The Number-Shapes not only proved effective in spatializing the quantity aspect of a number but also its numeral character through a unique pattern for each number. The closely spaced Number-Shapes were no longer confusing, as in the case of previous prototypes.
4.4 Action-Cycle 4: The Tessellation Based Triangle-Thread Prototype

4.4.1 Plan
The tessellation concept discussed in Action-Cycle 3, holistically catered to the objectives of the design problem; therefore, the designer decided to explore it further through a tangible physical manipulative.

4.4.2 Action
As planned, the designer tinkered with a prototype that reflected the concept of Action-Cycle 3 by cutting out right-angled triangles out of cardboard. The small right-angled triangles were cut in thick paper. Several ways of connecting the triangles were explored which would offer sufficient freedom of movement to the triangles for easy construction of Number-Shapes. Amongst all the alternatives, a thread-based connection was found to be cheap and quick for prototyping as well as testing. The designer assumed that more refined alternatives for the final material could be explored after obtaining the confirmation of this concept’s viability in the field. The vertex of each triangle was connected to the adjacent ones with a thread. These Threaded-Triangles or TTs were made for each number from 1 to 10, such that the TT for a number \( x \) comprised of \( x \) number of triangles, and enabled formation of various Number-Shapes for the number \( x \). These Number-Shapes were the same set of unique triangular, symmetric patterns which were developed in Action-Cycle 3. The TT for number 4 and its various Number-Shapes are shown in Figure 11.

Since the students were below five years of age, the tool had also to provide sufficient affordance for holding and grasping because fine motor skills at this age are not highly developed (Booth Church & Poole, 2019). Thus, the size of the triangles was increased, and they were cut out from a thicker and lighter material similar and equally inexpensive to cardboard.

4.4.3 Reflect
The design of the TTs reaffirmed the realization of the designer in Action-Cycle 3 that the uniqueness of these Number-Shapes was easy to identify, remember, and recall, though the initial learning curve could differ between users. While using the TT, the designer also realized that composition and decomposition of numbers was easier than earlier prototypes because the nesting of smaller Number-Shapes in larger ones was far more evident and easier to discriminate in the TTs.

However, the most significant addition to the iterations of prototypes in each action cycle was the possibility of physically manipulating the Number-Shape. Unlike the Number strips or the Tree-fractals, the TTs could be physically rotated without affecting the quantity or composition of the number. Symmetry in shape, irrespective of rotation, was also a prominent feature of TT that would assist spatial visualization as established in the literature. TT could also evaluate the student’s ability to construct and deconstruct various Number-Shapes in all possible number combinations, and their ability to identify shapes in various orientations.

By now, the designer was in a position to test the potential of the TT by its ability to enable construction and deconstruction of the symmetric Number-Shapes, to provide freedom of exploration while also allowing students to undo errors quickly. However, the designer was unsure whether the student would only create symmetric Number-Shapes with TT, as it provided a high degree of freedom for the exploration of many kinds of shapes, including the asymmetrical ones. The threaded TT also offered some resistance for flipping over of triangles while making the Number-Shapes. This could act as a hindrance for the students to make quick iterations or undo a mistake. To clarify these apprehensions, the designer planned to deploy the TT with the students.
4.5 Action-Cycle 5: The Loose Triangles Prototype

4.5.1 Plan
Understanding the limitations of the thread in the previous action cycle, the advantages of a tessellation model, as well as the unfamiliarity of the students with the TT manipulative, the designer planned to introduce the tool in a phase by phase manner. In phase 1, the unthreaded independent triangles were planned to be introduced to test whether the students can comprehend and construct symmetrical shapes. Further testing of the TT tool was to be made based on the response of the students to the triangles.

4.5.2 Action
In a class of 8 students, the authors with explicit permission from the Principal of the school held a small workshop. The authors showed children a few simple symmetric patterns and asked them to construct similar patterns with the given loose cut-outs of triangles. While students were able to reconstruct the demonstrated symmetric patterns, they also showed a tendency to create new symmetric and non-symmetric ones of their own. A few students were excited after creating a pattern and invited their friends to their seat to show them their pattern. They often moved around the class instead of sitting in one place, sometimes with the triangles, and sometimes without it.

4.5.3 Reflect
Reflecting upon the session, the designer realized that the designed TT tool, similar to the loose triangles, also provided the affordance for non-symmetric patterns in addition to the symmetric ones. The TT manipulative was also unportable and not designed to exhibit or share the created patterns with peers, a tendency which had emerged in students during this workshop session. During the session, the students also showed little patience which made the designer realize that they might get frustrated with the threaded TT prototype due to the resistance offered by the thread.

4.6 Action-Cycle 6: The Cut-Out Prototype

4.6.1 Plan
Since students were able to create symmetric patterns in Action-Cycle 5, the designer was convinced that Number-Shapes or tessellations do have the potential to impart the concept of number composition and decomposition. However, the TT tool required to accommodate two more additional features - first, a constraint for building only symmetric shapes and second, portability. These features required a further iteration of the TT manipulative as explicated below.

4.6.2 Action (by the Designer)
In this action cycle, the designer began by tinkering with manipulatives that had a symmetric boundary within which only symmetric shapes could be created, thus imposing the constraint. This exploration resulted in the design of the Cut-Out tool, which consisted of the following parts- (1) a base with a Cut-out niche that acted like a symmetric boundary condition and secondly (2) a set of loose Number-Shape cards that fit into the niches. These are shown in Figure 12.

The base comprised of a thick cardboard niche representing the outline of a Number-Shape, which facilitated the placement of the Number-Shape cards inside it. A transparent sheet then was pasted at the back of the base to hold the placed cards and to view the numerals written on them. It also ensured portability. The Number-Shape cards, on the other hand, were created by cutting out the various Number-Shapes by their outline from coloured papers. They contained the line-diagram of the Number-Shape pattern on the front side and the respective numeral written at the backside (Figure 12).

The Cut-out tool facilitated the construction of Number-Shapes through the placement of various combinations of smaller Number-Shape cards in the Cut-Out base. The tool also enabled rotation of various smaller Number-Shape cards to be correctly fit into the base. This process of construction and deconstruction of Number-Shapes was also quick and less tedious, unlike in the case of the TT tool. The transparent sheet, as expected, facilitated viewing of numerals at the base by lifting it up as well as offered seamless portability. Since the tool was found to fulfill the requirements, it was then revisited to check its appropriateness of being deployed with the students.
As the tool was to be handled by the young students, the Cut-out base as well as the number cards were designed with an appropriate size, large enough, to be comfortably grasped and carried around by the students. The fidelity of the tool was kept low due to the uncertainty of the success of the tool and anticipated future iterations. Various Cut-out bases and Number-Shape cards were created for deployment with students, as shown in Figure 13.

![Figure 12. The Cut-out prototype for 4 with two 2s](image)

![Figure 13. Cut-outs for numbers, 4 and 5 with paper Number-Shapes](image)

### 4.6.3 Action (by the Students)

During the workshop session, the designer introduced the Cut-out tools for numbers 1, 2, 3, 4, and 5 to students and demonstrated them about how to fill it up with various smaller number compositions. Students were then given a Cut-Out each to let them fill up the Cut-Out with various smaller Number Shape cards.

The prototype was able to evaluate the student’s ability to correctly fill up the Cut-out manipulative, rotate the shapes appropriately to fit them inside the Cut-outs, and construct and deconstruct the same Cut-out Number-Shape in all the possible smaller number combinations. On the other hand, the students evaluated the prototype by its usefulness, flexibility of enabling construction with any smaller Number-Shape combination, level of forgiveness if an error is committed, ease of portability, and the enhancement of their mental rotation skills.

### 4.6.4 Reflect

During the session, students learned to construct various Number-Shapes with Cut-out tools. After filling up the niche, students also counted the triangles on their own to state which number they had created. As planned, the prototype was successful in restricting the students to create only symmetric Number-Shapes. It also enabled them to explore the composition and decomposition of the same Number-Shape with multiple smaller Number-Shapes, while also providing the affordance for quick iterations, error identifications, and corrections. However, the prototype was
unable to make students speak of number construction in terms of smaller numbers as a whole, as they were counted only as ones. For example, after construction of a four with two 2s, students still counted the four individual triangles of the Number-Shape 4 instead of viewing it as a composition of two 2s.

4.7 Action-Cycle 7: The Foldable Number Card Prototype

4.7.1 Plan

With the Cut-out prototype, students were able to recognize, construct and deconstruct a number spatially and numerically. However, the prototypes required further iteration to enable students to speak of number construction in terms of smaller numbers other than ones. This required visual and tangible strengthening of spatial overlaps of different sets of nested numbers.

Since the tessellations-based Number-Shape concept in the form of loose triangles (Action-Cycle 5) and the Cut-out tool (Action-Cycle 6) was partially successful, the designer preferred to constrain the design exploration to incrementally modify the existing prototype to incorporate the new features. With this in mind, the possibility of folding the Number-Shapes into their constituent smaller Number-Shapes, in order to increase their visibility as a whole, was planned. For example, a Number-Shape card of 3 constituting of three 1s could be folded into all 1s. On the other hand, another Number-Shape of 3 constituting of one 2 and one 1, could be folded into a 2 and a 1, respectively, as shown in Figure 14.

![Figure 14. The Foldable number card tool for number 3 with 2+1 and 1+1+1](image)

4.7.2 Action

The Number-Shapes of a particular number were capable of being folded according to its smaller Number-Shape constituents. Thus, enhancing the number’s viewability in terms of its smaller Number-Shape constituents, instead of just ones. The Cut-out prototype was accordingly modified. The foldable number cards were created by cutting triangles in acrylic sheets and thick paper. The edges of the triangles were taped with one another such that each side could be folded onto one another.

Since the designer was still uncertain of the success of the folding concept, the prototype was kept as frugal as possible. A tape was used to hinge the smaller Number-Shape cards (both acrylic and paper-based ones) with each other for enabling the desired foldability. The folding number cards were deployed separately without the Cut-out bases to first test if the folding modification has any effect on the student’s ability to view smaller numbers as a whole. After a demonstration of the concept, each student was given the Foldable tool for numbers- 2, 3 and 4 (one after the other) to tinker with. The designer tested the ability of the students to view and explain a Number-Shape in terms of its smaller number constituents as a whole and not as ones.

4.7.3 Reflect

Almost all the students folded and unfolded the numbers into various possible smaller number combinations. They showed greater interest in the prototypes which could be folded into a stack of single triangles (the all one’s Number-Shape) and also counted them after folding. The tool also facilitated the design of some interesting 3D structures. For example, one of the students created a tetrahedron from a 3 foldable into ones (Figure 15), Another student created a structure as shown in Figure 15, with the Foldable card of 4.

After tinkering with the Foldable Card tool, almost all the students were able to speak of all the numbers (till 5) in terms of their composition into ones -as in 3 ones make a three. However, the prototype was still unable to make student focus on numbers other than ones. Questions like- how many threes were present in a four, or how many twos make a four, still remained unanswered.
4.8 Action-Cycle 8: The Disc Prototype

4.8.1 Plan

On reflecting upon the workshop experience so far, it was realized that the Cut-out, as well as the Foldable Card tool, had always emphasized more on the shape aspect of the Number-Shapes than their quantity aspect. For example, the user had to focus more on the outline of the Number-Shape to decide if it can fit into the Cut-out base and not so much on the number of such shapes being picked up to be filled. Thus, failing to emphasize the quantity aspect. Shifting the user’s focus from the shape to the quantity aspect of the Number-Shapes forces one to see the Number-Shapes as a single entity. That is, in order to make a student say that the Number-Shape of the number 3 is made up of – one Number-Shape of 2 and one Number-Shape of 1, they have to be first shown multiple units of Number-Shapes of 2 and 1 out of which a single unit of each has to be selected (Figure 16). Thus, forcing the students to see the entire Number-Shape of 2 as a single unit and not as two ones; therefore, designer’s objective now shifted towards enhancing the tool’s emphasis on the quantity aspect of the Number-Shape, such that the prototype may trigger the student to say “I will take one 2 from here, and one 1 from here to make a 3”.

Figure 16. Composition of number three through the disc tool concept

4.8.2 Action

Brainstorming and ideation on this plan led to the creation of a disc tool. The tool comprised of central cardboard with the Number-Shape Cut-out at its centre and two spinning discs attached at its corners (Figure 17). Each disc consisted of multiple units of smaller constituent Number-Shapes. The central Cut-out number was created by spinning the discs and selecting any one of these multiple smaller Number-Shapes from each disc to fill the central Cut-out. For example, a tool for number 4 contained two discs, disc-1 having three 3s and disc-2 with four 1s (Figure 17). The central Cut-out cavity, representing the number 4 was filled by spinning the discs and choosing one 3 from disc-1 and one 1 from disc-2. Thus, emphasizing on the concept of viewing smaller numbers as a whole by choosing one of it, at a time. Similar tools were designed for numbers 2, 3 and 4 and presented to the students.

The disc manipulative was again a low fidelity prototype, completely made out of cardboard. The size of the discs was kept sufficiently large to ensure comfortable handling by the students. After the demonstration, each student was given individual manipulatives to handle.
4.8.3 Reflect

The students were now able to see the constituent Number-Shapes in terms of various other smaller Number-Shapes, instead of just ones. Students were also able to transition from the spatial to the number domain since they began to speak of number composition in terms of various smaller numbers such as “2 and 1 combined to make 3” and “two 2s make a 4”, etc. While playing with the discs of the number 4, the discs accidentally got dismantled, when a student fixed it, and excitedly showed it to his friend “See Mannat, 3 and 1 combine to form a 4’’. This also indicated that students were more engaged with numbers while making the manipulative, rather than when solving a problem.

The prototypes assisted the students to view and communicate their understanding of numbers in terms of various smaller number compositions. The designer was delighted to see the students spin discs like a fan or often simply run the tool on a bench like a car. The manipulative had become truly portable.

5 Conclusion

This study revealed to the authors the challenge to build prototypes that speak to the users, and in turn, the users converse with the designers. Prototypes are incomplete (Lim et al., 2008) and therefore, often not self-explanatory, hence the features of a prototype that a designer decides to retain or filter (Lim et al., 2008) during every action cycle plays a key role in the success of the prototype and the process of prototyping. Despite the messiness of this process of exploration, the constant requirement of an unbiased awareness of one’s own thoughts, decisions, and subsequent actions, and the difficulty in communicating with users who are verbally inarticulate (children), the authors were able to conduct successive action cycles informed by designerly thinking.

5.1 Prototyping as the Intersection Space of Users, Prototypes and Designer

The externalization of the designer’s ideas in the form of designed prototypes acted as the medium for the students to speak back to the designer, through their feedback given on the prototype. This, in turn, led to the emergence of new functional dimensions and interactivity dimensions in the study. Thus, the process of prototyping, in our case, was not independent of the users as explained by Gero (1990). Instead, prototyping was done at the intersection of the designer, the user, and the prototypes, as shown in Figure 18.

In light of the above, the model of Houde and Hill (1997) consisting of Role, Implementation, Look and Feel, and Integration can also be updated with another dimension- the user. The inclusion of the user increases participation in the process of prototyping, adding, and further problematizing the design process.
5.2 Interaction over Manifestation

It was interesting to observe how little the appearance dimension (Lim et al., 2008) of an intentionally designed low-fidelity prototype affected the user when the level of interactivity was high. The uneven colors, roughly cut edges, clearly visible pin, and the unfinished appearance of the prototype did not seem to affect the response of the students in Action-Cycle 8. The interactivity of the prototype in Action-Cycle 8 was far higher than that of finished, neatly colored prototype of Action-Cycle 1. However, the students not only played and learned with the former prototype but were also able to articulate it in their language.

5.3 Thinking with Hands - Externalization Makes the Prototypes Shape Designer’s Thinking Process

The study was able to realize prototypes as the medium of externalization of the designer’s ideas so that the ‘world can speak back to the designer’ (Schön, 2017). In our study, the world was restricted to not only the users, i.e., the students, whose speaking back (in terms of their feedback) resulted in significant changes in the prototype, but the prototypes during the process of externalization themselves acted as the world. This is because, while designing a prototype, the material can be said to speak to the designer through the affordance it offers. As in our case, while tinkering with the acrylic triangles, the material gave the designer the affordance of stacking them on top of each other, which in turn triggered the idea of a Foldable Card tool. This also demonstrates how prototypes make the designer think with hands, thus shaping the designer’s thinking process, in addition to the designer’s thinking shaping the prototypes.

5.4 Perceived Manifestation Dimension

The acrylic-based Foldable Card tool provided a strong affordance for foldability due to the thickness and hardness of the material. It was also possible to stack the triangles on top of one another, which intuitively made students to count the pieces. The hardness of the acrylic also gave students the affordance for creating 3D structures like the tetrahedron and the vehicle like structures to be moved around on the bench (Figure 15). The paper-based Foldable Card tool, on the other hand, lacked in thickness and hardness, and hence failed to provide equally strong affordances. Thus, the evaluation of the design idea of folding was affected by the use of material, i.e., the manifestation dimension, as also explained by Lim et al. (2008).

References


### About the Authors

**Ekta Surender** is a Ph.D. scholar at design program, IIT Kanpur. Having exposed to the worlds of both logic and creativity, i.e., engineering and design, I consider myself a tinkerer and a creative problem solver. I believe that design is not just about *how it looks*, but also *how it works*. I have been exploring the potential of design in the field of education- having designed learning tools for science education earlier, now I am delving into the world of mathematics.

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An Exploratory Study for Provocative Prototypes: Creating Personas

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Abstract: In a typical design process, the user group is one of the most important pillars for design decisions. The characteristics of the intended user group is usually identified with the help of personas. Personas help designers to create empathy with their user group and understand their needs and preferences better. In other words, designers use personas as a prototype to provide constructive design critiques to their designs. However, persona creation for the design of products with novel technologies is challenging as there is no real user of these technologies to base the persona on. This problem leads us to a workshop in which we question a provocative design solution where personas from fictional users are created and tested by the designers. Two groups, each having three participants, prototyped personas by real world scenario mapping and tested them by provoking conceptually with binary questions.

Keywords: provocative prototypes; persona; design fiction

1 Introduction

Design was used to be perceived as a way for looking for solutions to people’s problems. However, recently, with the rising interest on critical design, the importance of asking questions about the problems has gained equal importance as solving the problems. Therefore, design has started to be used for the exploration of the interested issues.

Raptis, Jensen, Kjeldskov and Skov (2017) categorise the design research such as speculative, ludic, reflective, slow, counter-functional, value-sensitive and adversarial design under the term of provocative design as they have the common aim of challenging the existing with discussions and critiques and exploring the area of interest. They propose that, provocative designs can be used in research either by research through design for understanding the current practices or for exploring the potential of future design. Either way uses research through design which is explained as one of the three types of research in design by Frayling (1993).

According to him, there are three types of research in design, namely, research into design, research through design and research for design. Research into design deals with historical research, aesthetic and perceptual research and research into theoretical perspectives on art and design; research through design is more into materials research,
development, work and action research such as altering a technology to innovate and contextualizing it; and research for design focuses on the end product as the artefact aiming at knowledge in the sense of communication tools.

To understand possible technological futures, hypothetical or fictional prototypes can be used as a source of knowledge to both their designers and users in the practice of research through design (Vaihinger, 1921/2009). Here, the prototypes are not necessarily be the physical products representing the final design, but the tools used as a source for exploring not only the consequences of a design but possibilities for a design.

In this study, personas as representatives of users in the futures are used as the prototypes for the source of questioning the future technologies where no or very little experience of users is within reach. Being in quest of a design problem where asking questions is as important as searching answers is the prominent reason of this exploratory study. By using real world scenario mapping method, designers can create fictional personas or persona prototypes and get immersed in the created persona’s life to reach not the results of the designers’ imaginary boundaries but the results of the interactions occurring in the story world, therefore, to produce richer design insights.

2 Related Literature

2.1 Persona Creation in the Design Process

The concept of persona, along with its coined name was originally defined by Cooper (1999, p. 123) as “pretend users”. Cooper’s personas are representative and archetypal: although they are products of the designer’s imagination, they are created by the deduction of actual data. Using personas is a family of methods in which designers attempt to extrapolate from their data, preferably in situations where direct communication and testing with real users is unfeasible (Pruitt & Grundin, 2003). However, personas potentially offer more than being time savers. This deduction brings its own value to the table: most often than not, raw data from user observation is either not directly convertible to design insights, or such different stakeholders in the process come up with conflicting insights (Pruitt & Adlin, 2006; Mulder & Yaar, 2007). Personas can solidify coherent design intentions from data and allow different parties to communicate on them. This communication then leads to another important purpose of using personas: they allow and encourage extrapolation (Pruitt & Adlin, 2006). Once data is shaped in flesh, designers, as well as other stakeholders can imagine its reactions in further contexts. Extrapolating personas can especially be useful in processes where the design problem is not set in stone, where designers would not only anticipate the results of an imaginary interaction but the entire interaction.

Extrapolating future interactions using personas is dependent on the complexity of them. Grudin (2006) summarized this position in three steps: (i) human beings can empathize with and anticipate hypothetical scenarios of other real human beings by creating their mental models. (ii) These models can then be transferred to fictional characters, in this case, personas; enabling them to anticipate interactions of fictional people. (iii) And this transfer requires that the fictional characters are modelled with a similar rigor and level of detail as the real human beings. This last assumption of Grudin (2006, p. 646), which in his own words is difficult to prove, relies on experimental psychology: and is inherently different from persona creation methods which relies heavily on representing empirical data (Sinha, 2003; McGinn & Kotamraju, 2008) and instead focuses on qualitative and rich representations. While Grudin (2006) uses various approaches of psychology to define and understand human beings for anticipating hypothetical behaviour (cultural stereotypes, personal traits, goals, routine scripts of daily life and intimate information from personal observations); there is extensive literature in media and communication studies which deals with cognition of and immersion through fictional characters in narratives.

One related method of understanding fictional characters is called scenario mapping and was developed by Sanford and Garrod (1998), as a way of describing how fictional material is initially understood. Real-world scenario in their body of work is used as a “known situation” (Sanford & Emmott, 2012, p. 20), as in a situation that the reader either experienced first-hand or knew enough about from third party sources. Scenario mapping theory asserts that the reader, initially tries to map the text he reads to real world scenarios in order to understand it. While this is often the case when the fictional personas are modelled after first-hand experience with real people, it is also a reflex applied to the fictional material by the reader. Known as the rule of minimal departure, people would apply their real-world knowledge and experience to a fictional narrative unless the narrative explicitly states otherwise (Ryan, 1980).

Grudin’s (2006) transfer, from the designer’s model of real people to personas align with scenario mapping: personas are born from known situations by first-hand experience. However, the qualitative complexity of personas, which afford extrapolation comes from immersion: empathizing with a fictional character on a deeper level in a way one can
anticipate her reactions in hypotheticals. As readers interact with narrative, they do not merely construct and comprehend meaning, but they get immersed in the narrative (Zwaan, Madden, Yaxley & Aveyard, 2004). Events or emotions depicted in the narrative plays in the minds of the reader, as if they were literal.

Green and Brock (2000) explain this phenomenon, one where the reader gets lost in the narrative as transportation-imagery. Transportation refers to complete immersion to the story world, by losing the sense of time and place (Green, Brock & Kaufman, 2004). Gerrig (1991) uses the physical transportation as an analogy, in which one travels to a distant location, with restricted access to her origin location, and comes back with insights learned from the experience. The level of transportation is related with the cognitive abilities of the reader: the level of transportation is correlated by the balance between the cognitive challenge received from the text and the cognitive abilities of the reader (Csikszentmihalyi, 1991; Sherry, 2004). In this line of thinking, a narrative is more immersible when it proves to be challenging for its reader, whether by its form or content; however, it should also be mappable in the designer’s mind via real-world scenarios. This also means that immersion is subjective, and it varies among individuals. In other words, the complexity of a persona would be correlated to the challenge it brings. At the ideal level, the complexity should trigger a discursive space in the designer’s mind, encouraging her to drive the persona and the situation forward; while not being overwhelming so that it stays mentally manageable.

Real-world scenario mapping establishes a relationship between the designer and her persona within the real world where she is designing for; while transportation establish mirroring with the designer’s cognitive self. Both are mechanisms employed in narrative immersion. Since people plan their behaviour over fictive hypotheticals in their minds before taking action (Busselle & Bilandzic, 2008; Stecker, 2011), high narrative immersion has exceptional utility for designers in exploring futures in terms of novel technologies and cultural settings in which these technologies will be used.

Our proposed question then is: how can designers create qualitatively rich personas with the right amount of narrative immersion within reasonable time constraints? Our proposed answer is rapidly prototyping personas. By applying iterative and provocative prototyping techniques to personas in design ideation, we argue that designers will receive the maximum immersion in a limited time and therefore effectively generate insights for designing within novel technologies of the future.

2.2 Provocative Prototyping for Persona Creation and Testing

Prototypes are defined as the tools used for representing the final artefact to inform design process and decisions (Moggridge, 2007). Sethu-Jones, Rogers and Marquardt (2017) gather two different kinds of prototypes in technology research. In the first kind, prototypes can be used for the introduction of a new technology to everyday life and to intended context or they can be used for the introduction of an existing technology to a novel context. In the second type, prototypes are used as tools to explore the interesting technologies to be designed in the future. The second type is also referred as technology probes (Hutchinson et al., 2003) as they carry some of the characteristics of cultural probes such as being contextually appropriate and aiming to understand the use patterns. However, they are argued to be referred as exploratory prototypes (Heyer & Brereton, 2008) because they are not only for exploring the use, misuse or non-use of an existing technology in an established practice but for also exploring the new technologies in novel settings. Therefore, the exploratory prototypes do not have to be used continuously like cultural probes to be open to technologic innovations, but they must be in line with the context and provocative at the same time. Auger (2013) points provocative design to keep up with the balance between them because in design fiction, prototypes cannot be too familiar or too far to the users because they either are condemned to be unnoticed or confronted with revulsion.

In provocative design, prototypes are used as an incentive of discussion instead of a representation of the final artefact. For example, for speculative design, Dunne and Raby (2013) define prototypes as the props for imaginary films because according to them, the viewers should be active and should produce their own interpretation when engaging with the prototype instead of being passive consumers of them. These props should also be legible by the user, be consistent within the story world to generate truths compatible to that world, help people imagine the possibilities, create fictional ideals, values, and beliefs that challenge the existing ones, trigger speculation and be plausible instead of believable. In other means of provocative design, in design fiction, Coulton, Lindley and Akmal (2016) say that prototypes should be future oriented. In other words, prototypes should belong to the future world and be compatible with that world. Lindley and Sharma (2014) also refer to the plausibility of the prototypes by writing that audience can relate the reality of diegesis within the fictional world to be able to render the alternative world. With these prototypes, designers will be able to anticipate how technologies might affect the everyday lives of people (Grand & Wiedmer, 2010) and create what if scenarios (Knutz, Markussen & Christensen, 2013).
### Table 1. Comparing provocative and traditional prototypes

<table>
<thead>
<tr>
<th>Provocative Prototypes</th>
<th>Traditional Prototypes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aim at understanding what future can bring</td>
<td>Aim at understanding current concerns</td>
</tr>
<tr>
<td>Encourage active participation of the audience</td>
<td>Passively consumed by the audience</td>
</tr>
<tr>
<td>Embrace different interpretations</td>
<td>Try to reach common sense</td>
</tr>
<tr>
<td>Present the plausible to reach the preferable</td>
<td>Present the possible</td>
</tr>
<tr>
<td>Create challenging ideal, values, beliefs</td>
<td>Refer to the current ideals, values, beliefs</td>
</tr>
</tbody>
</table>

### 3 Study

For this study, we used provocative prototyping techniques to create the fictional world as well as the motivation for the designers to generate rich personas. The study was carried out as a full-day workshop, although only the first half is planned to be used for the scope of this paper. The workshop was organized within National Design Research Conference (UTAK) at Middle East Technical University in 2018. Within the conference program, we called for undergraduate (at least in their third year) or graduate students of industrial design or related programs and ended up with six participants who are all undergraduate students. Four participants were industrial design students while two of them were from architecture departments; from 5 different institutions in Turkey and Cyprus.

Workshop environment was decorated using provocative prototypes prepared by the researchers, which were posters depicting a near future fictional world. This world is marked by the “Enhanced Privacy Certificate (EPC)”, an optional certification program for smart devices. In this world, EPC enabled devices cannot directly ask for demographic information, or grab personal data from other services or devices. However, they are expected to offer personalised services to their users, from personal traits learned from mundane daily interactions. To assist the understanding, we construed a simple kitchen appliance, a coffee machine whose job is straightforwardly to make coffee. In the story world, the smart coffee machine must make coffee to its user according to the user’s preferences by being responsive to the user’s context. However, this machine has to be personal without asking any personal questions. The aim here was to provoke the participants’ creativity for getting to know the personas.

We asked the participants to split into two teams of three and generate personas in order to design a smart and connected coffee machine for this fictional world. After the introduction of the fictional world, each team was given...
three roles to distribute to their three members. These roles were (i) user, (ii) machine intelligence and (iii) observer. A summary of each role can be found in Table 2.

<table>
<thead>
<tr>
<th>Role</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>User</td>
<td>In the fictional world, the user had just bought the smart coffee machine and casually interacts with it through answering its questions.</td>
</tr>
<tr>
<td>Machine</td>
<td>In the fictional world, this is a smart coffee machine with a conversational interface, which wants to get to know its user more through casual interaction.</td>
</tr>
<tr>
<td>Observer</td>
<td>In the fictional world, the observer is a designer/usage tester, which observes the casual interaction between the user and the machine and takes notes.</td>
</tr>
</tbody>
</table>

The workshop process involved 3 steps:

1. Users and observers of each team came together and created personas, using character sheets created by the researchers. Character sheets included but not was limited to demographic information, physical appearance, tastes (music, food, colour, etc.), facts about family and friends, fears, regrets and character traits.
2. Machines and observers of each team came together, to create questions that would be later asked by the machines to the users, in order to get to know them better. For clarity and coherence, questions were limited to binary choices (e.g. “Which one would you prefer: coffee or tea?”). Machines were asked to prepare as many questions as they need to understand the user’s character, using question sheets created by the researchers. Questions were written on these sheets, as well as the type of information that was expected to be derived from the said questions. Even though the machines prepared the questions together, they were free to add or extract to them and about the order of the questions. If they found meaningful to ask a different question according to the answer of the previous question, they had been encouraged to do so.
3. At this point, users and machines did not know each other’s preparations (Machines did not know the personas, and the users did not know the questions). A roleplaying session was conducted. For each team in turns, the machines asked the users a binary question, listened to the answer, and filled an answer sheet created by the researchers. Users were encouraged to be in character and answer the questions as their personas would. They were free to elaborate their answers on their own, as well as use theatrical elements. Machines recorded the answers with their deductions from these answers, regarding the user’s persona. Meanwhile, observers of each team, who has access to both the personas and questions, took free format notes on whether the machine deduced the correct information from the answer and if not, why.

After the roleplaying session was concluded, we asked the observers to retrospectively walk us through the process using their notes. Initial personas were compared to the guessed personas of the machines, and a discussion was had about how effective the questions and the resulting assumptions were.

4 Findings

Findings of the session are grouped in the following tables: Question tables show each question, its expected outcome and the information recorded by the machine after an answer was received. Persona tables show the information for the persona generated beforehand by the users and the persona deduced by the machines at the end of the process. Questions and persona tables were created by Team 1 (Table 3 and Table 4) and Team 2 (Table 5 and Table 6) and presented below respectively.

With the help of the persona creation session, the participants in the role of users envisaged characteristics of a typical persona would have such as physical characteristics, personality, social life, likes and dislikes, history, pains, regrets and dreams. Even though they were encouraged to take their time to create their personas and write their thoughts on the character sheets provided to them, they pointed that, the empathy level increased as they spoke on behalf of the personas. Similarly, the answer sheets, provoking the machine users to extract these typical persona characteristics proved that, as the machine users got immersed in the conversation, they revised their projections in a more accurate way. For example, the user participant of first group created a shallow, materialistic girl archetype and the machine participant pointed that they understood their user was as such, I after a few questions and changed their projections accordingly. Likewise, the user participant of the second group created a Spanish woman and talked with an accent during the role playing and the machine participant of the first group indicated that the way of the participant’s talk and act had a huge effect on their projections after the first answer of their user.
### Table 3. Question table for Team 1

<table>
<thead>
<tr>
<th>Questions designers asked as a machine (P1)</th>
<th>Information expected to be found</th>
<th>Projections to the user’s answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working in the morning or working during night</td>
<td>Order of life Working hours Working place</td>
<td>Age Gender Financial situation Education Character Living space State of health Sleep pattern Dietary preferences Physical Activity</td>
</tr>
<tr>
<td>Public transportation or private vehicle</td>
<td>Financial situation environmentalism</td>
<td>Age Gender Financial situation Education Character Living space State of health Sleep pattern Dietary preferences Physical Activity</td>
</tr>
<tr>
<td>In or out*</td>
<td>Sociability Consumption</td>
<td>Age Gender Financial situation Education Character Living space Physical activity</td>
</tr>
<tr>
<td>Homemade food or fast food</td>
<td>Time at home Dietary habits</td>
<td>Age Gender Financial situation Education State of health Sleep pattern Dietary preferences</td>
</tr>
<tr>
<td>Automatic or manual</td>
<td>Age Travel frequency</td>
<td>Age Financial situation</td>
</tr>
<tr>
<td>Following the agenda on the Internet or from the printed publication</td>
<td>Internet access Age</td>
<td>Financial situation Age Living space</td>
</tr>
<tr>
<td>Coffee or tea</td>
<td>Life style Age</td>
<td>State of health Sleep pattern Dietary preferences</td>
</tr>
<tr>
<td>Instagram or Twitter</td>
<td>Hobby Interests</td>
<td>Age Gender</td>
</tr>
</tbody>
</table>

*This was open to inference and the participants stated that they designed this question intentionally open to interpretation believing that the response would give hints about the characteristics of the user.

### Table 4. Persona table for Team 1

<table>
<thead>
<tr>
<th>Persona created by the machine (P1)</th>
<th>Persona created by the user (P2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>College student (18-30)</td>
<td>High-school student (16)</td>
</tr>
<tr>
<td>Women</td>
<td>Women</td>
</tr>
<tr>
<td>Living with family</td>
<td>Living with family</td>
</tr>
<tr>
<td>Drinks coffee during night for studying</td>
<td>Drinks coffee to be hip</td>
</tr>
<tr>
<td>Eats fast-food but thin</td>
<td>Avoids unhealthy food for better appearance</td>
</tr>
<tr>
<td>Upper-middle class</td>
<td>Upper class</td>
</tr>
<tr>
<td>Enjoys showing-off</td>
<td>Popularity addict</td>
</tr>
<tr>
<td>Active physical life</td>
<td>Active physical life</td>
</tr>
</tbody>
</table>
Table 5. Question table for Team 2

<table>
<thead>
<tr>
<th>Questions designers asked as a machine (Team 2)</th>
<th>Information expected to be found</th>
<th>Projections to the user’s answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working in the morning or working during night</td>
<td>Order of life Education</td>
<td>Order of life Sleep pattern</td>
</tr>
<tr>
<td>Public transportation or private vehicle</td>
<td>Financial situation Environmentalism</td>
<td>Financial situation Education Character</td>
</tr>
<tr>
<td>In or out*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*This was open to inference and the participants stated that they designed this question intentionally open to interpretation believing that the response would give hints about the characteristics of the user</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Homemade food or fast food</td>
<td>Time at home Dietary habits Age State of health Living space</td>
<td>State of health Education Living space Dietary preferences</td>
</tr>
<tr>
<td>Automatic shift or manual shift</td>
<td>Age Travel frequency</td>
<td>Age Financial situation</td>
</tr>
<tr>
<td>Following the agenda on the Internet or from the printed publication</td>
<td>Internet access Age</td>
<td>Age</td>
</tr>
<tr>
<td>Coffee or tea</td>
<td>Character</td>
<td>Ethnicity</td>
</tr>
<tr>
<td>Wake up in a good mood or bad mood</td>
<td>Life style Working conditions</td>
<td>Character Physical Activity State of health</td>
</tr>
</tbody>
</table>

Table 6. Persona table for Team 2

<table>
<thead>
<tr>
<th>Persona created by the machine</th>
<th>Persona created by the user</th>
</tr>
</thead>
<tbody>
<tr>
<td>Middle aged (31-50)</td>
<td>Young adult (23)</td>
</tr>
<tr>
<td>Women</td>
<td>Women</td>
</tr>
<tr>
<td>Living alone</td>
<td>Living with 2 cats and a dog</td>
</tr>
<tr>
<td>Drinks coffee a lot as a Latin American</td>
<td>Drinks coffee a lot as a barista</td>
</tr>
<tr>
<td>Eats healthy, no restrictions</td>
<td>Pescatarian</td>
</tr>
<tr>
<td>Manager in a plaza</td>
<td>Barista</td>
</tr>
<tr>
<td>Activist</td>
<td>Buddhist</td>
</tr>
<tr>
<td>Regular sleep</td>
<td>A party person at the weekends</td>
</tr>
</tbody>
</table>

By looking at the question table, it can be said that, the machines corrected their assumptions about the users’ characteristics iteratively until they got clear about their doubts. However, the persona comparison tables show that, even though the machines are certain about their inference and do not need any further interrogation, they could still be wrong about their persona.

When we investigated further to the point projections, we saw that in the related questions, the user participant can be described as to be more in character and gave the response with more explanations, mimics and gestures. Moreover, the machine users explained that they were affected by their user’s language use. For example, the
machine participant took a note on their answer sheet with a big question mark asking, “Is that a Cadde girl?” after the use of a jargon of the user participant.

5 Discussion

As can be seen in the tables the questions of the designers were designed to be easy to interpret on the response rather than to get a solid answer. If it was to be elaborated on the binary options that machines offered their users for preferring, it can be realised that the options are the possible answers of the questions that were asked for having a good comment on their user’s life. The questions included, what time period of the day they prefer for working, how they choose to travel, where they like to spend their time, what reading medium they like, what is their beverage preference, how is their mood in the mornings and which one is their favourite social media platform. By asking these questions, they intended to acquire the answers about their user’s age, order of life, working place, working hours, financial situation, sociability, consumption habits, dietary habits, travel frequency, internet access, internet use, hobbies, interests, state of health and even their character. It seems a bit naïve to infer all these characteristics of a user from comments on binary questions but as the participants construed the characters in their conversation better, when the participants in the roles of machines finished with creating personas, they definitely had an image of their user in mind.

The question tables show that excluding age which was updated by nearly all kinds of answers, not many data points were coherent between expected information and the projections. For most questions, machines ended up discovering different types of information from the personas, from what they thought the questions would dig up.

This was in line with our expectations regarding immersion. As the roleplaying session carried on, users became increasingly more relaxed and in-character, adding more vocal features and body language as they give their answers. This richness resulted in machines to deduce new and unexpected types of information from the answers, not only by the content but also by the delivery. However, increased immersion was not only relevant to the machines who were getting to know their users. Users themselves were more immersed into the personas they devised as the process carried on. In addition to being more capable actors in roleplaying, they also made new connections between their character’s data, discovering parts of and improvising on their personas. As confirmed by the concluding discussions, users were more knowledgeable about their personas at the end of the session.

However, even though they were able to create a superficial persona based on the data they collected, the insightful nuances may be overruled by the inferences of the designers. When the main concern was to be recalled, for designing for novel technologies where no experienced users are within reach, this experimental study can be taken as a starting point for creating persona prototypes to be followed by a supportive study for freeing designers from their presumptions by encouraging immersion in the story.

Scenario-mapping was an inherent part of the process via machines, deducing information from simple binary questions, but it was also used by the users to improvise on their personas. As users became more immersed in their persona, they started mapping scenarios from their persona’s world as they answered questions, by coming up with information that was not thought beforehand while creating the personas. This both enabled participants to expand on their personas throughout the process, and to generate a follow-up discussion on what information should have been added or removed from the initial character sheets to generate rich personas.

Finally, we argue that using provocative prototypes to generate a fictional world in which the sessions occurred speed up the process. Technically speaking, the process was not much different than roleplaying; however, the inclusion of a context by such prototypes and hence, rules for roleplaying, gave a reason for the participants to be highly immersed. Machines were motivated to probe into the personas as quickly and effectively as possible, while the users were motivated to be more in-character as the machines attempted to reveal their persona, right or wrong.

6 Conclusion

Designing for products with novel technologies could bring unprecedented experiences. However, setting a stage for a predefined product or for predefined stereotypes could obstruct the emergence of these rich experiences. Therefore,  

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1 Street name for Bağdat Avenue, a posh street and neighborhood in Istanbul.
An Exploratory Study for Provocative Prototypes: Creating Personas

Putting the designers on the shoes of both the product and the user may break the empathy barrier between a novel product-user interaction and foster creativity and eventually result in design insights for new products.

At the end of the sessions, both teams had immersive and realistic personas at hand, that could potentially be used further in the design process, devised in a relatively short time. This was made possible by employing provocative prototypes to create the initial motivation to be immersed in the narrative. Further, personas were also quickly prototyped and tested by roleplaying, further enhancing their richness.

This exploratory study allowed us to speculate on Latour’s (2007) definitions of inscriptions and prescriptions. The designer’s intentions about the effects of a design on user’s actions, inscriptions, are limited to designers’ understanding about their users. Immersion in the narrative might enhance the perception of the designers about their users and thus positively affect the design process. The product’s actions that users are allowed to, prescriptions, are again depended on the designers’ knowledge about their users. By looking from the perspective of the machines, designers can test better the boundaries of the personas and question their prejudices. Therefore, quick prototyping and testing of the personas could be a way for enhancing the design process and guide the designers to more meaningful design insights.

References


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Design for the Nonhuman

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Abstract: Students, even from non-design disciplines, are sometimes familiar with the use of prototypes to develop a commodity. Rarer, even among students from design disciplines, is the awareness that prototypes can be used to address research questions. In this paper, we discuss a case study for the idea of using prototypes to better understand a situation that includes nonhuman actors. In particular, we used the famous squirrels on the University of Illinois campus as the subject of our design efforts. A group of undergraduates from mainly non-design disciplines was led through a half-day workshop on prototyping. Instead of focusing on prototyping towards a commodity—an object or experience that the squirrels could use—our workshop encouraged students to think of investigation as their primary goal. Thinking through making, participants produced artefacts with features that could help us better understand squirrels. Some prototypes, for example, embodied strategies for observing behaviour in more detail, while others were designed so that their very conceptualization led immediately to additional questions. We recommend workshops of this kind as a tool for encouraging two things: a broader appreciation for the different purposes of prototyping, and an awareness of the limitation of human-centeredness in design.

Keywords: human-centred design; prototypes; workshop; squirrels; design research

1 Introduction

The University of Illinois at Urbana-Champaign, established in 1867, is a land-grant university, sometimes referred to as one of the “public ivy” schools. Its prestigious status was one of the intentions of the founders, as is evidenced not only by the size of the campus, but also by its impressive architecture. And also by the squirrels. They are grey squirrels, not native to the area, but rather imported—along with the architecture and ivy—from elsewhere. A breeding project in 1902 sought to domesticate squirrels to the campus (Miller, 2018) and succeeded, after two years, in establishing a population, though the squirrels were not, and never have become, tame (Grennan, 2012; Figure 1).
The eastern grey squirrel (*sciurus carolinensis*) gets its Latin name from its habit of sitting in the shade of its own tail (*sciurus*), combined with where it was first observed by European taxonomists (in the Carolinas). These squirrels are easily observed on campus throughout the year. They have a rich vocabulary of sounds (ranging from quacks and moans to a short puffing noise) and their vocalizations include an alert, an alarm, and an all-clear. These three main vocalizations make it clear that they are cooperative creatures. Their body language is also complex, and the position and activity of their arms, tails and ears are all significant (Bates, 2014). Individual squirrels may display particular *character traits*, demonstrating more or less aggression, curiosity or willingness to tolerate risk (Cooper, Neff, Poon & Smith, 2008).

Students on campus are generally positive about the presence of squirrels, to the extent that “Sassy the Squirrel” has become an unofficial mascot (Figure 2). The University of Illinois is not by any means the only university that feels that squirrels are somehow an appropriate symbol for an academic institution; Kingkade (2013) lists 50 in the US alone. Yale, Harvard, Princeton, and Vassar are all on the list. Penn State, famous for its black squirrels, has a squirrel Facebook page and Twitter account, so that students can find observations on the campus from a squirrel’s perspective. University of Texas at Austin has albino squirrels; it is considered good luck to spot one when heading into an exam. Squirrels are the official mascot of Mary Baldwin College. Given these various degrees of enthusiasm, Illinois only appears in the honourable mentions in a list of squirrel-positive campuses (Kingkade, 2013).

Unfortunately, the lives of the urban squirrels at University of Illinois are not as luxurious as one might hope. The university and its surrounding communities boast an impressive number of high-canopy, squirrel-friendly trees, but only a minority bear the nuts or seeds that gray squirrels rely on as their primary food. The area around the campus has a fair amount of the greenspace that helps urban populations thrive but bird feeders, a welcome source of supplemental food for many gray squirrels, are few and far between (Parker & Nilon, 2008). Instead, human garbage is supplying the squirrels’ food deficiencies. It is not unusual to see them at the University of Illinois, as elsewhere, foraging in garbage cans and dumpsters for French fries, candy, stale rolls and the occasional piece of leftover pizza. Similar food interests, and in particular fast food, might therefore be considered a relational space for people and squirrels. In the main quad, where students (and their meals) are readily found, squirrel nests can be spotted in clusters around the most promising garbage cans, and fresh snow will show a starburst of squirrel tracks around any accessible source of waste food.
However, the provision of better food is only one possible approach to improving the lives of urban squirrels, and it is not always a wise course to undertake a project of that kind without sufficiently understanding its possible effects on the larger ecosystem of which those animals are a part. Many systems link humans, squirrels and the urban environment, and the complexity and sensitiveness of these interactions is hard to overestimate. The connection between grey squirrels and oak trees, for example, is so old as to be co-evolutionary, but biologists are still uncovering its details. It is a complex system involving both benefit (nutrition, living spaces, nesting material, seed distribution) and harm (indigestible tannins, trunk damage, seed destruction). Squirrels sometimes resort to startlingly sophisticated tactics to gain the upper hand—for example, sterilizing certain acorns by chewing a notch in them that prevents germination (Steele, Turner, Smallwood, Wolff & Radillo, 2001).

Figure 2. “Sassy the Squirrel” (Veronica, 2015).

The relationship between humans and grey squirrels is not immune from issues of culture and change. Although many universities, including the University of Illinois, have thought of the grey squirrel as a symbol of status; for many others, the squirrel is primarily a pest. Newly arrived out-of-state students in particular can sometimes be seen responding to the approaches of University of Illinois squirrels by shrieking or recoiling in horror, as though they were being approached by a creature that is verminous. The word *vermin* is a somewhat painful one in English, since it means, essentially: “you are alive but I wish you were not,” or, at best: “you are alive but I wish you were not living near me.”
Many of the qualities that these students may fear—violence, rabies or squirrelpox—are rare or non-existent in gray squirrels. But the systems that link humans and squirrels within the urban environment are constantly changing, producing new kinds of relationships and interactions. At the micro level, the presence of students and other human beings on campus has a cumulative effect on squirrel behaviour, making them less likely to flee both people and dogs (Cooper et al., 2008). At the macro level, many students travel to and from campus using vehicles that produce greenhouse gases, contributing to wide-reaching environmental change that impacts the lives of local gray squirrels among many other living creatures. Experts predict, for example, that changes in climate will expand squirrels’ role as a global invasive species in coming years (Di Febbraro, Martinoli, Russo, Preatoni & Bertolino, 2016).

2 Background on Design for the Nonhuman

Increasing interest in the environment has caused some designers to ask whether the emphasis on human-centred design has led in a direction that is less than optimal (e.g., Forlano, 2017). Primarily intended as a corrective to the idea that the designer can stand in for the user, human-centred design has produced decades of work that is more useful, attractive, and enjoyable to use from the perspective of the actual users, as opposed to the users as the designer might have imagined them to be. Although still not ubiquitous (c.f., for instance, in the contemporary practice of architecture), human-centred design has also been challenged as not going far enough, resulting in its expansion into participatory design, where the users are not just studied but are also actively consulted, and engage in co-design, where they take a role throughout the project.

Unfortunately, however, this laudable effort has had the possible connotation of emphasizing that the proper interest of design is in serving people, to the neglect of other sentient beings and the environment. This state of affairs has not escaped the notice of some designers. Temple Grandin, for instance, famously walked the path to the slaughterhouse as a way of better understanding the perspective of the animals (Grandin 2013), resulting in somewhat more humane designs of an experience that unfortunately marks the violent end of approximately 40 million cattle each year in the USA alone.

On a more positive note, Adreon Cheok’s poultry internet project was an attempt to consider the daily lives of chickens who are kept as pets in Asia (Lee, 2006). His team produced a jacket the chicken could wear that would allow the owner to pet the chicken remotely. Less interested in the experience of the owner than that of the chicken, they devised a study where the chicken could choose between one door that led to food and water, and another that led to food, water, and the jacket. Nearly three-quarters of the time, the chickens chose the second door.

In their work at the National Zoo of Chile, Hermansen and Tironi (2018) had students develop a series of prototypes to try to improve the lives of the animals. Originally conceived of as a means of having students understand that they are not adequate stand-ins for the user, the project had the additional advantage of making it more difficult for the students to encounter the observer expectancy effect, where study participants are inclined to try to please the investigators by telling them what the participants imagine they would like to hear. Hermansen and Tironi have theorized this work with reference to Isabelle Stenger’s concept of the cosmopolitical, where an “idiotic” encounter results in a reflective pause in the normal course of events, providing a space for incorporating the perspective of actors not usually given a voice in conventional politics.

These forays into developing designs that acknowledge and incorporate the non-human inspired our student workshop on design for the urban squirrel.

3 Workshop Design

The advertising copy for the workshop briefly outlined the history and contemporary situation of grey squirrels on campus, and described some of the key activities of squirrels that might benefit from design intervention:

Designing for the Nonhuman is a workshop that will engage students by asking them to evaluate the built environment from multiple perspectives. It is common that design problems are framed for a certain demographic and the requirements of a client are carefully considered, analysed, and investigated before developing a solution. However, designers are rarely asked to lay on the ground, stand on a trash can, or climb a tree to gain insight into their client’s needs.

Workshop participants will do all of the above as we try to understand how to provide the proper habitat for a small non-native creature on our campus. A little known historical fact is that University of Illinois President
Andrew S. Draper and University Trustees entrusted Professor of Geology Charles W. Rolfe with $250.00 and the significant responsibility of enlivening our campus with squirrels. President Draper, a strong supporter of the mission of Land Grant Institutions, stated, “If successful, the influence upon University life, and upon the feelings of students, would be considerable, and students would carry that influence to all parts of the State” (Grennan, 2012).

While difficult to assess the direct impact of these creatures, the contributions of professors and students has been quite tremendous ever since. Despite the academic and intellectual prosperity, our furry friends have been neglected any recognition. Moreover, the 21st-century descendants of this species have been observed to be feeding off trash. How might this be remedied? Workshop participants will be faced with this question and provided materials to help create a built environment that responds to the needs of a very important co-inhabitant on our campus.

Approximately a dozen students signed up for the event. They were provided with some suggestions for homework they could do before arriving on the day. These consisted of secondary research using YouTube videos that could be located using the following search terms:

- squirrel plays with stick
- squirrel eating

Although it may seem surprising for anyone who has not looked, there are a variety of videos that show squirrels picking up a stick and seeming to toss it around at random. If it drops the stick, it will pick it up again and do some more juggling. What these videos seem to suggest is that at least some squirrels are interested in finding ways to amuse themselves. We have certainly observed them chasing each other, sometimes in the service of mating, but also in aggressive competition for food, territory or, in the case of young nest-mates, what appears to be just pursuit in the style of the Marx Brothers, where there is an unspoken rule that the person in the lead cannot be cut off, but instead must be closely followed, no matter how circuitous the path. Videos of squirrels eating are even more common, perhaps since there is something charming about them holding the food in their paws, turning it around, and in the cases of nuts or peanuts, chewing through the shells. Although it was not essential for everyone to watch videos in advance, we felt that it would give people a starting point and perhaps prime their creative curiosity.

When the participants arrived at the workshop, we greeted them outside the building, where they were instructed to spend 20 minutes in primary observation of the squirrels. We emphasized again the difficulty of getting to know the user in a case where the animals were not tame, so that the cosmopolitical agenda is often complicated by a certain recalcitrance to participate. To facilitate the interaction around the relational space of food, each student was handed two peanuts that they could use to feed a squirrel. Upon their return, the students were energized by the complexity of dealing with the squirrels. No squirrels were willing to come up to a student and accept a peanut from the hand. In fact, they were more inclined to play coy, either running around behind a tree, scampering up the branches, or sitting on the ground and pretending to have something else interesting going on. Squirrels routinely attempt to deceive squirrels and other animals about the locations of their food stashes, so deception is part of their daily lives.

The students had to respond to the squirrels by tossing the peanuts to them in various ways—against a sidewalk that would make an attractive sound; at the foot of a tree where the squirrel was able to see it; near where the squirrel was sitting so that the smell might be enticing once the student turned away and was no longer obviously looking. Although peanuts are less nutritious than some other kinds of actual nuts, they are readily obtained and safe enough as long as the shells are fresh.

After the students had the experience of interacting with the squirrels, they came into the studio and were given the brief: using a rough collection of wood that had been recovered from a local barn demolition, design and build a prototype to find out more about squirrel behaviour in one or more of the following areas:

- nesting
- eating
- drinking
- washing
- storing food
- playing
The purpose of this list was to constrain the exercise sufficiently for participants to quickly begin getting ideas, while at the same time not limiting the scope unnecessarily. Note, for instance, that the goal of the prototype was not to address a problem and find a solution. It would have been possible to produce a design brief that framed the project this way. For example, we could have said “the squirrels on campus eat too much garbage. Figure out a solution.” However, one of our larger, ongoing agendas is to suggest that design research through prototyping is a valuable approach to new knowledge production. Since we were holding the workshop at a tier one research university, even undergraduate students can be expected to have had some exposure to methods of knowledge production in their own disciplines, although not necessarily in design.

Although a quick briefing, a few minutes of online video, and 20 minutes of throwing peanuts provided some knowledge, this was really only at a superficial level. This was obvious to the participants. The purpose of the prototyping exercise could therefore be recognized as a way to consider how more could be learned, either through creating an object that helped the students to think, or through creating a research instrument that could be placed in the environment so that observations could be made of the squirrels interacting with it.

From the options we suggested, the teams chose playing, eating, bathing, and storage (Figure 3). However, in several cases there was more than a single option being studied. For example, one of the “fun” activities imagined the squirrels jumping up a stair to retrieve a nut perched on the top of a post. One of the “feeding” activities included a board only fastened down on one side, so that reaching the nuts might be more fun, since it would require some unusual balance and dexterity.

The prototyping exercise itself was done in two parts. First, we asked each team to do some conceptual work on paper, sketching out one or more ideas, and explicitly identifying which aspects of the squirrels’ lives they were going to try to learn more about (Figures 4 and 5). They were initially given only 20 minutes to complete this phase, although in fact we extended the time closer to 45 minutes once we realized that they had a lot of ideas and not much experience with sketching.

We then reviewed the sketches as a group, offering additional ideas and helping each team select which of their concepts they wanted to build. In some cases (e.g., Figure 4) the decision had less to do with the potential research value and more with the limited time, equipment, and materials that were available.
Figure 4. One of the ideation pages (this one by a designer) shows a dust bath (relatively straightforward to build) and a possible game (decidedly more complex).
4 Analysis and Discussion

As a brief event intended to introduce non-designers to design thinking, the workshop was largely a success. Since we had structured it using the standard design sequence of secondary research (videos), primary research (feeding the squirrels), conceptualization (sketches), and prototyping (building), the participants were able to experience how the process works. They were also introduced to the idea that a project could begin at any stage, and would typically cycle through more than once.

We observed many of the students going through a process of approach and retreat with the concept of prototypes for research questions. During conceptualization, for example, the participants did quickly realize that there was a lot to learn about squirrels, and that they knew relatively little. During the review of the design sketches, for instance, it was obvious time and again that we simply could not answer questions about squirrel thoughts, emotions, behaviours or preferences. The question was repeatedly asked “how do you think a squirrel would respond to X,” to which we could only answer “that is something that it would probably be worth finding out.” This lack of knowledge made it comparatively easy to think about ways that a prototype might help us understand better.

As the participants began the building phase, however, we observed a shift towards thinking of the prototype as a commodity—an object designed for a user. Since the participants were for the most part non-designers, their fabrication skills were minimal and forced them to focus tightly on the practical details of construction. Talk at the task stations became almost entirely about the affordances of the object, and questions about squirrels faded from student conversations. During this part of the exercise, we might say that the students were engaged in design-driven innovation (Verganti, 2009), having temporarily set aside the focus on the user. This change of mode across different points of the workshop might lead us to inquire whether there is a cycle at work, not just for participants who are non-designers, but in fact for all participants, where rather than holding multiple concerns in mind throughout the
process, some sequence is happening of addressing user concerns, setting those aside for technical concerns, returning to user concerns, and so on.

That said, at the end of the day, the research function of the prototype came to the fore again as participants evaluated their final products. We observed “if-then” conversations taking place around the object: “if the squirrel uses X, we could always shorten Y” or “if it can’t get around A, we can add another one at B.” Thinking in terms of if-then causal connections is nothing new to university students, but in this context, we were able to see that the teams were using this construction in trying to imagine how the squirrels might behave. That is, they were asking research questions and thinking about how this first generation of prototypes might give them some answers. This is very different from the initial prototype being the start of a sequence toward an eventual commodity.

![Figure 6. Participants with questions for the squirrel. What if we put a peanut on the top of this peg? Will they use the ramp or the stair or some other way of getting it?](image)

The workshop was scheduled as part of a larger campus-wide event, and gave us only a few hours. This turned out to be too short for most of the task groups. Their lack of design experience meant that there was not a pre-existing body of making skills that we could draw on. As a result, several of the teams worked over time, and a couple of them did not complete the prototype. In some respects, this is fine, since the purpose of the exercise was to think through making (Ingold, 2013), and specifically to think about how a prototype might help us understand more about a topic we have not fully explored. From that perspective, whether or not the artifact is finished is somewhat irrelevant.

5 Conclusion

In some respects, this workshop was an experiment in how much can be accomplished in just a few hours, in terms of introducing students to prototyping as a research method and in considering design for the non-human. Since our participants were largely non-designers, we were also introducing prototyping and thinking through making. The outcomes suggest that the workshop was largely a success in meeting these goals. Participants could be seen moving through multiple phases of thinking, considering at different points in the process the importance and difficulties of understanding the nonhuman user, how prototypes might contribute to that understanding, how those were different from prototypes that constituted potential commodities or services, and how the constraints of materials and skills on production played a non-trivial role.
In repurposing the workshop for design students, it would be necessary to emphasize that this use of prototypes is significantly different from the typical use. For designers, the use of prototypes outside the context of taking steps toward a new commodity of some kind is sufficiently unusual that there are habits of mind formed through previous training that need to be overcome. Further, that the audience should be not human is a novelty that in itself may not make entire sense. It would therefore be useful to take the time to explicitly critique the paradigm of human-centered design.

Given more time, the logical next step would be to put the experimental prototypes into the field, in order to find out what could be learned by observing squirrels interacting with them. This is a key component, for instance, in the work done by Hermansen and Tironi (2018), who were dealing with animals in captivity, but still nonetheless were faced with the recalcitrance of the user to follow a program of action planned by the designers. Following these initial observations, a next generation of prototypes can be produced to address the new questions that have arisen. Ideally, the result would be a report of what was learned, so that subsequent projects could draw on that knowledge to produce commodities.

In summary, the process of learning to prototype research questions has, in our experience, many layers of discovery. The participants were hungry to pursue these.

References


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Using Cat-Centred Research to Learn the Design Thinking Process

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Abstract: A new design centre at an American university was given the mission to incorporate design thinking and human-centred design across the university through multi-disciplinary collaborations. An opportunity arose with the university’s College of Veterinary Medicine to conduct research around cat house-soiling in preparation for a Hackathon to create new products and services to combat this type of behaviour. The design centre worked in collaboration with veterinarians to adapt the design thinking process to incorporate both cat owners and their cats while allowing students the chance to practice their design thinking skills in combination with an exploration of interspecies relationships. Through in-context field research conducted in cat owners’ homes, students used both human-centred and cat-centred design techniques to understand the cat-cat owner dynamic. By observing cats’ environments, behaviours, and human relationships, students were able to uncover three key opportunity areas for design around house-soiling for the Hackathon participants: leveraging data to modify cat behaviours, owner acceptance of existing undesirable behaviours, and a lack of understanding amongst owners for their cat’s motivations and intentions.

Keywords: other-than-human centred design; experimentation in design education

1 Introduction

At many universities across the United States, the philosophy of human-centred design has garnered great interest as an approach to identifying opportunities for innovation. Many of these universities are thus creating design centres to further promote and teach this process. This year a large design centre started its initiative at a well-known American university. This centre’s mission is to foster multidisciplinary collaborations across campus, using design thinking as an approach to promote human-centred design and mandated quick iterations. Being new to the campus, the centre was looking for opportunities to teach design thinking and human-centred design within a university setting. Early on, a Hackathon focused on specific cat behaviours, sponsored by the university’s College of Veterinary Medicine, emerged as an opportunity to experiment with the design thinking process through a non-human-centred lens. With the design centre team’s goal to collaborate broadly across the university, the question emerged why not cat-centred design? This Hackathon would allow more direct interaction with students and further the centre’s mission, all while promoting design thinking’s application to non-traditional subjects (e.g. cats). The opportunity would allow the centre...
to showcase how design thinking is not a concrete process; one must always be adapting, evolving, prototyping, and experimenting within the process as needed in order to capture the necessary insights. Additionally, design research would allow Hackathon participants to better understand the challenge of the Hackathon while learning the design thinking process and applying it to their prototypes.

While the processes described throughout this paper may resemble speculative design, adversarial design, or other less solution-oriented forms of design, the clear impetus for the work was a product-oriented hackathon. The aim of producing a low-fidelity solution to the problem of cat house-soiling presented a clear bias towards action a well-documented fundamental tenant of today’s practice of design thinking (von Thienen et al., 2018). Broader conversations resulting from the research conducted do examine the very aim of the initial prompt and open up the phases of a cat’s experience for further questioning, but ultimately the purpose of the project was to inspire the creation of solutions to this problem space. Experimentation, as discussed in this paper, should be viewed as in the lens of Hans-Jörg Rheinberger’s experimental system (Rheinberger, 1994). Action was taken in the spirit of “let’s just try and see what happens”, not in the rigorous analytical methodology one may associate with traditional scientific experimentation.

2 A Hackathon to Address Cat House-Soiling

Traditionally, university Hackathons are multi-hour events in which computer science students compete to create a prototyped idea to solve a given problem and the best ideas are awarded a prize, often a cash reward. Some Hackathons attract students outside the realm of computer science, but computer science remains the most common field of participation. However, recently there has been a shift toward Hackathons encouraging those in all departments to participate.

Two alumni of the aforementioned university’s College of Veterinary Medicine had recently formed a new company focused on innovation in the field of veterinary medicine called VetMed2.0. Being young and looking to interact with their alma mater, VetMed2.0 came up with the idea of hosting a Hackathon surrounding a topic in veterinary medicine. They decided upon cat behaviours, specifically cats eliminating outside of their litter boxes, as the focus for this Hackathon.

The issue of feline house soiling is of great concern to many veterinarians and animal lovers alike as it results in many cats being relinquished to shelters, which unfortunately often leads to euthanization (stated by Dr. Aaron Smiley, DVM). The American Association of Feline Practitioners (AAFP) and the International Society of Feline Medicine (ISFM) have created a brochure for cat owners that details all the known reasons for why a cat may eliminate outside of its litter box [Appendix 1], along with a worksheet listing what owners can do in attempt to remedy the situation [Appendix 2]. Though these resources exist in addition to veterinarian and animal behaviour specialist recommendations, there are still cats and owners facing this problem. Understanding that despite these resources the issue of house-soiling remains, VetMed2.0 felt it would be appropriate to use as the problem of interest for their Hackathon.

3 Leveraging the New Design Centre’s Mission

Around the same time that this Hackathon was being planned, the design centre at the same university was structuring its first official year on campus. Following the like of giants such as the Stanford Hasso Plattner Institute of Design, these design centres aim to teach human-centred design through various courses and programming. While some American design centres are located within a specific college such as engineering or the applied arts, this centre is not affiliated with any college on the campus and aims to offer a space for multidisciplinary collaboration regardless of one’s focus or background.

Being in its first semester, the design centre had five main initiatives: building design thinking mindsets, leveraging students’ passions for social innovation, teaching basic design thinking skills, working with the humanities to build dialogue into design and action, and facilitating multidisciplinary projects. To fulfil these initiatives, the design centre began offering a variety of resources and planned several programs to engage the campus community and raise awareness of the centre’s presence. The centre’s first-semester offerings were courses on design thinking and partnerships with the humanities, large-scale collaborative events focused on raising awareness, campus-wide student-focused projects, and small-scale educational events. Pop-Up Workshops were created as one such small- scale event, creating opportunities for members of the university to experience the process of design thinking and human-centred design on a smaller scope than they would taking a semester-long course on the topic.
Early at the start of the semester, the design centre’s director crossed paths with the VetMed2.0 team, who had been looking for organizations to potentially collaborate with. The design centre thought this could be a unique opportunity to not only practice human-centred design, but also experiment with cat-centred design, given that both humans and cats living together needed to be observed and understood in order for one to understand opportunity areas for design. In discussions with the VetMed2.0 team, it was decided that the design centre would conduct field research on cats, interview and observe said cats’ owners regarding their experiences, and consult veterinarians with professional knowledge regarding the issue.

With one of the centre’s initiatives being to teach design thinking skills, a Pop-Up Workshop was constructed and students were invited to join the centre’s team during the research and synthesis process. Findings would then be presented to the Hackathon participants to provide empathy for both cats and cat owners facing this particular behavioural situation and aid user groups in the prototyping of possible solutions.

4 Conducting Field Research to Include Both Cat Owners and Cats

A typical human-centred design project would begin with recruiting research participants to shadow and interview in order to collect insights around emergent behaviours and unmet needs. For this research, both local house-soiling cats and their owners were contacted for observation and interviews. To source these local cats and cat owners, a survey was created and dispersed for cat owners to fill out detailing information about themselves and their cat(s) [Survey Questions for Cat Owners]. After the survey was closed, cat owners experiencing the target problem were contacted to participate in a one-hour interview in their home. Immersion in the cat’s world would allow Pop-Up participants to gain empathy for the cat’s unique situation(s) and develop an understanding of the cat-cat owner dynamic. Students who joined in the field research were given a booklet [Appendix 3] containing interview tips and techniques along with suggested interview questions to guide them through the process.

4.1 Survey Questions for Cat Owners

1. Tell us a little about yourself.
2. What is your first and last name?
3. What is your email address?
4. What is your gender?
5. What is your age?
6. What is your marital status?
7. How many children live in your home?
8. How many cats do you have?
9. Tell us a little about your cat(s).
10. What is/are your cat(s) name(s)?
11. What age is/are your cat(s)?
12. Tell us more about your litter box issues.
13. Let us know if there’s anything else you’d like to add about your cats!

Overall, seven different cat owners, with a total of nine cats, were interviewed. Interviews with cat owners and observation of individual cats (Figures 1 and 2) and scenarios of house-soiling (Figure 3) contextualized the existing ecological demands on cats. This research provided a deeper understanding for cats’ lives and behaviours -what may have instigated changes in behaviours, what might have frightened them, what their responses had been to a change in the family, how owners treated them and dealt with the situations, how the families may have not been able to reconcile the new behaviours and were now dealing with the house-soiling scenarios.

After each interview, the design centre team and student participants relocated to the team workspace to debrief and synthesize the information gathered (Figures 4 and 5). Student participants in the Pop Up were thus able to experience both the interview process as well as the synthesizing of insights to guide further design -two crucial steps in design thinking. Interviews and observations established an initial understanding of the existing ecological demands and surrounding environments for all the individual research participants -the cats and their respective owners.
Figure 1. Meeting cat Zoe in her home.

Figure 2. Observing one of the cat’s in-home eating environment.

Figure 3. Surveying the damage from the house-soiling of one of the cat research participants.
4.2 Overview of the Seven Interviews

4.2.1 Interview 1: Owner Peggy and Her Cats Nemo and Sunny

Peggy is a recently widowed woman in her sixties living alone with her two cats Nemo and Sunny. She is a long-time cat owner and volunteers at the local humane society. Both of her cats are from shelters and both were declawed prior to Peggy’s ownership. Nemo is an 8-year-old cat with diabetes. His diabetes causes him to urinate more often, usually on the pads Peggy has placed around the 6 litter boxes in her home. Nemo is more reserved than Sunny but has more house-soiling problems. Sunny is a very social 12-year-old cat. Though he is outgoing, he is very sensitive to sound and tends to urinate outside of his litter box when there are loud noises, such as when Peggy’s grandchildren visit or when Peggy uses her new vacuum cleaner. There is a screened-in porch in the house that he loves to relax in, and he gets sad when it is too cold to use. Peggy’s house is large and thus has litter boxes in almost every room. She said that no cats she has had have ever liked covered litter boxes, so all of hers are open. She uses tidy cats unscented litter and stated she doesn’t clean the litter boxes too often. She noticed that both cats prefer using a litter box close to where people are in the house so they can watch out for people. With her home being renovated at the time of our interview, she said when the carpet in her family room was first ripped up the cats could smell an animal that previously lived in the house and would urinate on the floor. The floor was then sealed which seemed to solve this
problem. Occasionally Peggy uses a hormonal spray to deter the cats from urinating on furniture. She also hangs plastic on the walls surrounding the litter boxes to protect them.

From this interview, two potential opportunities emerged: how might we protect the walls and floors in houses where cat soiling is imminent and how might we account for inevitable stressors such as noise?

4.2.2 Interview 2: Owner Amy and Her Cat Seraphina

Seraphina the cat lives with Amy, her husband, and her son. Amy’s daughter used to live with them but has since moved out for college. Seraphina is the family’s first cat and is 6-years-old. She was bought from a breeder in Indiana as a kitten. When she was first brought home she hid under a couch for a week, and it took 6 months to a year for her to adjust to her new home. She also had to be taught to use her litter box, not instinctively knowing how to use it. She is cared for by a sitter for one week twice a year but shows no difference in personality during those times. She only has one open litter box in the basement of the house. At one point, the basement flooded but that did not deter Seraphina from using her box. She used to have a problem with urinating on the couch and people’s clothes, but a homemade repellent stopped this from happening. Amy’s husband can now point toward the litter box and Seraphina will use it.

Based on this interview, it was discussed how cats learn cat-behaviours, how owners learn as part of this process, and what happens if there are challenges with either user group.

4.2.3 Interview 3: Owner Rachel and Her Cat Mika

Rachel, her husband Jeremy, and their twin daughters live with their cat Mika. Rachel and Jeremy work seasonally at a local apple orchard where there are several orchard cats that roam the premises freely. Mika was one of those cats, and they decided to adopt her when all the cats were up for adoption at the end of the season. However, one day she disappeared. Rachel and Jeremy posted for her to be brought back if someone took her, and she finally was. She seemed well cared for, so they assumed someone took her as their own for a period of time. Mika seemed fine after all this when they initially brought her home and wasn’t having any house-soiling problems. She would climb on their curtains and rip them up, so they decided to get her front claws declawed at the same time she was spayed. They noticed she became less playful after being declawed. When she was around 2-years-old they started noticing that she was urinating on the carpet as well as on clothes on the ground. Rachel stated that she would urinate on things after being messed with, though she never urinates on Rachel’s clothes. Mika has two litter boxes that are covered and has never had an open litter box. Because of the house-soiling problem, Rachel and Jeremy began confining Mika to smaller portions of the house, until she was finally only allowed in one room. Mika prefers Rachel the most though Rachel doesn’t like her much. Mika also doesn’t like children, including the twins, or other cats, and is very territorial. She needs to be petted every night or she will urinate on things. She enjoys being outside, though one time she randomly attacked Rachel outside. Besides her house-soiling problems, she is a healthy cat. Her vet recommended a hormone spray to deter her from urinating places, but it was very costly.

Based on this interview, better preparation of humans for cat ownership, adaptation of spaces to accommodate for old behaviours a cat exhibits, identifying trauma in a cat, and identifying moments of non-routine in a cat presented themselves as opportunities for design.

4.2.4 Interview 4: Owners Marsha and Randy and Their Cat Zoe

Marsha and Randy live in a house built in the 1920s and are themselves in their 70s. They have two daughters that have moved out, and they were currently replacing their carpet when we interviewed them, due to extensive cat house-soiling problems. Zoe is their first cat, and they admitted they don’t have much experience with cats. Zoe was brought home as a kitten and is now 17-years-old. Four years earlier their basement flooded, which was where Zoe’s litter box was. She started having house-soiling problems after this incident and would act confused when she was put in her litter box. She was treated at one point for a bladder infection and was started on a new diet, though there was no follow-up with her vet. Marsha and Randy noted that she seems to prefer a dirty litter box and suggested she may have problems smelling it when it is clean. Her problem got better until Marsha and Randy went on vacation. She then started urinating in dark or corner areas. Marsha and Randy have resigned themselves to Zoe’s behaviours, saying she’s like a family member with a health problem. They’ve tried many different litter boxes and litters and moved the box to different locations in the house. They finally began keeping a tally of when she would go to the bathroom so they could know when to put her in her box.

This interview brought into question how we might adapt spaces to accommodate new cat behaviours and reminded researchers of analogous situations such as incontinence in the elderly. Marsha and Randy trying to understand Zoe’s
situation by using a tallying method to quantify the behaviours of their cat was indicative of opportunities to capture data to better track and change undesirable cat behaviours.

4.2.5 Interview 5: Kaity and Her Cat Cali
Cali is a 4-year-old cat living in a small apartment with her owner Kaity. One of her two litter boxes is in the kitchen area and Kaity stated she is very efficient cleaning them out. Kaity said Cali is very playful but vengeful, though she loves people. It was noticed that Cali seemed to occasionally get stressed around 10pm. Lately she has been urinating on anything made of paper or box-shaped, and one time urinated on a DVD case. Her house-soiling problem is not unique to her current apartment, as Kaity stated it started two apartments ago. Kaity also said she does not have room for a very large litter box but has two smaller open ones that Cali seems to use equally. She’s tried many different types of litter, but nothing has helped. She says Cali will urinate anywhere, even if her litter boxes are clean.

This interview made researchers question how we might create a space-saving litter box and if there is potential for some sort of stacked litter box.

4.2.6 Interview 6: Megan and Her Cats Hans, Casper and Sophie
This was our only three-cat household. Hans is one-years-old but was brought home at two months. He is a very large cat and does not have any house-soiling problems. He is friendly to other cats but tends to bully Sophie. Sophie is a very social 2-year-old cat that was brought home at 6 months. She was pregnant when she was 6-months-old and had two kittens, though they both passed away due to how small Sophie was at the time she had them. She doesn’t cover her excrement when she uses her litter box and has issues with getting her paws dirty. Megan tried toilet training at one point, but it didn’t stick. Casper is a 12-year-old, three-legged cat. His back leg was amputated due to infection, but he is able to get around fine. However, he does have issues using his litter box because he can’t squat down, leading to urine going outside of his box. Megan tried using a closed litter box, but urine still got out. He is a shy cat and has been with Megan for 10 years. When he gets anxious, he likes to go to Megan’s parents’ house, and will stay there if Megan is away. He occasionally is bullied by other cats at Megan’s parents’ house, with which he has to share a litter box. He does not like children much but will tolerate them. His litter box currently is just a pan and he has two litter mats surrounding it, though he still manages to track litter throughout the house.

After this interview, researchers questioned how we might make a litter box with high walls for disabled cats such as Casper, how we might make a litter box that cleans a cat’s paws or masks odours, and how we might design a litter box that makes cats such as Casper aware of its entrance.

4.2.7 Interview 7: Argentina and Her Cats Stevie and Evie
Stevie and Evie are about 2-years-old and live in a home with 2 adults and 2 children. Evie is an overweight cat and started urinating outside her litter box a few months after her family returned from vacation. She has urinated on clothes left on the floor, the sofa, the daughter’s bookbag, and all over one of the children’s room while the child was away for the summer. She has also lost a few pounds in the past few months because of a new diet. The other cat, Stevie, has not had any house-soiling problems. They had multiple litter boxes in their house, but they were all way too small and Evie could barely fit into them.

After this interview, further questions on why cats tend to urinate on human-scented things, and also if cats will act out due to the size of their litter boxes remained as opportunities for exploration.

5 Including Expertise from Veterinarians to Provide More Insights into Cat Behaviours
Through the storytelling and synthesis process for the field research, common insights around opportunity areas for design in the house-soiling scenarios were compiled. Patterns emerged around cat and cat owner behaviours that could be addressed with expertise from the veterinarians on the VetMed 2.0 team. A series of questions was created to fill in the gaps of knowledge and posed to these experts. The answers to these questions were to be explained during the Hackathon to help participants better understand cat owners and their cats.

5.1 Questions for Veterinarians and Corresponding Answers
1. What is the recommended size for a litter box?
   The recommended size of a litter box is 1.5 times longer than the cat it’s for. However, cat owners tend to not want to buy a large litter box, which could be the cause of many house-soiling incidents.
2. Should a litter box be opened or closed?
   Litter boxes are recommended to be open – cats are generally afraid of being trapped.

3. Are there any alternatives to litter boxes?
   There are many alternatives to litter boxes; cats can be toilet trained or trained to go to the bathroom outside, but owners are wary to do anything besides litter boxes because it's not generally how owners want to interact with their cats.

4. What is it about urinating on soft things on the ground?
   Cats will urinate on anything; they prefer clay litter but otherwise owners should use non-perfumed, non-clumping litter. Soft things hold smells better, and cats want to mark their environments with scents.

5. How else do cats mark their territory?
   Cats mark territory by rubbing with their paws, face rubbing, or urinating on things.

6. Are there artefacts or signifiers in the house that have meaning to a cat?
   Not necessarily, but owners can observe how a cat moves around its environment and take note of what it's comfortable with. Cats move through a house differently than owners would, and a cat would divide up a room in a non-fixed structure.

7. Is it typical to not contact a vet about litter box issues?
   Rarely do owners contact vets regarding litter box issues – we hear about urinary tract infections, but maybe owners do not think vets can help with house-soiling? Additionally, behaviourists are expensive.

8. How does a vet usually follow-up about litter box or behavioural issues?
   It's difficult for a vet to follow-up about such issues because owners tend to not schedule follow-ups—compliance is terrible.

9. Do cat owners usually resign themselves to these behaviours?
   Yes; owners will resign themselves to their cat's behaviours because it's easier.

10. How is trauma diagnosed and treated in cats?
    One thing that must be considered is that cats can be primed at young age to stress, even while in their mother's womb. It is difficult for a vet to diagnose trauma in cats, and even more difficult to treat – cats are hard to pill.

11. How do cats recover from trauma?
    They find ways to change their environments – cats will try to take control of their situation, such as limiting stress, getting up high, getting secure food sources, etc.

12. Do cats get angry? Do they urinate out of spite?
    Spite is a high-level emotion, which is impossible for a cat to comprehend. There’s a new smell, so the cat is going to urinate on it to put their scent on it – this is my territory. Everyone needs to know this is my house.

13. Why are some cats more adaptable than others?
    Some cats just happen to be more adaptable than others, as is the case with humans.

It is worth noting that several of the insights gathered from the veterinarian interviews may come under scrutiny when examined with attention to the perspective of the cat. Some animal psychologists, such as Vinciane Despret, may argue that higher level emotions and considerations of abstract concepts like spite or freewill are well within the capacity of a cat. Despret has suggested that cat's perform *feline civil disobedience* (Bussolini, 2013). Further consideration of cats' capacity of higher level cognitive functioning were not accounted for in this research due to limited time and resources. However, further investigations into these issues may show that the 'spiteful cat' is a useful behavioural persona to pursue for design.

### 6 Final Hackathon Opportunity Areas for Cats and Cat Owners

From observations, interviews with cat owners, and interviews with veterinarians, three opportunity areas were identified that Hackathon participants could explore for new product ideas:

1. **The Quantified Cat**
   With technology available to capture data around a cat’s daily activities, what might an owner learn about her cat that could better help the owner adapt a situation to the cat’s existing behaviours? Quantification of the pet-human relationship is already being investigated by researchers interested in the field of human computer interaction (Lawson, Kirman, Linehan, Feltwell & Hopkins, 2015).

2. **The New Normal**
   When owners accept new behaviours from their cat, whatever these may be, how might the environment adapt to this “New Normal”?

3. **Preventing Owner Error**
Cat ownership is perceived to be easy – cats are thought to be convenient, inexpensive, and good for small spaces, and therefore a good choice for first-time pet owners. Additionally, many owners perceive house-soiling as a spiteful behaviour and yet experts know that spite is a high-level emotion cats are incapable of comprehending. How might we help educate new cat owners to the world and behaviours of their new cat?

7 Conclusion

Through this research, design thinking was carried out in a non-traditional manner, forgoing the typical anthropocentric biases of human-centred design for cat-centred research. While human owners and veterinarians were interviewed as part of the process, all insights were taken in the context of the cat’s experience. In the instance of the spiteful urination explanation amongst owners, it was found that anthropological bias with owners was contradicted by species experts (veterinarians). Additionally, exploration of the interspecies relationship between humans and cats identified three opportunities for design: the quantified cat, the new normal, and preventing owner error. These opportunities then guided the designs of the Hackathon. In addition, students learned the value of empathy and observation, key techniques of the design thinking process, whether with human or other-than-human research participants.

Acknowledgements:
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References


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Rachel Switzky is the director of the Siebel Center for Design. Prior to her current appointment, she has been a global design leader working with Fortune 100 companies over the past 20 years. As an Executive Director at IDEO, the company who pioneered the concept of design thinking, she helped teams imagine futures and then put them into action.

Rebecca Sweeney is a core member of the Siebel Center for Design team, primarily focusing on marketing, events, and social media for the centre.
Appendix 1: Feline House Soiling-Handout for Cat Owners

Feline House-Soiling

Useful Information for Cat Owners

**FEMUR BASIC CAUSES OF HOUSE-SOILING**

- Cats by nature are very clean and need adequate unobstructed locations to eliminate, especially in multi-cat households.
- Some cats may avoid using a litter box located in a high-traffic area near cat doors or stairs.
- In a multi-cat household, the presence of a more dominant cat near the litter box area may cause a less confident cat to seek out other places for elimination.
- House-soiling may occur if a cat had a negative experience while in or near the litter box (e.g., someone administered medications, family members or children trampled a cat in the box for any reason, a dirty litter box, or even being startled by sudden noises from nearby furnaces or other loud appliances).

**Marking behavior**

- Urine spraying is a normal part of feline behavior in which a cat marks to leave its scent. Marking behaviors can include scratching, rubbing, urine spraying, and marking urine on objects.
- Cats may target items with urine or exogenous scents such as backpacks and shoes.
- Marking behavior that starts at windows and then usually suggests that the perceived threat is coming from outside the home. Marking in steamy windows, hallways, downspouts, or the corners of rooms usually indicates stress or threats from inside the house, such as other pets or new people in the household, active children, or remodeling.

**Medical Causes and Problem**

- Medical issues can cause a cat to exhibit behaviors such as house-soiling. Your veterinarian will be able to diagnose or rule out any medical conditions that could be a factor in the house-soiling behavior.
- Every cat that starts to house-soil requires a thorough physical examination and urinalysis to check for medical problems such as infections, cystitis, arthritis, kidney problems, diabetes, and other medical issues.
- If you observe behavior that makes the house-soiling behavior caused by a medical reason, you may need to monitor additional factors such as a urine culture, abdominal radiographs, abdominal ultrasound, complete blood count, and biochemical profiles. Digital rectal exams or fecal testing may be ordered for cases of house-soiling with toxins.

**Feline idiopathic cystitis (FIC)**

- Feline idiopathic cystitis (FIC) is a frequent medical cause of house-soiling. Cats suffering from FIC have increased frequency of urination, difficulty and pain when urinating, and can have blood in their urine. This inflammatory condition can increase and decrease in severity over time and is aggravated by stress, changes in diet, and other issues.

**TREATMENT AND MANAGEMENT OF HOUSE-SOILING**

The design and management of the litter box are critical for encouraging acceptable toileting habits. When house-soiling occurs, always evaluate the litter box.

**Designing the Litter Box**

- The litter box should be placed near a quiet, private area away from the kitchen and other high-traffic areas.
- Cats usually prefer quiet, private places. Avoid burying any area of the home and location where a cat could be surprised. Avoid dark, cluttered, or hidden areas that cats find reassuring. Avoid placing the litter box on top of furniture or other areas where a cat cannot observe its surroundings.
- Keep the litter boxes apart at different locations because your cat considers boxes close to each other one large litter box.
- If a cat is soiling away from its box, try placing an additional litter box at the next site.
- Use a multi-cat litter box to keep the box in each room. If you have an older cat, place a litter box on the floor where the cat spends the most time, as it may not be easy for the cat to be up and down stairs each time it needs to use the box.

**Slide**

- In general, bigger is better and many commercial litter boxes are too small. Litter boxes should be 1.5 times the length of the cat from the nose to the base of the tail. Suitable alternatives can include concrete-mixing trays or storage containers. You can place the lid behind the box to protect the wall. Place the lid behind the box to protect the wall.

**Fitting**

- If your cat is exhibiting house-soiling behaviors, you may need to try different types of litter until the cat indicates its preference. For preference rotation, provide multiple boxes with different litter and variable litter sizes. Most cats dislike scented or dusty litters, litter deodorizers, and box liners. Most cats prefer soft, unscented clumping litters.

**Misusing the Litter Box**

- Remove waste at a minimum of once per day and add litter as needed. Clean the litter box every 1-4 weeks using soap and hot water only. Avoid strong chemicals or any ammonia-based products.
Appendix 2: Handout for Cat Owners to Track House-Soiling Problems

Owner’s name: ___________________________ Date: ___________________________
Cat’s name: ___________________________

Resolving house-soiling problems may require making changes to several aspects of a cat’s home environment and care. All the changes are interrelated. They will help to provide the optimal litter box/tray and decrease stress by meeting the cat’s other social and environmental needs. They may also include medical treatments and diet suggestions. Please make the following changes in your cat’s home environment, as indicated by the checked boxes.

Environmental management

1. Number, location and design of litter boxes:
   - Provide _____ additional litter boxes making a household total of _______. Offer some large (1½ times the cat’s length from nose to base of tail) deep, open boxes. Storage containers, sweater boxes and concrete mixing trays are examples. If necessary, cut a door in one end and cover edge with duct tape to avoid sharp edges. Your cat may prefer a hooded litter box if it is kept scrupulously clean.
   - If your cat often urinates over the edge of the litter box, put plastic covered by newspaper around the litter box to absorb the urine. A rigid sheet of plastic cut so that it can be positioned vertically inside the box can protect adjacent surfaces.
   - Put the litter boxes in separate locations around the house, ideally in quiet private places that are easy for a cat to access. Locate litter boxes where the cat needs them, such as in previously soiled sites, and in areas separate from other pets’ locations. Avoid high traffic or remote areas.
   - This is the recommended litter box plan for your home. See house floor plan in the Cat Owner Questionnaire for clarity if needed.

<table>
<thead>
<tr>
<th>Type of litter</th>
<th>Location</th>
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<tbody>
<tr>
<td>Box 1:</td>
<td></td>
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<tr>
<td>Box 2:</td>
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<td>Box 3:</td>
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<tr>
<td>Box 4:</td>
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2. Types of litter:
   - Offer a variety of litter types and allow your cat to choose its favorite. Cats most commonly prefer fine-textured unscented clumping litters. Brands...
   - In addition, examples of alternative litters include play sand, potting soil or peat moss, or a piece of carpet or other soft material used as a temporary measure only in select cases.

3. Scooping and changing litter:
   - Scoop the litter box daily and replenish litter. **Wash the box every _______ weeks and replace the litter.**
   - (Some behaviorists feel that weekly washing and replacing the litter is optimal. Others find that every 2–4 weeks does not compromise the cat’s response. Rarely because of a particularly difficult to control urinary tract infection, daily washing of the litter box may be recommended.)
   - Use soap and hot water only; avoid strong chemicals or any ammonia-based products.

4. Litter attractants:
   - Herbal products for this use are available in the US (but may not be available in other countries).
   - An alternative is to sprinkle a small amount of the cat’s urine-soiled litter on top of the clean litter.

5. Synthetic pheromone sprays or plug-ins:
   - Use a spray or plug-in diffuser in areas we have marked on your house floor plan. Spray vertical surfaces.
Appendix 2 Cont.

Behavior management

Behavior modification efforts should focus on positive reinforcement of desired behaviors. Physically punishing a cat during or after house-soiling only creates stress and increases the motivation to continue the behavior. Punishment can lead to fear-related aggression and will almost always reduce the bond between a cat and owner. Punishment also tends to encourage house-soiling in less obvious areas.

1. If you catch your cat in the act of house-soiling, sneakily distract but do not scold it with noise that is not associated with humans, such as a whistle or by rattling coins in a can. Use your cat’s temperament as a guide to how loud this noise should be.
2. Praise your cat if you see it using the litter box. Keep a supply of treats near litter box stations for use as rewards.
3. Confine your cat in a single room according to the following timetable:
   - At all times
   - When you are unable to supervise the cat
   - When the cat is separated from other pets
   - Whenever your cat is confined, provide food, water, and two litter boxes.
4. Make sure that adults, children, noisy appliances or assertive cats do not block traffic patterns or a cat’s access to litter boxes, especially in the case of timid or anxious cats.
5. Place a bell on the collar of the most assertive cat in the house.
6. Set up multiple (____) food and water stations in the following locations (see floor plan for clarification if needed)
Cleaning soiled areas

Many products are available for cleaning areas affected by house-soiling. Urine will fluoresce in the dark under ultraviolet light. Use a black light from a poster store to find soiled areas. Clean affected areas with a good quality urine odor and stain remover according to the type of surface that the cat has soiled. Test products on an inconspicuous area first. Always ensure that you clean a sufficiently large area to remove the odor – this may be up to three times the diameter of a fresh wet patch or stain.

1. **Carpets:** Chemical, bacterial-based and enzyme-based cleaners can all be effective when used as directed. Scrubbing the area with a 10% solution of biological washing powder (enzyme-based laundry detergent) to remove the protein content of urine, allowing area to dry and then spraying with isopropyl alcohol to remove the fat component is also effective. You may need to pull the carpet up for several days and treat the subflooring underlay again using either a specifically designated cleaner or both the washing powder and isopropyl alcohol. If the padding under the carpet is soiled, cut out the affected area and replace with new padding. Use a concrete sealer if appropriate or a polysulphone or other sealant product if there is wood subflooring underlay. Treat the back of the carpet with urine odor remover and tack the carpet back down.

2. **Concrete:** If allowed in your area, use a sodium hypochlorite bleach (1 tablespoon per gallon of water) to wash a concrete floor. Make sure the area is well ventilated, and eyes and hands are protected. Avoid all ammonia-containing cleaners.

3. **Wooden baseboards/skirting boards:** Use a wood soap then seal the edge of the board to the wall with a silicone sealer.

4. **Walls:** Use a product designed for urine and stain removal.

5. **Blanket:** Launder in washing machine using your usual soap or detergent; add a peroxide-based bleaching agent, if available.

6. **Upholstery:** Use products designed for these materials; for example, fabric or leather cleaners.

**Medical testing**

<table>
<thead>
<tr>
<th>Urinalysis results:</th>
<th>Normal</th>
<th>Abnormal (blood, crystals, bacteria)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Very concentrated</td>
<td>Other: ____________________________</td>
</tr>
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</table>

**Urine culture:** ____________________________

**Blood panel:** ____________________________

**X-ray/ultrasound:** ____________________________

**Medical treatment**

- Treat for lower urinary tract disease;
- Treat for constipation;
- Treat for diarrhea;
- Treat for kidney disease;
- Treat for other medical condition;
- Dietary changes needed (see below);
- Antibiotic;
- Pain medication;
Appendix 2 Cont.

**Take-home instructions / House-sitting**

- Other: 

- Treat with anti-anxiety medication:

  NOTE: There are no anti-anxiety medications approved for use in cats. These drugs are prescribed for feline use as an extra-label application. Anti-anxiety drugs may cause side effects such as sedation, dilated pupils, weight gain, diabetes, increased appetite, liver and kidney disease, and cardiac arrhythmias. Do not change the medication dosing or frequency without consulting with your veterinarian. Laboratory tests are required before and during the use of many of these medications. Keep these medications out of the reach of children.

  Give: __________________________ times a day.

- Other side effects that can be seen with this medication include: 

- Full effects may take up to 4-6 weeks to be seen.

- Clinical examination and blood tests must be performed before using this medication and every ____ months thereafter due to potential liver and kidney side effects.

- Other treatments: 

**Dietary changes**

Gradually change to the diet recommended below. We can offer you suggestions on how to make the change if needed.

- Change to: 
  - Prescription:  
  - Non-prescription:  
  - Other: 

- Sequentially offer the new foods we send home with you. Please purchase more of the prescription diet that your cat prefers and continue your cat on the prescription food until ____________ (date). Note: Do not stop feeding the prescription diet unless directed to do so. Most cats will have further health difficulties on regular dry foods. If your cat will not eat the prescribed diet please contact us!

- Dilution is the solution! Mix canned food with water to make a slurry consistency or ‘kitty soup’. Warming may improve palatability.

- Give ______ cc (12 ml) syringes of water daily by mouth to dilute your cat’s urine if it will not eat canned food. Increase active feeding by placing food in toys or using puzzle toys to dispense food.

**Follow-up**

- Medical progress exam and repeat urinalysis and/or blood panel on: ____________ (date)

- Call with progress report on: ____________ (date)

- Other follow-up actions: 

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Appendix 3: Inside of Booklet for Students Attending Cat-Cat Owner Interviews

WHY DESIGN RESEARCH?

Design research aims to understand why people do what they currently do, with the goal of understanding what they might do in the future. By understanding motivations, values, and context, we can understand not only what is wrong, but also how we can learn what we might use design and design thinking to fix existing problems and identify new opportunity areas.

INTERVIEW TIPS & TECHNIQUES

APPROACH WITH AN OPEN MIND
Don’t judge or jump to conclusions. Be curious.

HAVE A CONVERSATION, NOT AN INTERVIEW
Avoid following a rigid script. Don’t make them feel like they’re being tested. We are here to learn from these people, not evaluate them.

EMPATHIZE AND IDENTIFY WITH THE PEOPLE YOU MEET
Try to see things from their viewpoint. Understand their perceptions. Don’t correct, refute, or challenge.

ASK OPEN-ENDED QUESTIONS
Avoid leading questions. Instead of “Do you like this?”, ask “What do you think of this?”

TELL ME ABOUT A TIME WHEN...
Ask participants to tell a story about an actual event in their past. This encourages people to move from the abstract to the real.

TRY NOT TO FILL ANY SILENCE
After asking a question, give them time to reflect and answer.

DO NOT ASSUME YOU KNOW WHAT THEY ARE GOING TO SAY
Don’t put words in their mouth. Always ask participants to explain their reasoning.

ALLOW FOR INTERPRETATION
Keep in mind that what they say might not match up with what they do. They may not be able to articulate (or even know) what they need.

...AND TAKE LOTS OF PHOTOS!

SOME PEOPLE TO SPEAK WITH

CAT OWNERS
VETERINARIANS
PET STORE OWNERS/EMPLOYEES
PET SHELTER VOLUNTEERS

SOME QUESTIONS TO ASK...

IF YOU’RE SPEAKING TO A CAT OWNER

TELL ME ABOUT YOUR CATS.
What are they like?
How long have you had them?
Why did you choose to adopt?
Where did you get them from?

DOES YOUR CAT HAVE ANY SPECIAL HABITS? WHAT ARE THEY?

CAN YOU EXPLAIN YOUR CAT’S BATHROOM ROUTINE TO ME?
What do they go out and they receive any special training?

IF YOU’RE SPEAKING TO A VETERINARIAN

WHAT TYPES OF BEHAVIOR DO CATS KNOW NATURALLY? WHAT TYPES OF BEHaviors HAVE TO BE LEARNED?

DO OWNERS HAVE ISSUES WITH THEIR CATS GOING TO THE BATHROOM IN THE WRONG LOCATION?
What do you advise they do? Are there any common methods of which owners use to combat this behavior?

IF YOU’RE SPEAKING TO A PET STORE OWNER

DO CAT OWNERS COMMONLY BUY ANY ITEMS TO HELP THEIR CATS GO TO THE BATHROOM?
Can you show me those items? How do they work? Why do cat owners purchase them?
Learning Fashion Outside Academia: From Sewing Circles to Maker Spaces

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Abstract: In the current state of fashion, industry and educational institutions are challenged by digital technologies and the ways that they disrupt traditional practical and designerly skills. New design tools including 3D modeling, coding and electronics are not currently covered in the context of a formalized fashion design education. However, maker communities and maker spaces that are dedicated to fashion and textile production and innovation, provide alternative learning environments for self-made designers with skills beyond traditional clothing development. The aim of this research is to explore current maker spaces and maker communities related to fashion and textiles outside the formal education institutions including the skills acquired, methods and tools used, the training programs offered and the dynamics of knowledge transfer within these communities by a critical analysis of the literature. The study reflects on the processes of learning in maker communities and maker spaces in comparison to formal fashion design education offered in higher educational institutions, exploring the potential implications for future of fashion design education.

Keywords: fashion; maker movement; learning; digital fabrication; maker spaces

1 Introduction

Formal and institutionalized fashion design education dates back to the creation of the London College of Fashion in 1906, which offered skill-based learning curriculum (Williams 2018). The German state school Bauhaus (1919-1933) strongly influenced the foundations of U.S. higher education in fashion design where learning design principles by doing and making was emphasized and students studied basic art and design courses before progressing to a chosen design specialization (Marshall, 2009). Many U.S. fashion design programs continue to adopt a similar approach that includes a foundation year for building the practical skills of pattern making and garment construction, then further time spent implementing these skills creatively, generally leading to designing fashion collections (Faerm, 2012; Gully, 2009). However, today, both the educational institutions of fashion and the fashion industry are challenged by new digital technologies that disrupt the traditional practical and creative skills that have been taught in academia (Sun & Zhao, 2018). Additive manufacturing, textiles and clothing with embedded electronic functionalities, new materials such as bio textiles and digital tools like 3D body scanners and virtual dressing rooms are transforming the world of fashion (Sun & Zhao, 2018). New businesses in fashion specializing in different digital fabrication tools and
technologies are emerging. For example, Julia Daviy identifies as a 3D printed clothing designer and producer, ElektroCouture creates ready-to-wear fashion technology pieces for the everyday woman, Sensoree defines itself as bio responsive fashion company, Kobakant’s recent initiative creates a tailor shop for electronic textiles (e-textiles) and wearable technology. The common feature of these new ventures is that none of the founders/designers come from a formal fashion design education background and all of them acquired their knowledge and skills through making activities outside of academia.

Acquiring skills related to clothing making outside formal education institutions has a long history where skills are passed from generation to generation within families and communities. Sewing circles, knitting clubs and quilting bees are examples of communities where groups of people meet together to sew or knit and at the same time socialize and share knowledge and skills about their projects. It is important to note that these groups have grown to become relevant within the fashion space. In the late 1960s and early 1970s in the U.S., a small Appalachian women’s quilting group, the Mountain Artisans Co-op grew to fame when they collaborated with the designer Oscar de la Renta to bring their patchwork quilt inspired garments to haute couture (Lewis et al., 1973). Such communities have provided opportunities for self-made crafters, makers or designers who use the practical skills they acquired outside the academia to develop creative artifacts. Today, new maker communities and maker spaces using digital fabrication tools and technologies in fashion have formed in parallel to the worldwide maker movement. There are also many maker labs cropping up at fashion design schools that formalize the impact of these alternative-learning environments on formal education. Due to the rapid speed that these maker spaces and communities have evolved, and their alternatively formalized organization, it is increasingly significant for continued research on how the impact of communities that they foster and many ways that the technology, materials and products they help pioneer are directly impacting the future of fashion in academia.

There has been increasing interest in incorporating learning by making in a wide range of education systems. In the cumulative primary and secondary education, STEAM (science, technology, engineering, arts and mathematics) is now commonplace in many countries and has also made its way into higher education. Many education institutions have experimented with using maker projects to inspire active learning where students engage in the process rather than passively listening. Originally created as prototyping platforms for community, maker spaces have attracted the attention of educational institutions for their hands-on project-based learning environments. However, learning in the context of community practice and the impact of its potential for collaboration and creation has not been as deeply explored (Forest et al., 2014). In addition, although there is large amount of knowledge on the maker movement from different angles (Resnick & Rosenbaum, 2013; Wilczynski, 2015; Tanenbaum et al., 2013; Browder, Aldrich & Bradley, 2017; Richardson, Elliott & Haylock, 2013; Jordan & Lande, 2016) research on the implications of the maker movement with specific respect to fashion design education does not exist. The aim of this study is to explore current maker spaces and maker communities related to fashion and textiles outside of formal education institutions including examining the skills acquired, methods and tools used, the training programs offered and the dynamics of knowledge transfer within these communities by a critical analysis of the literature. The study reflects on the processes of learning in maker communities and maker spaces in comparison to formal fashion design education settings offered in higher educational institutions. We do this by researching the potential implications for the future of fashion design education. The importance of this research is two-fold, both to understand the current state of maker spaces as they are increasingly incorporated into the study of fashion in higher education; and to critically analyze the impact of the maker movement which is occurring outside of academia to inform the evolution of the fashion design education to ensure that it is current and reflective of the industry and real-world problem-solving strategies.

2 Maker Communities and Maker Spaces of Fashion

In order to fully understand the impact that maker spaces and maker communities have within fashion design education, it is important to recognize the history of their evolution as well as their current applications for fashion design. The intellectual foundations of the maker movement dates back to the 2001, The Massachusetts Institute of Technology’s (MIT) Bits to Atoms’ program (Voigt, Montero & Menichinelli, 2016) which defines itself as an “interdisciplinary initiative exploring the boundary between computer science and physical science, studying how to turn data into things, and things into data”. The maker movement as a social phenomenon emphasizes creating things via personal digital fabrication, learning by doing and sharing (Hatch, 2014). Honey and Kanter (2013) define this hands-on nature of making as “to build or adapt objects by hand, for the simple personal pleasure of figuring out how things work” (p. 4). Limor "Ladyada" Fried, founder and CEO of Adafruit (a DIY electronics kit company) lists maker activities ranging from 3D modeling on a computer, printing with a 3D printer, making animations to screen-printing fabric or sharing knitting patterns via the Internet.
Make Media, publisher of Make Magazine and the founder of the Maker Faire event that started in the Bay Area in 2006 has been critical in promoting the maker culture and building maker communities. The bimonthly publication Make Magazine first coined the word “Maker” to name the community and continues to feature informative articles on technology and crafts-oriented maker projects. Make magazine covers all areas of making from robotics and computing to textiles and food. The Maker Faire continues to function as a critical platform where makers exhibit and share their creations. In addition to these in real life meet ups, there are other physical and digital maker spaces and maker communities which have been created around certain topics including fashion and textiles. The Maker Faire has been critical in promoting the maker culture and building maker communities. They have also created a template for potential labs within higher education that can foster a similar sense of collaborative, innovative technology exchange and a venue for community to foster contemporary fashion design.

2.1. Digital Fabrication Technologies
Digital fabrication, new material technologies and the availability of accessible knowledge and skills from communities related to these technologies act as foundations of the maker movement (Martin, 2015). Digital fabrication is defined as a “process that unifies design with production through the use of 3D modeling software or computer-aided design (CAD) and additive and subtractive manufacturing processes.” (Millard et al., 2018, pp. 2-3). Open-source, low cost hardware and software such as Arduino and Raspberry Pi which can link to digital fabrication devices (Nascimento & Pólvara, 2018) reinforced the spread of this movement across different creative fields and multiple forms.

Technologies that have formulated digital fabrication have been prevalent in applications of architecture, product and fashion design (Schumacher, 2017). Especially in fashion, they have been mostly associated with wearable technologies and e-textiles, bio textiles, 3D printed textiles and clothing, soft robotics and tools like laser cutting, digital printing and CAD embroidery and knitting. E-textiles and wearable technologies have been a growing maker activity combining physical aspects of textiles with digital technologies (Buechley et al., 2013), computing and electronics (Kafai, Fields & Searle, 2014). Easy to use, sewable microcontrollers and availability and accessibility of conductive threads and fabrics have been influential in wide spread of such making activities. Lilypad Arduino developed by Leach Buechley as a technologically identical alternative to Arduino, which can be sewn to fabric and connected with power supplies, sensors and actuators with conductive thread enabled crafting soft circuits and interdisciplinary practices among designers and technologists (Guler, Gannon & Sicchio, 2016). Digital textile fabrication technologies go hand in hand with e-textiles. For example, CAD based jacquard weaving, knitting and embroidery machines enable turning digital designs into finished textiles and clothing with electrical characteristics embedded in them via use of conductive threads during construction.

Laser technologies are mainly used to create patterns and textures by cutting through the textile materials or by engraving on the surface of textile materials. Laser technology not only enables digitized cutting ability but can also be used for fusing or welding synthetic fabrics together by melting them in layers as an alternative to traditional stitching (Guler, Gannon & Sicchio, 2016).

In addition, 3D printing in fashion industry has found applications in one of a kind experimental designer pieces and in mass customization to provide users with the ability to personalize products (Vanderploeg, Lee & Mamp, 2017). 3D printing technology in fashion heavily uses interlocking three-dimensional units and patterns that can create 3D printed fabric structures using flexible filaments that mimic drape of textile materials (Lipson & Kuman, 2013). 3D modeling which is a necessary tool for 3D printing enables creation of complex shapes that are not possible by two-dimensional fabric (Guler, Gannon & Sicchio, 2016). Integration of body scanning technology which allows retrieving three-dimensional body measurements digitally in a rapid manner with 3D printing and 3D modeling could lead to disruptive innovations into present design and productions processes (Wang & Chen, 2014).

The ability for higher education maker spaces to house and maintain the equipment that is needed to remain relevant within digital fabrication technologies can be game changing. On the other hand, the integration of digital fabrication technologies in fashion design education requires new sets of knowledge and skills to be delivered where only the procedures of flat pattern making and draping or sewing would no longer be relevant. Different types of materials in the forms of Polylactic Acid (PLA), conductive threads and fabrics would come into play in addition to traditional textile materials (Sun & Zhao, 2018). 3D modeling skills compatible with rapid prototyping methods that are entirely different from traditional clothing construction methods would be necessary.
2.2 Digital Maker Communities

The interaction with these new digital fabrication tools and materials has also formed online communities with shared interests where new learning opportunities are offered (Martin, 2015). Websites that host open-source visual or video tutorials have played a critical role in the formulation of online maker communities. These online making venues also function as alternative learning environments for individuals interested in making related to fashion.

Instructables.com, owned by Autodesk, offers user created content that includes step-by-step instructions with accompanying visuals and videos for projects. Some examples of these tutorials range from upcycling old clothes, creating waterproof textiles and developing leatherwork to tutorials on hand sewing and designing e-textiles. Instructables also provides an education module with free online video classes on 3D printing, sewing, embroidery, wearable technologies and such. The modules are taught by an active member of the Instructables community who have experience in the specific subject matter. Thingiverse.com is an open platform, online design community dedicated to making and sharing 3D printable files with how-to instructions where anyone can use or alter any design. Thingiverse offers 3D printable files of jewelry and accessories as well as flexible textile structures one can download and experiment with 3D printed fashion. Kobakant.com is another collaborative web platform developed by Mika Satomi and Hannah Perner-Wilson in 2008 to explore hand crafted textiles with electrical functions. Kobakant offers an accessible online database titled “How to get what you want” to share their e-textile and wearable technology projects with step-by-step instructions and videos. Burda, a German pattern making and fashion magazine, launched Burdastyle to promote open fashion design and to connect community of users to exchange ideas on how to design and sew clothes. Through the Creative Commons license platform, users can access a large collection of patterns to download and print, an encyclopaedia of sewing, and a close-knit community that exchanges tutorials, templates and tips on how to sew on your own.

Both the accessibility of digital fabrication technologies and collaborative values of digital maker communities have formed an organic and open design process where ideas, tools and methods can be modified and evolved as they are shared within these communities to fit individual needs and tastes (Richardson, Elliott & Haylock, 2013). In this context, the traditional fashion design processes where a designer relied on tacit knowledge and intuition (Sun and Zhao, 2018) is disrupted by a new discourse of open-source. Although fashion design education in higher institutions heavily uses learning tools like video tutorials, the concept of making creative ideas and processes accessible for iteration is an entirely new framework. A recent application of open design framework in fashion design curriculum has been observed in experimental fashion design courses on wearables and e-textiles where students are required to develop step by step instructions about their creations to be shared in online platforms and in courses that utilize social media to build online communities and share students’ projects.

2.3 Physical Maker Communities

The maker movement continues to grow as a result of different infrastructures that support community engagement (Martin 2015). Physical maker communities have developed through social and technical practices and transmission of tacit knowledge via face-to-face interactions that take place in physical locations (SChrock, 2014). According to American Society for Engineering Education (2016), maker spaces are open community spaces where people explore, create making related projects and collaborate in multidisciplinary and organic learning environments. The term maker space, hacker space and fab labs have been interchangeably used in the maker movement literature. Maker spaces, fab labs and other physical spaces of making all support the grassroots exploration of personal projects and provide venues for the formation of community cultures with shared goals and values (Forest et al., 2014). Over 1000 Fab Labs worldwide are networked under Fab Foundation, a U.S. non-profit organization, and form a knowledge-sharing network in 78 different countries. A research initiative in Europe called the Textile & Clothing Business Labs (TCBL), funded by the European Union’s Horizon 2020 program, also clusters 39 maker spaces and fab labs dedicated to textiles and clothing with the goal to create alternative ways to over production and diminishing value of textiles and clothing and to reduce environmental footprint.

Fabricademy is another global network of fab labs focusing on new approaches to textiles and fashion, which may have some nod towards higher education. Fabricademy functions as a multidisciplinary education and research platform that utilizes advanced technologies in creating textiles and fashion products through courses titled computational couture, e-textiles and wearables, bio dyes and bio fabrics, skin electronics and such. Fabricademy has a distributed education model where local fab labs form nodes in which students learn in local workgroups with peers and mentors and connect to the global network via video based interactive classes and online content sharing. The curriculum and teaching content are developed and foreseen by the Fabricademy and transferred to local node instructors in boot camp training sessions. In addition, the textile academy boot camp by Fabricademy offers intensive
coursed for fashion and textile designers, and digital fabrication experts that explore new alternatives to the current textile and clothing manufacturing systems. Similarly, e-textile summer camps started in France in 2011 are peer-to-peer led, self-organized gatherings of e-textile and electronic craft practitioners in fashion where they share their expertise via hands on projects as a community.

Including but not limited to the examples above, there is a breadth of maker spaces and maker communities of fashion and textiles that are providing distributed, active learning opportunities where the individuals can craft their educational experiences tailored to their unique needs. Since maker related activities of fashion require expertise and skills in significantly different areas, collaborative courses offered by multiple instructors from different fields and fashion design courses related to maker subjects open to other disciplines that utilize different digital fabrication tools are applicable in fashion design curriculums. Extending courses beyond classrooms to exhibitions, maker faires and workshops to build communities and increase sense of belongingness are also alternative paths to incorporate maker mindset in fashion design education.

3 Learning Fashion in Maker Communities

One of the most distinguishing characteristics of the maker movement is the common mindset of collaborative, hands-on making and learning (Martin, 2015). This is not unlike the traditional fashion design higher education experience, where students create a body of work via making. However, an important aspect of learning and knowledge transfer in maker communities and maker spaces in comparison to formal educational settings is the intrinsically motivated, peer-to-peer learning in a process focused manner using newly acquired digital skills.

3.1 Peer-to-Peer vs. Top Down

Maker spaces outside formal education not only provide a meeting space to experiment with wide variety of digital fabrication tools and building capabilities (Forest et al., 2014) but also a platform for peer-to-peer and networked learning (Nilsson, 2012). New maker enthusiasts build relationships and commit to values of their ever-evolving communities through regular and progressive participation in the varied maker activities valued by that community (Wenger, 1998). Most maker projects involve a group working together on a common goal in a collaborative nature that includes both novices and mentors in a physical and cognitive apprenticeship model (Kuznetsov & Paulos, 2010; Brown, Collins & Duguid, 1989). In this setting, expert practitioners make tacit processes accessible to novices, furthering the learning experience for both mentor and mentee (Forest, 2014). This climate also allows for creative problem solving across genres, something that is increasingly important for the fashion designer in practice. By supporting collaboration and the ability to look outside fashion design, to biology (bio science), engineering, etc. there is the opportunity for the instruction to inspire a cultivation of interdisciplinary tools that will be invaluable to prepare the fashion designers of tomorrow.

Fashion design studios are not passive places where students work in but also engage with interactive tools for discussion, reflection and articulation (Gully, 2009). However, learning is mostly an individual experience guided by an instructor in a top down structure in which pattern making and construction are taught in a craft-based model through replicating a sample made by an instructor (Gully, 2009). Especially in introductory fashion design courses, similar learning practices still apply although instructors may use video tutorials of demonstrations as an aid for learning. Students present their ideas and creations informally in peer groups and formally in critiques (Gully, 2009) but most of the time they work individually on projects with set deadlines. This atmosphere creates a climate of the designer working in a bubble, and depends upon the individual to seek out opportunities to collaborate or even be exposed to new tools, technologies or materials.

In addition, making spaces in formal educational institutions are typically places accessible to trained students and most digital fabrication activities are run by trained professionals like technicians (Forest et al., 2014) rather than led by collaborative peer groups. In fashion education, students experience learning in studio environments where they operate sewing machines of different kind. However, when it comes to specialized machinery such as a jacquard loom or a CAD knitting machine, students tend to seek instruction from a technician or an instructor. This institutionalized way of learning is important, as it provides attention to the details of the subject, however maker mindset can be complementary in helping to add a layer of collaboration and help to alleviate the designer working in seclusion.

3.2 Intrinsic vs. Extrinsic Motivation

Farritor (2017) defines intrinsic motivation, as opposed to extrinsic motivation, referring to behaviour that is driven by internal rewards rather than rewards coming from another source. According to the author, while the decision of
“pursuing a college education requires intrinsic motivation, the day-to-day activities such as attendance to lectures, assignments and exams are extrinsic motivations in formal education”. While learning is very structured in formal education contexts, in maker communities the student learns by designing and creating objects of personal interest. The juxtaposition between a disciplined and a degree focused course curriculum and a maker space-learning environment is pronounced. In maker communities and environments, learning happens in an authentic, engaging and personal context rather than relying on a fixed curriculum. Makers are free to focus their activities where they want to; “they can develop their areas of strength, or venture into new territory when they want to learn something new” (Martin, 2015). On the contrary, in fashion design education, the learning process is highly structured. There is a specific list of required courses focusing on fashion design related skills and elective courses from other fields with some flexibility. Students build skills and knowledge by accomplishing prescribed hands on projects in a given order. Fashion design students are restricted by external requirements in their projects such as the type of fabric they can use, the sewing and finishing techniques they can apply or the target market they need to design for. Only after students acquire these basic skills, projects become more flexible, less defined and open to creative exploration but still guided by expectations and deadlines. Therefore, there is a need for further research into the potential for integration between the formalized higher education experiences with the maker space model.

### 3.3 Process Driven vs. Product Driven

The maker mindset provides the contexts of playfulness, being process focused and failure positive. Dougherty (2012) notes that although the emergence of maker movement was ignited by accessibility of digital fabrication tools and online maker communities, the core of the movement is experimental play or a playful environment that encourages experimentation, failure and variation of experiences (Martin, 2015). According to Schrock (2014), making requires social contexts called the “creative play” as he quotes David Gauntlett’s (2013) definition of making as social collaboration and connection between individuals and materials where creativity functions as the social glue. Play draws people into state of flow in which they make things simply for the reward of enjoying how it turned out. Therefore, making in comparison to formal fashion design education is more involved with the process rather than the products as objects are created in an ongoing process fuelled by the satisfaction that comes from experiencing it.

Making is process driven, a polished and finished product is not the end goal and most of the time products are unfinished or are hyper functional, futuristic and conceptual as they function as the means to explore and push boundaries of different fabrication techniques. Learning in making happens through an iterative process of experimenting, failing and experimenting again (Petrich et al., 2013) where failure is as much as appreciated as the success. Makers use social media to share their creations and processes and it is very common to see a maker sharing failed attempts and failed end results as much as finalized creations. In contrast, failure is not appreciated in most educational contexts. In formal fashion education, making process is fuelled by the requirement to have a high-quality finished piece; perfectionism in craftsmanship and fully designed and completed end products are expected and critically evaluated. The emphasis in this evaluation is on the end product rather than the process.

### 3.4 Digital Skills vs. Traditional Skills

Makers of fashion outside academia utilize digital fabrication technologies and tools and have related skills beyond clothing development and production. Learning of these skills in maker communities is a continuous, collaborative discovery as a result of encountering with tools, materials and methods and environments. According to Wertsch (1991; 1998), tools are active objects that have influence on how we think and behave enabling individuals learn and experience things otherwise not possible. A combination of the traditional skills with new digital tools and technologies in fashion leads to completely new and disruptive approaches to fashion that are not taught in educational institutions. Implications of the maker movement on the future of fashion design raises the need for alternative educational approaches that would integrate new skills such as 3D modeling and coding, new knowledge about entirely different material technologies as well as new interdisciplinary and collaborative learning models (Raj & Morris, 2016; Sun & Zhao, 2017). Many fashion design schools are beginning to address this paradigm shift. For example, Parsons School of Design is defining their students as more than designers producing clothes but as innovators and thinkers and emphasizing the importance of interlacing craftsmanship with technology in innovative fashion (Cyr, 2014) and Royal College of Art is offering M.A. degree with Soft System specialism that focuses on smart textiles and digital fabrication.

### 4 Conclusion

The maker movement has been an influential social phenomenon that is challenging design education by blurring the boundaries of design disciplines, engineering and art. Availability of learning opportunities outside academia and
Learning Fashion Outside Academia: From Sewing Circles to Maker Spaces

access to digital fabrication tools to experiment with new ideas have led to formation of self-made, hybrid designers who have untraditional skill sets. Especially in the context of fashion design, technologies such as 3D printing, CAD based manufacturing, and sewable, textile-based electronics have challenged the higher education system as a whole. Different educational institutions are responding to this challenge with different strategies. Some schools are emphasizing ‘design thinking’ to educate fashion designers who have broader conceptual understanding (Faerm, 2012), some schools have started maker centres where students can interact with variety of tools and techniques while some are building internal and external collaborations and formulating making related projects across different educational programs (Cyr, 2014). While this is a beginning, there is also a need for the implementation of the learning experiences that are fostered within the maker culture to be conveyed within the fashion design school model. The terrain itself is a natural fit, with the maker space setting a perfect parallel to the design studio. The world of fashion is a climate of constant change and creativity and therefore a very apt place for this type of rethinking of the climate of learning and education exchange to occur.

Fashion design education can be restructured to incorporate new materials and technologies in clothing design. Making activities related to fashion outside academia require adopting digital and technical skills beyond traditional clothing making and experimenting with untraditional materials. It is important for the design educator to consider the ultimate fashion design industry that they are preparing their students for. In contemporary fashion houses, brands and creative studios, there is a demand for designers who are well-versed in a multitude of modalities, even if they are not proficient in each one. The ability for designers to look beyond the tools that they are using to create, and across industries that can benefit from design thinking will only increase their viability as successful candidates for roles as well as their potential for longevity in the industry.

The top-down learning in academic settings of fashion can benefit from peer-to-peer, open source learning models of maker communities. Fashion is a much more self-expressive field than the other design fields and designing in teams in a collaborative manner is very rare. Fashion design courses which challenge students to design within an interdisciplinary participatory design framework and to experiment with open source activities where their ideas can be hacked and altered would help to build new competencies sought after by the industry. Such courses in contrast to traditional courses available in the fashion design curriculum should be process driven rather than product driven where unfinished or conceptual products as well as failed attempts serve as a medium to challenge boundaries of creative thinking and digital fabrication capabilities.

Building community within the formal education can also be a powerful context to incorporate non-traditional tools, materials and to promote intrinsic motivation to learn new skills in fashion. Fashion design studios could be restructured or maker spaces could be made available within an institution to offer informal and after-hours gatherings for making and socializing with peers. Creating projects for exhibitions, maker fairs and other off campus activities as a cohort could be used to foster community building around fashion and making related subject matter.

For future research, case studies of online and physical maker communities of fashion can shed further light into learning experiences in these environments. In addition, important aspects of learning in maker communities as described by this study can be explored through real world applications in formal fashion design education.

References


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A Design Course for Craftspeople in İstanbul

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Abstract: This paper aims to present a design course conducted for craftspeople at İSMEK, an adult education organisation in Istanbul, Turkey. The aim of the twelve week long program was to introduce novel perspectives in design by instructing fundamental issues about design methods, providing critical inputs and mentorships through the design processes. The participants did not have a background in design education, had a mastery in a particular area in crafts, and were already tutors in their own field. Thus, the aim of the design course was to enhance a broader look at the existing processes in craft making by supporting the participants to experiment and create novel interpretations of traditional crafts. As a unique example of designer-craftsmen collaboration, this design course is introduced in this paper with its background, context, structure and outputs in order to discuss its possible contributions to prospective studies.

Keywords: design course; design and craft relation; innovative craft products; lifelong learning; craftspeople

1 Introduction

What should be the scope of a design course conducted for craftspeople? As a possible answer to this question, this paper presents a design course organised for craftspeople, who are also crafts tutors at İSMEK (İstanbul Metropolitan Municipality Art and Vocational Training Courses) in 2017 and 2018. This course was organised to support the development of contemporary craft production as targeted by İSMEK. The pilot project was proposed as a response to İSMEK’s pursuit to differentiate its content for the end of year exhibitions to be held as a part of 20th foundation anniversary of İSMEK. Under the guidance of industrial design and history of art instructors, this program encompassed a twelve week long schedule and resulted in the production of novel craft objects and curation of their exhibition. This paper introduces the background of the design course, actors taking part, its education model, as well as the process and discussing the results.

One of the main goals of the education program was to provide craftspeople in İSMEK community a novel perspective that they may apply in their thinking and making process by the help of design input and mentorship. The design course operated as a laboratory in which novel craft products were designed, developed and produced.
Compared to current designer-craftsman collaborations, this program, both with its unique process and outputs, offered a different attitude to the accustomed relationship between designer and craftspeople; and design and craft as well. Here, the designer worked as a mentor and kept a more subdued position in order to bring craftspeople to the forefront of creative activity. Accordingly, one of the main aims of the program was to include craftspeople, who are usually positioned outside of the mainstream design community, into the domain of design and as the main actors of the designed products. Crafts tutors were learners, and also the actors of designing innovative craft objects. The program was structured especially for participants who have not had a design education before, but instead achieved mastery on a certain field of craft and became a tutor. The program did not intend to provide university level design education to craftspeople in a short span of time, but aimed to provide a setting to experiment and try novel interpretations of traditional crafts. Besides concentrating on introducing design principles to craftspeople, this project also encompassed the curatorial organisation of production processes and the exhibition of innovative craft products. Through intervention in the above-mentioned levels, the project aimed to affect a new cultural climate in İSMEK. At the same time, the educational program targeted crafts tutors who actively participated in the design course to transfer newly acquired perspective to their teaching environments and to their students. The project also aimed to reach and affect a broader audience in İSMEK through seminars, exhibition and workshops organised with public participation.

2 Craft-Design Relationships in İstanbul

Design course developed for İSMEK and the final craft objects can be evaluated from the point of view of design-crafts relationships and its examples.

The exhibition, Past, Present, Future: The Artisanal Labour, which displayed novel craft objects as the results of the design course, was the first exhibition held after the announcement of Istanbul as the UNESCO Design City ("Dün Bugün Yarın Sergisi Açılıdı," 2018). In 2018, Istanbul was included into UNESCO’s Creative City Platform with the title of Design City. One of the reasons for the acceptance of Istanbul Metropolitan Municipality’s application (among other points) can be claimed as the acknowledgement of craft and design relationships in Istanbul and a pledge to support them. Therefore craft, design and their interrelations were officially on the design agenda in Istanbul. In the first four years, the city commits to undertake three initiatives within the framework of its designation as the UNESCO Design City: Establishing Usta (master, in Turkish) & Designer program, a Documentation program, and İstanbul Design and Innovation Center (IDIC). Usta & Designer program’s mission is to bring artists and craftspeople of traditional crafts together with designers, in order to make connections between craft and design, and enable knowledge transfer by offering opportunities to work together. ("UNESCO Creative Cities Network," n.d.; "İstanbul City of Design", n.d.)

One of the examples of design-crafts relationships in Istanbul was Craft, Art and Design Platform that was established by Istanbul Modern in 2016. Supported by Istanbul Development Agency, the aim was to support artists, designers and craftspeople to work and produce together and learn from each other’s experiences. The scope of the project highlighted craft-focused design and production relationships. ("İstanbul Modern Zanaat" 2018.). The platform’s first project was about the re-interpretation of diminishing materials and production techniques to create design objects and artworks. In this context, the focus was on materials such as mother-of-pearl, wood, bone and copper that were used by craftspeople. For the project, five artists/designers came together with five craftspeople to examine and to investigate materials and techniques of the craft in order to generate ideas. Prototypes were produced after the design process. The resulting products aimed to initiate adesign collection in Istanbul Modern and were exhibited in the museum shop with accompanying information. ("İz sanattan Tasarıma", 2016).

Another example of the craft-design relationships in Istanbul is Made in Şişhane Project. The project aims to bring to the agenda the social and activist role of design for safeguarding the craft neighbourhoods in Istanbul since 2006. It focuses particularly on neighbourhoods of Şişhane-Galata areas of Beyoğlu district and supports the enrichment of neighbourhood’s local craft networks with participation of designers, artists, architects and academia. Made in Şişhane Project became the finalist of City to City Barcelona FAD Award 2016 Learning Initiatives in The City. The project re-creates and reveals the local knowledge of the craft neighbourhood by organizing design workshops and exhibitions, making publications and collaborating with other craft neighbourhoods in Istanbul. The project attempts to increase and enhance relationships between craftspeople and designers; and to create an awareness about the neighbourhood and its potentials. ("Made in Şişhane", n.d.; Kıyak İngin, 2013)

As a part of the Made in Sishane Project, the craft neighbourhood and knowhow of the craft workshops have been matched with design education. The Craftsman’s Diary/Apprenticeship in Design, has been a studio project for the
second-third years industrial design students at Istanbul Bilgi University since 2013. As a part of the design studio course, the students became apprentices and worked in craft workshops. (Kıyak İngin & Altay, 2014).

Another example is *Masterpiece of Beyoğlu* project, which studied the relationship between design and craft through education. The project led to a new model for the traditional and informal training of craftsmanship and attached it to the formal education system in 2016. The project was directed by Culture City Foundation and supported by Istanbul Development Agency. Istanbul Bilgi University and Beyoğlu Municipality were the partners of the project. The project aimed to re-design Beyoğlu District as an open and innovative training area that nurtures creativity and production, while putting craft workshops in the centre and associating them with formal education (“Usta İşi Beyoğlu”, 2013).

*Crafted in İstanbul* project initiative is an online platform created by Master Program Students of Istanbul Technical University Industrial Design Department. It aimed to create an online map system that will make craftspeople visible and promote possibilities of designer-craftspeople collaborations, by documenting and analysing the process, and searching for possibilities to integrate craftspeople into current design systems (“Crafted in İstanbul”, 2013).

### 3 Structuring the Design Course

Compared to the above examples, the design course for ISMEK offers a different position on craft-design relationships. Here, the relationship is established through education, based on the idea of giving craftspeople more autonomy over their production. Rather than producing objects created by designers, craftspeople would themselves design and create objects, under guidance from design instructors. Design instructors, using tools from design education, would assume a more passive role, and direct craftspeople in their design and production process.

#### 3.1 Context

**3.1.1 ISMEK**

Founded in 1996, ISMEK is an adult educational organisation set up for adults over 16 years old, with the aim of improving participants’ vocational and artistic knowledge, increasing their employability and contributing to their income generation. Periodical training courses in ISMEK are free of charge, and upon completion, participants receive certificates approved by Turkish Ministry of National Education. Through their 235 course centres with 540 branches distributed to 38 districts in Istanbul, it has reached 2,619,534 students. Since 2010-2011, ISMEK has been offering advanced vocational training in 14 specialist schools: School of Informatics, School of Accounting and Finance, School of Graphic Design, Baking and Pastry School, Culinary Arts Schools, Language School, School of Beauty and Hair Care, Retail School, School of Turkish Islamic Arts, Çolpan İlhan School of Fashion, School of Music and Performing Arts, Telecommunications Training. (ISMEK Programlar, n.d.)

**3.1.2 Craft in ISMEK**

ISMEK offers training for numerous craft branches, including ceramics, felt, leatherwork, porcelain painting, embroidery, lacemaking, jewellery making. Duration of the courses varies for different branches, from 64-hours (ex. Wood Painting) to 399-hours (ex. Rug Weaving) and 653-hours (ex. Home Textile Production).

Especially in crafts-focused courses, workshops, seminars, competitions and publications further support and enhance the skill-based arts and vocation training. Students regularly have the chance to showcase their work through exhibitions. These are initiated by tutors, who put together an exhibition proposal, which is evaluated by ISMEK Exhibition and Fair Organisation Unit. In addition to smaller exhibitions, craft tutors and students showcase and sell craft objects and artwork at annual General Exhibitions which takes place at the end of term. In addition to teaching students a craft, ISMEK aims to provide a system to support students economically through their craft practice. Proficient students can apply to work at the production classes to sell their work under supervision of a craft tutor, to obtain income. (E. Tunaboylu, personal communication, December 29, 2018)

Outputs of the production classes are sold through national and international fairs (Sultanahmet Fair that takes places every Ramazan, Lalefest), as well as at various retail points including Art Street in Sultanahmet Arasta, Starcity Mall, Taksim Metro Station.

Since the certificates are endorsed by the Ministry of Education, tutor qualifications are extremely important. Criteria of teaching at ISMEK differs in different crafts, a university degree from a related craft is preferred; but if the learning process of the crafts-making is based on master-apprentice relationship like glass blowing or felt making, *certificate of mastership* is accepted. In traditional arts ratification from masters is important too. Candidates also have to pass a
test about their subject, a general culture test and interview. (E. Tunaboylu, personal communication, December 29, 2018)

### 3.2 Decisions and Criteria Behind the Course Model

The project intended to expand impacts of the design course throughout İSMEK’s design community; therefore, in addition to education of the participants, the design course aimed to produce and exhibit a new collection of novel craft objects made by craftspeople. Another intention of the design course was consequent transfer of new knowledge from participant craftspeople to their own students. Similarly, public workshops that took place during the exhibition were structured to facilitate experience and knowledge transfer and gave clues about the sustainability of the design course.

The project has been structured through various modes, including seminars, design course, exhibition, panels and workshops. Prior to the design course, crafts and traditional arts tutors of İSMEK attended seminars on topics including: history of art, history of design, design-crafts relationships; which offered participants an information platform that provided new perspectives on the work they do.

The decisions about the design course and its model were structured around some questions.

- How to respond to, and intervene in, the education and production system of İSMEK?
- How can a design course be constructed when the subjects of design education are craftspeople?
- Where does craft training and design education overlap and differentiate?
- How can a design approach and process be applied/adapted to craft production?

The project intended to integrate to İSMEK and its structure. Considering the existing system, some points to take account of while designing the course stood out.

The main actors of the projects were participating crafts tutors of İSMEK who mainly focus on traditional art and crafts. Most of them had no design education background, but were masters in certain crafts. Other actors were the design instructors, two of whom were designers with experience in the field of crafts, and tutors in the Department of Industrial Design at İstanbul Bilgi University. The other instructor was an art historian academic at the Faculty of Art and Design at Yıldız Technical University.

While structuring the course, instructors took a curatorial role as well, in order to bring a novel and unified approach to outputs of the design course. Instructors set the criteria, encouraged and directed craftspeople throughout the process, whereas craftspeople actively participated to design and production as the primary actor. In practice, teaching a variety of crafts at the same time with a similar method was a point that needed to be considered.

The process of acquiring knowledge in both crafts and design, and their potential contributions to each other, was another question. Design learning is a way of changing a student’s thinking through self-regulated learning where students develop knowledge and skills by themselves, through participating in a design-oriented problem-based process. (Powers, 2017, p. 3). This distinct way of learning bears resemblance to the way of acquiring craft knowledge, which is “a distinctive form of skilled knowledge that is intuitive, acquired through an apprenticeship mode of learning and expressed through making and doing.” (Gardner, 1997, cited in Maho, 2010). On the other hand, design education, which centres around working with open-ended problems (Powers, 2017, p. 193) differs from craft education, which is based on copying works from previous masters (Cross, 2007, cited in Hasdoğan & Hasdoğan, 2016). At this point, presenting participants with concepts coming from design education, like open ended problems and multidimensional thinking, were introduced.

In the light of the questions and decisions mentioned above, some basic steps created the original structure of the design course. Firstly, going back to the elements of craft, by returning to the components of the craft, such as materials, techniques, tools, design course aimed to uncover and investigate new possibilities of craft production. Secondly, craftsmen were encouraged to go out of their field by working together. İSMEK is an institution where many different craft branches work side by side, without much information exchange. Instead of this, project suggested interdisciplinary cooperation.

To achieve this, the design course participants worked in pairs to develop different perspectives by taking into consideration different materials and technical knowledge of the other craft branch outside his/her area of mastery.
Another decision was to implement basic design exercises at the beginning of the design course, on the assumption that associating basic design principles would present fundamental notions of design to participant craftspeople and create a common ground for diverse crafts, as well as to start collaborating.

4 The Design Course

Participants attended to course for a period of 12 weeks, 1 day a week at the İSMEK Çolpan İlhan Fashion Academy building meeting room. The course was initially programmed for 8 weeks, but in order to finish the products for the exhibition, an additional 4 weeks were added. The studio participants consisted of 40 craft tutors selected from 27 different craft branches at ISMEK. They were originally chosen from a list of participants who had volunteered for the project. These names were suggested by the branch heads and İSMEK officials. From the list, craft tutors who attended the introductory seminars were selected by the course instructors. Instructors also decided on how many participants from each craft would be selected. Craft branches which have potential of creating 3-dimensional objects were selected. While determining the branches in the selection, some crafts like patchwork, jewellery design, and feltwork were chosen in higher numbers for their potential ease of working and establishing connection with more specific crafts.

Classes which took place once a week were not usually utilized for producing work, rather they were programmed as interactive critic sessions where everyone was encouraged to take part. During the classes, all 40 participants gathered around a table where the weekly works were laid out together in the manner of a pop-up exhibition. During the critic session for each project, all other participants were encouraged to listen and participate.

At an early stage of the course, participants were asked to group together with another craft to work with throughout the design course, guided by the instructors. Participants chose their pairs for different reasons, including interest in a specific craft, or knowing the craftspeople. When working in pairs, participants communicated and worked outside class hours by using an online messaging service to share photos and exchange ideas, visiting each other’s workshops or houses. The diagram in Figure 1 shows a pairing of the crafts.

4.1 First Meeting and Introduction

In the first week of the design course, instructors gave information about the approach, general outline of the course and resulting exhibition. Participants were asked in advance to bring along their portfolios and samples from their work. The aim was to get to know the participant by understanding the work she/he had done in order to create a common ground with the other participants through this informative environment. This proved to be useful since many participants were not accustomed with each other’s area of work.

Some of the participants who knew about the final exhibition brought initial ideas, although this was not requested by design instructors. These proposals were briefly evaluated by instructors, but advised to be kept aside in order to concentrate on creating new work during the design course. Figure 2 shows examples from these.
4.2 Deconstructing the Craft

For the second week of the course, each participant was asked to explain their craft through a swatch card, in order to let the designer tutors and other craftspeople know each other and their works in detail. Each craftsperson has prepared a *craft swatch* which reveals the techniques, materials, patterns, motifs, textures and finishes of their mastery (Figure 3). The few craftspeople that had already created this type of card for their students in İSMEK developed them in more detail. Participants were encouraged to comment on each other’s work, and draw similarities and differences between their craft subject and others.

By deconstructing craft to motifs, materials, techniques and components, craftspeople were encouraged to look at the elements of their craft. Rather than understanding craft as a finished object, they were motivated to think about components of their own craft, all of which can be altered, adapted and related to each other.

4.3. Basic Design Activities

The creation of the craft swatch cards was followed by basic design activities borrowed from design education. To start, a visual presentation with examples explaining basic design concepts (such as composition, harmony, balance, hierarchy, dominance, similarity, contrast) was given. This presentation was accompanied by interactive discussion about these concepts, both in relation to the presentation, and also to their own work. This encouraged participants to evaluate work according to these principles, and consider these concepts when designing.

The craftspeople were then asked to abandon their materials of craft and work with readily available materials like cardboard, paper, packing materials, to create a response to one of the basic design concepts they chose, in a two and three-dimensional collage format. Participants first worked individually, then worked with another craftsperson, as exemplified in (Figure 4). All outputs were discussed and evaluated in an interactive manner using criteria such as legibility of basic design concept, choice of materials, elements and their relationship with whole composition.

Using materials such as paper, cardboard, rope, off-cuts encouraged them to focus on basic design principles, rather than working from their own craft’s point of view and capabilities. This separation from familiar materials generated a space for participants to notice, question and intervene their intuitive thinking and making practices, which are closely entwined with craft and its materials. It also made it possible for them to try and find new things relatively quickly, since creating a composition with paper takes far less time than creating a composition with lacework. Finally, in a
group with 27 craft branches, working with materials outside their own craft also made it possible to create a common ground for evaluation and comparison.

Figure 3. Examples from craft swatch cards, 29 March 2017.

Figure 4. Examples from individual basic design activities, 5 April 2017.

4.4. Developing Craft Objects in Pairs
One of the main decisions made when structuring the course was to pair participants to work together. The motivation behind this was to interrupt the habitual thinking and making process of craftspeople and to help reposition themselves in order to respond to an input coming from outside their own craft.
For participants, each of whom have trained in and mastered a specific craft, this approach was unusual and unexpected, as it was not in line with their craft training or practice. The pervading attitude in İSMEK was to produce work within only their own craft field and collaborating with craftspeople from the same craft branch.

The group work started with the second set of basic design exercises, as participants from two craft fields responded together to basic design concepts, again with readily available materials. Taking into consideration the feedback from instructors and other craftspeople, they were then asked to transform their work with the material or technique input from both crafts.

This exercise was supported by a mapping exercise in order to make relationships between the crafts visible. Pairs were asked to analyse the two branches in terms of materials and techniques and, using keywords, diagrams and visuals, participants compared, contrasted and drew possible ways of connecting the two branches. With this approach of transforming work through changing materials and techniques, basic design principles were naturally adapted to craft practices. This way design and craft merged throughout the process almost naturally, rather than being perceived and studied as two separate practices of making. Throughout the classes, craftspeople pairs continued to work for eight more weeks to develop their objects, receiving feedback from instructors and their peers. Some work in progress examples are shown in Figure 5.

Figure 5. Examples from design course process, April-May 2017.

5 Outputs

5.1. Products

The 12-week design course culminated with two craft objects or collections from each craft pair. Different responses to the design course are outlined below, in terms of transforming techniques, use of materials and changing the context(s) of the craft.

Both string art and needle work create two dimensional patterns but, unlike needle work, string art requires a rim in order to stretch threads to form patterns. The craft pair started collaboration with a traditional flower pattern applied by both crafts in their own techniques, also matching in colour, as shown in Figure 6. After the critic and feedback session, their second trial was asymmetrical and had a simpler pattern, with point lace imitating the thinness of threads. Tutors motivated the pair to try 3 dimensional possibilities of the wire and manipulate the technique. The pair then tried to take the strung strings out of their frame and use them to create three-dimensional forms, with different color and lacework combinations. For the final object, the pair increased the size and created an amorphous volume from threads, combined it with lacework emphasizing the form. String art was transformed into the third dimension and the technique took on a completely different form.
Similarly, the feltwork and leather decoration crafts pair started out their collaboration by trying to interpret characteristics of other craft’s material. Rather than working with and decorating surfaces in the usual way, the pair transformed their craft materials to linear elements; then combined these elements by weaving, in order to create a collection of baskets from felt and leather seen in Figure 7. Like the example mentioned above, the new, combined technique brings both crafts to the third dimension and opens up possibilities for new applications.

For patchworks and silverwork crafts, the mapping exercise where they compared their crafts was an important point. They decided to interpret flower patterns in their own craft, starting by placing them on a grid. After trying different color combinations, the pair decided to combine them on felt, a material they had not worked with before. By applying similar patterns made from different materials and techniques to accompany felt background, the pair created a runner with accompanying decorative bowl as seen on Figure 8.

Being a closer match, ceramics and tile painting crafts pair did not concentrate on material. Instead, they worked on and refined their first basic design exercise, a circular form covered with decreasing sizes of broken ceramic balls with decorations. Throughout the process, they experimented with distorting basic ceramic forms and tile painting decorations. They created a collection of decorative wall panels where they used each craft to emphasize the other’s change of form. In addition to wall panels, they used this same approach of distortion to create a collection of rings and bracelets, and used the technique in new contexts altogether (Figure 9).
Figure 8. Runner with accompanying decorative bowls designed and produced by Mühibe İper/Silverwork and Kudret Karahan/Patchwork (İSMEK, 2018, p. 96).

Figure 9. Ceramic jewelry and decorative panels by Dilek Aksevi/Ceramics glazing and Seyma Balci/Ceramics (İSMEK, 2018, p. 114-115).
Figure 10. Decorative accessories by Şengül Er/Patchwork and Esra Küçük/Jewelry Design (İSMEK, 2018, p. 118-119).

Figure 11. Story table by Şermin Büyükbaş/Decorative home textiles and Emine Uygun/Ceramics (İSMEK, 2018, p. 124-127).

Figure 12. Decorative panels by Hatice Uçar/Kat’ı Paperwork and Bahar Şen/Decorative Glass Objects (İSMEK, 2018, p. 98-99).
5.2. Exhibition, Panels and Workshops

Outputs of the design course were shared with a wider audience through an exhibition, which was also curated by the course instructors. The exhibition took place at the Naval Museum, İstanbul between 8 January-28 February 2018 and promoted by the municipality through billboards and overpass advertisements. The opening was attended by officials from the municipality, including Adult Education Director of İstanbul Metropolitan Municipality ("Dün Bugün Yarın Sergisi Açıldı," 2018).

The exhibition space and its catalogue was designed by practices outside İSMEK organisation, which was different to their standard procedure of working with their in-house exhibition and graphic design unit. This outside point of view on presenting work differentiated the exhibition from previous İSMEK exhibitions in terms of visual look and feel.

As mentioned above, curation and organisation of an exhibition was part of the initial proposed project, aiming to showcase the diversity of İSMEK’s craft production. This was done by structuring the exhibition around three parts: past, present and future. Past section presented 21 works from craft tutors of İSMEK Bağlarbaşı Turkish and Islamic Arts Specialist School, areas including miniature painting, marbling, modern calligraphy. The Present section showcased İSMEK’s contemporary education of art and craft areas, like painting, fashion, stained glass, string art, ceramics jewellery, pyrography (İSMEK, 2018, p. 10-15). Exhibitors from present section consisted of 19 works selected by curators from 2017 General Exhibition, and 11 new works selected from the submission made to open call. The Future section presented outputs of the 12-week design course. For this, the process of the craft production was conveyed along with finished objects. Participants were asked to save and document all production including drawings, assignments and mock-ups they have produced along the process and selected examples were exhibited as shown in Figure 14 with explanations of design and production process steps.
The exhibition also hosted two round-table discussions open to the public, which took place in the exhibition hall. The exhibition and the design course was also evaluated by speakers, and possible future applications and projections were discussed.

In the first talk, titled *About Artisanal Labour*, design instructors and four participants expanded on their experience and comments of the course. The second session, *Looking at Design-Craft Relations in 21st Century*, was held with national and international guests from design fields. The topic of the final talk was *What Can Craft and Design Education Learn From Each Other* and was held with guests from the International Council of Design ("Özgün Yakınlaşmalar" 2018).

In addition to the talks, during the exhibition of the course, a series of one day workshops were held in the exhibition space and were open to public and free of charge. These workshops were structured around the resulting craft objects of the design course, which were displayed in the future section of the exhibition. Rather than explaining specific craft techniques, the aim was to share the method of collaboration between two crafts which came forth during the design course, and try this with new participants. After a short explanation made by the craft pair about their process and approach, participants were asked to produce small craft objects in pairs under supervision of craft tutors and design instructors. These workshops were: mould making with 3-dimensional model making and relief, tabletop objects with leather decoration and felt work, body accessories with patchwork and jewellery, making wall panels with aluminium embossing and decorative home textiles, jewellery making with jewellery and carpet weaving.

![Figure 15. Panel at Naval Museum, January 6, 2018.](image1)

![Figure 16. Workshop process and results from Naval Museum, at January 2018.](image2)
6 Conclusion

Through creating a framework for experimenting on traditional crafts, the design course structured for İSMEK craftspeople resulted in a collection of novel craft objects, where participants investigated the elements of their crafts to build upon them through basic design exercises and interactive critic sessions. Pairing two crafts took this approach further. By manipulating materials and techniques, participants understood and adapted to craft branch they were paired with. Experimentation, openness, mutual learning, sharing ideas were important tools utilized in the design course, which resulted in development of a collaborative thinking environment through which craft objects were produced.

“Throughout the course I learned about how parts come together as a whole, that materials obtain a meaning when becoming a 3-dimensional object. I am always inspired by this, in my own works. Using another material, thinking there are no limits made me learn that I can do functional things as well. Basic design projects we did opened our minds, each week we witnessed the works changing and developing. Finding a common ground on group work made our design stronger. It made us think differently and improve the quality of our designs. We apply what we learn in design course in our own classes. We can develop designs with other materials, and evaluate the results.” (Z. Ekmekçi, personal communication, March 15, 2019)

This new approach created significant changes in the participants' perspectives, which they could reflect on their own production and teaching processes.

“This course has been instrumental in bringing traditional position of craftspeople to a contemporary point. David Grosmann puts forward that the most important output of the exhibition is the mutual respect between the craftspeople and designers, neither craftspeople nor designers aimed to obtain each other’s role. “In these works, crafts people met with some basic design ideas, and this interaction improved their works, made them more contemporary and rich.” ("Özgün Yakınlaşmalar" 2018)

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A Design Course for Craftspeople in Istanbul


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Abstract: Maker movements arose with a democratisation of technology and outspreading of a culture of sharing knowledge. Makers are involved in every step of creation and distribution of the items they make: ideation, production and selling. For production, both traditional and digital techniques are used by makers. Woodworking, which appears as one of the most common practices performed by makers, has a material-oriented skill knowledge which is mostly based on personal experience. Makers from different educational and professional backgrounds are able to acquire the tacit knowledge for woodworking via easily accessible printed and online resources. Besides, their relationship with craftsmen and customers act as other means of knowledge transfer. The aim of this study is to examine the tacit knowledge acquired and used by makers, the effects of makers’ educational backgrounds and motivations on knowledge transfer and product ranges produced. In order to do so, 24 makers dealing with woodworking were interviewed.

Keywords: maker movement; woodworking; tacit knowledge; knowledge transfer

1 Introduction

The act of making is one of the fundamental activities of human kind. Moreover, making has become a distinct sign of identity with Do It Yourself (DIY) activities and maker movement. Do It Yourself is defined by Wolf and McQuitty (2011, p. 1) as activities in which individuals engage raw and semi-raw materials and component parts to produce, transform, or reconstruct material possessions, including those drawn from the natural environment. By democratisation of technology and information, the Maker Movement appeared as the next generation of do it yourself culture. These activities are “the antithesis of the prescribed design of the mass marketplace” (Atkinson, 2006, p. 1). Maker movement shares the mind set with do it yourself culture; yet technology is involved in not only production methods but also sharing information. Makers such as hobbyists, tinkerers, engineers, designers and artists shape the Maker Movement (Martin, 2015). Kail (2013, p. 12) defines makers as people who design and make things in their leisure time with a motivation to produce, solve problems, and discover and share what they have learned. “Knowledge sharing and peer-to-peer learning create a place for makers to fulfil their desire to make something, mobilize their knowledge, allow for socializing with other makers, and generate collective innovation” (Capdevila, 2013; cited in Kwon & Lee, 2017). Maker activities include traditional craft activities involved with technology and design.
Technology may be involved at different levels: Skill learning, innovation in products, production methods, opportunities in manufacture and distribution. Chris Anderson (2013), states that the maker movement creates an industrial shift which is referred to as the third industrial revolution – via digital tools and culture of entrepreneurship.

Woodworking, being one of the most traditional crafts, has its own technical knowledge owned by craftsmen and wood is a common material which is abundantly used by makers. As an easily accessible material that can be processed with common tools even outside a workshop, wood provides a means of knowledge generation and transfer in maker culture. In addition, there are numbers of resources about woodworking that are accessible on different platforms such as schools, craft courses, books and internet tutorials. Wood is a material that can be formed by both modern methods utilizing digital tools such as laser cutting and traditional methods based on hand skills such as engraving. As a result, the material provides a grounding of performance for makers with either digital competencies or hand skills making use of tacit knowledge.

An occupation is an assortment of tasks or activities which provides an income in return of some particular knowledge and skills demanded (Hughes, 1958; Svensson, 2015). Maker practice can be performed either as a main occupation to make a living or as secondary or side occupation. Performing a craft as a maker does not mean the display of a low level of skill. As pointed out in Maker Manifest, “Some makers have expert knowledge but most are individuals who create products as amateurs and non-specialists” (Hatch, 2014). Therefore, makers who have different levels of skills transfer the material-oriented skill knowledge of wooden craftsmanship. Nowadays, craft education has remained within the boundaries of skills training but craft training is also commonly available for those who want to apply it in their leisure time for self-expression, innovation and design. The aim of this study is to examine the reflection of education on makers’ knowledge and knowledge transfer processes. Within this framework, makers specialised in woodworking are analysed with respect to their educational background, orientation to craft and the products they make. In this study, the maker group is pro-makers dealing with activities which contain significant elements of self-directed, creative design input, and which might involve the skilled manipulation of raw materials or original combination of existing components, where the motivation is personal pleasure or financial gain (Atkinson, 2006, 3). Within the study, the term maker is taken as the person who is involved in every steps of creation of a product: ideation, production and selling.

2 Method

In order to explore the condition of makers particular for woodworking, semi-structured interviews were conducted both face to face and online between the dates June 2018-December 2018. During the time, 22 participants were reached between 31-68 ages in Turkey with diverse educational backgrounds and knowledge acquisitions.

The interview questions intended to collect data under three main topic areas: maker characteristics, maker knowledge and knowledge transfer (Table 1). The questions on maker characteristics addressed the educational and professional background and the motives of the maker. The second question set aimed to explore the technical aspects of the craft of the maker. The third question set is about knowledge transfer aimed to learn sources of knowledge on maker act as well as the interaction mediums of the makers.

<table>
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<th>Table 1. Interview questions divided by topics.</th>
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<tr>
<td><strong>Interview Questions</strong></td>
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<tr>
<td><strong>Maker Characteristics</strong></td>
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<tr>
<td>• What is your educational and professional background?</td>
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<tr>
<td>• How did you started to making?</td>
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<tr>
<td>• What are your future plans about working with wood?</td>
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<tr>
<td><strong>Maker Knowledge</strong></td>
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<tr>
<td>• What types of wood and materials do you work on?</td>
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<tr>
<td>• What are your methods for forming/polishing/colouring the wood? Why did you choose them?</td>
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<tr>
<td>• What is your product range? How did you create it?</td>
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<tr>
<td><strong>Knowledge Transfer</strong></td>
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<tr>
<td>• How did you learn your working technic?</td>
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<tr>
<td>• What are your resources in your new graphic/product designs?</td>
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<tr>
<td>• What are your marketing (promotion and sales) channels? (Digital platforms: Instagram, Facebook, Etsy, Zet; Non-Digital platforms: Festival, Fairs, Shop etc.) How do you get access to these channels? Which channel provides the most efficiency?</td>
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<tr>
<td>• Are you involved in organizations for craftsmen (Example: Maker networks / Movements / ...)? If you are involved, what are the contributions provided?</td>
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Maker practice is the main occupation of 11 participants and side occupation of 13 participants. The hobbyist-crafter participants are coming from diverse backgrounds as civil engineering, public relations, mechanical engineering, physiotherapy, graphic layout, industrial design, design education, interior design, biology, journalism and mechanics (Table 2).

3 Knowledge Transfer

Knowledge is the information which is identified, interpreted, and internalized by individuals. (Myers, 1996, p. 2) Knowledge is accessed either by acquisition, codification or transfer (Collins, 1974; Blackler, 1995; Lam, 2002). As Sennett mentions in his book The Craftsman (2008, p. 94), craftspeople have tacit knowledge as “they know how to do something but they cannot put what they know into words”. Tacit knowledge is information that cannot be completely encoded and made clear by definition. (Polanyi, 1962). Lam suggests the term embedded knowledge, a collective form of tacit knowledge which consists of shared norms (2002, p. 492) and tacit knowledge is personal, embedded knowledge is common and is shared by the members of a community such as makers. According to Lam, “tacit knowledge can only be acquired through practical experience in the relevant context.” (2002, p. 490). This experience, being highly subjective and internal, is acquired by training. In such a training, the trainer, generally the master, exposes his/her own labour effort as the model to be reached. The trainee tries to reach mastery by watching the trainer and by gradually getting involved with the work. Today, such kind of master-apprentice relation is observed in maker activities as well. The makers, rather than aiming to earn a professional degree or title, are involved with training activities as apprentices.

The democratisation of knowledge and design has given rise to the maker movement. In Turkey, municipalities and Public Education Centres arrange training programs which are broadly accessible for skills training. Among them, courses for woodworking serve for both leisure and professional purposes. These courses provide technical knowledge such as colouring, varnishing, assembling, inlaying, carving and burning; and are focused on products such as gifts, toys and furniture. In addition, there are independent courses on woodworking and workshops conducted by masters. In terms of woodworking techniques, formal and non-formal education programs are defined as:

- Craft originated/technical education (Vocational high schools and technical education faculties) Formal programs providing a diploma or a degree on woodworking
- Design education programs providing side-training on wood
- Non-formal education

Within this study, it was found that the participants experienced knowledge transfer in woodworking via 7 ways which are either formal or non-formal. These are craftsmanship (master-apprenticeship relation), technical education (formal diploma programs), design education (formal degree programs), directed courses, time spent with masters, experiential (self-taught), and by online learning. Characteristics of the participants examined with their educational background, occupation, knowledge acquisitions and techniques as shown in Table 2.

<table>
<thead>
<tr>
<th>Table 2. Characteristics of participants</th>
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<tbody>
<tr>
<td>Participant</td>
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<tr>
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<tr>
<td>Participant 1</td>
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<td>Participant 2</td>
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<td>Participant 5</td>
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<td>Participant 6</td>
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<td>Participant 7</td>
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In order to better understand the production act, products had been examined in three technical aspects as forming, colouring and polishing. The methods, tools and materials utilized in each aspect by the makers is regarded as the technical knowledge. Wood forming techniques of the makers are categorised according to their involvement with colouring and polishing. The methods, tools and materials utilized in each aspect by the makers is regarded as the technical knowledge. Forming techniques are generally learned by self-taught makers. The methods, tools and materials utilized in each aspect by the makers is regarded as the technical knowledge. Wood forming techniques of the makers are categorised according to their involvement with colouring and polishing.

Formal technical education and traditional craftsmanship depending on master-apprentice relation provides technical knowledge through learning by doing. In non-technical education, the maker earns the technical knowledge with learning by doing as well. Self-taught makers, on the other hand, stated that they learn by imitating existing models. In online learning, maker tutorials are an important resource for participants. Online media also provide interaction with other learners. Getting feedbacks and inspirations are the most important gains in online sharing environments. Internet is important in transferring different countries' know-how, yet some participants stated that they have language problems and can only learn through visuals. An online learning participant also emphasized the importance of the information, and stated that he has access to information written on the Internet from many years ago; however, he could not get a return most of the time when he experienced problems with these tutorials. The participants who had formal design education indicated that they got the skills and technical and material knowledge during their undergraduate projects.
technology. Techniques used in forming step are based on either hand tools, power tools or CNC (Computer Numerical Control) routers. Colouring and polishing were observed to be the approaches of the maker, some of which skipped this step, and included hand painting and digital printing. On the polishing step, the quantity and the quality of the polish applied varies according to the natural wooden appearance preferred. The materials used during polishing are natural oils and synthetic polishes.

Table 3. Techniques used by participants.

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</tbody>
</table>

In the forming step; participant makers were observed to acquire skills and knowledge mostly via experiential and online learning. The methods used by all participants are cutting and sanding. The technique of carving, which requires fine workmanship, mastery, and in-depth knowledge about wood types, was not performed by all of the participants. As a result, tools utilized for carving, such as wood chisels are used by only 4 participants. Almost all of the participants acquired hand-tool skills through learning by doing. The patterns and product templates are generally acquired from internet resources or pattern and craft books. (Figure 1).

Figure 1. Craft book as a resource (Asarcıklı & Keskin, 2002).

“For many years, I did compilations on the wood carving patterns of rural architecture in the Eastern Black Sea. These patterns, which are the common cultural values of Turkish, Greek, Armenian, Laz, Hemshin and Georgian peoples in the geographies from Trabzon to Artvin, are all my style. When I compile a pattern, I try to decode the drawing techniques of that pattern for days, and then use it as the same or with my own interpretation. If I directly copy a pattern, then I do not consider myself as a master of the technique.” (Participant 10)
Manual tools, which depend on hand skills rather than technological capabilities, require manual dexterity in techniques such as carving. Makers expose two opposite approaches in utilizing digital and manual techniques. Most participants that make use of manual techniques, do not have a strong motivation for selling their products and are not skilled in computer aided techniques. On the contrary, participants who have acquired formal design or technical education, have related computer skills and tend to use CNC (Computer Numerical Control) tools. In general, they create drawings by digital techniques and modify these drawings relying on other digital media and techniques.

It is observed that makers who work with wood acquire knowledge from three main sources: craftsmen, other makers and customers. Among the participants, only one of them was trained as an apprentice, in other words, acquired knowledge in craftsmanship tradition. Other 6 participants from other diverse backgrounds stated that they learned woodworking by observing a craftsman, rather than becoming an apprentice. Observing the craftsmen while working, differs from defined apprenticeship by not having a specific agenda, and is regarded as an alternative way to learn from the craftsman.

These makers experience an unidentified learning process by imitating the technique used by the craftsman and asking questions. In addition, some craftsmen participate in workshops as a trainer and provide short-term information. It was observed that participants who are self-taught learners were willing to attend these workshops. 3 makers who are self-taught, defined the family members of the workshop at the learning resource in the same manner with traditional master-apprentice learning. Although these people did not teach one-to-one technically, they created a learning place and motivation in childhood to trigger a motivation to produce.

Crafts books can also be regarded as a reference for skill training, however these books are utilized as material in formal education as well. In self-education, the self-taught makers continuously and abundantly make imitation. For this reason, in the absence of one-to-one communication with craftsmen, the output of the crafts knowledge is repeated by imitating traditional forms. Technology and craft learning traditions seem to be inversely proportional, as the technology is utilized in production increases, the traditional master-apprenticeship relation decreases. Correspondingly, the borders of craft education remained within the limits of skill knowledge, while mastering and material knowledge decreased.

It is claimed that being open source and sharing knowledge is one of the most important principles in the maker movement. The maker spaces where makers work in the same physical space, and the online platforms which makers from every part of the world are involved in, are important triggers and outputs of the maker movement. Participants involved in maker groups tend to have innovative approaches in their products. The makers who have a variety of professions were not aware of these groups and had their reservations about not being an expert.

Participants who are not involved in any maker groups have the chance of coming together in craft fairs and exchange ideas. Participants who are already in a maker group stated that they are actively meeting, organising craft fairs, and creating a movement against high commission fees of craft markets. Participants who are using the internet as a source of technical knowledge, mostly learn from video and blog tutorials created by makers like themselves instead of acquiring knowledge from other craftsmen or tutorials. Beyond being only a learning tool, 11 participants (with different levels of skills) stated that they used the internet to get inspiration for both their products and graphics. The internet, and specifically social media platforms such as Pinterest and Instagram, provides interactions with other makers, needed for inspiration and improvement. Participants keep themselves updated with the latest technical and aesthetic trends.

**4 Product Range and Distribution**

In this study, products produced by makers (Figure 2) specialized in woodworking were observed to be consisted of 6 categories:

- Accessories (Necklaces, earrings, pins, eyeglasses, bows, wallets, bags, ...),
- Furniture (Tables, coffee tables, ...),
- Home decoration (Figurines, boards, vases, ...),
- Kitchenware (Serving plates, mugs, utensils, ...),
- Lighting (Table lamps, floor lamps, ...),
- Other (Toys, instruments, ready-made hobby objects, stationery).
The knowledge acquisition channels of the participants and the product ranges are shown in Table 4. Participants state that accessories have many advantages with respect to other maker items. Firstly, they are easy to manufacture and store. The production is quick, the product can be customized, is easy to get to physical markets and has high profit return. Customers do not tend to purchase accessories only once. One maker who runs a store dedicated to her handmade objects, stated that customers primarily focused on low-priced products so that she always keeps the same low-price range in her store. The production of small-scale home decoration items exposes the same motivations as the production of accessories. Product categories other than accessories and home decoration items seem to require higher levels of technical knowledge in production. Therefore, these two categories are common with makers’ low-skill levels.

Motivation of maker effects the knowledge transfer paths followed. “The motivations for DIY behaviour fall into two categories and arise from marketplace evaluations of goods and services and identity enhancement.” (Wolf & McQuitty, 2011, p. 4). In this study, although most of the makers were selling the items they make, the motives of the participants for involving in crafts practice were diverse. Among all participants; only 3 participants, with 1 of them being an apprentice from childhood, stated that they had started to produce for sale. Other makers had started woodcrafts as a leisure time activity. 20 of 22 participants underlined that their primary motivation is not making

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Table 4. Participants’ knowledge acquisition channels and product range.

<table>
<thead>
<tr>
<th>Accessory</th>
<th>Furniture</th>
<th>Home Decoration</th>
<th>Kitchenware</th>
<th>Lighting</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Online</td>
<td>5</td>
<td>2</td>
<td>7</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Self Taught</td>
<td>9</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Time Spent with Craftsman</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Course</td>
<td>4</td>
<td>1</td>
<td>4</td>
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<td>3</td>
</tr>
<tr>
<td>Design Education</td>
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<td>1</td>
<td></td>
</tr>
<tr>
<td>Technical Education</td>
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<td>2</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Craftsmanship</td>
<td>1</td>
<td>1</td>
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</tbody>
</table>

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profit and earning a living. A participant who has her own craft store and takes part in craft fairs, stated that standing behind a desk and selling something causes unhappiness and sales aren’t a reward for her. When it comes to future plans of making, 14 participants stated that they want to improve their product range, branding and financial gain. 7 participants focused their future plan to improve their crafting skills.

As I enjoy it, I will continue to make the products that I’m satisfied with. I will continue to work as a boutique but not a mass production store. High volume of intensive production turns into grind. It is boring for me to do the same thing over and over again. I love to try new things and compete on my own. (Participant 4)

Makers have two marketing (distribution and advertising) mediums (Table 5):

- Digital: Social media platforms, common online stores (Etsy, zet etc.), maker’s personal online stores (Woodenist.com, velrut.com etc.)
- Non-digital: Maker’s personal stores, stores (Stalls in craft stores), temporary markets (Design and craft events, fairs, festivals)

### Table 5. Participants’ Marketing mediums

<table>
<thead>
<tr>
<th>Marketing Medium</th>
<th>Participants</th>
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</thead>
<tbody>
<tr>
<td>Digital</td>
<td>12</td>
</tr>
<tr>
<td>Non-Digital</td>
<td>5</td>
</tr>
<tr>
<td>Social Media Platforms</td>
<td>3</td>
</tr>
<tr>
<td>Common Online Stores</td>
<td>3</td>
</tr>
<tr>
<td>Personal Online Store</td>
<td>5</td>
</tr>
<tr>
<td>Personal Store</td>
<td>7</td>
</tr>
<tr>
<td>Common Craft Store</td>
<td>16</td>
</tr>
<tr>
<td>Temporary Event Stalls</td>
<td>15</td>
</tr>
</tbody>
</table>

Social media platforms are the most popular channels for the makers to reach their customers. With social media, makers have the advantage of accessible communication and marketing. However, participants stated that social media is time consuming and does not provide as effective contact with customers as non-digital media. 5 participants own a workshop that they use as a craft store and 16 participants are regulars in local craft fairs. Craft fairs, commonly named as design markets, is a trend that is becoming widespread in Turkey. These design markets; are craft-oriented events organized by maker communities, art museums and municipalities or as part of cultural festivals. Makers have the opportunity of face to face interaction with customers, reaching the customers which they are targeting and getting feedback from them. Participants try to increase their interaction with customers as they focus on sales; but rather than motivating sales, it is seen that interest in customer requests decreases. A participant who has her own craft store and takes part in craft fairs stated that standing behind a desk and selling something causes unhappiness and sales are not reward for it.

### 5 Conclusion

Maker movement spreads as a result of easy access to information, ease of distribution and democratization of design. Makers are those who create items by themselves and share the knowledge acquired during creation and production process. In this study, the maker community focus was limited to those who deal with wooden material. As a common traditional material, wood has its own traditional techniques for production. Falling outside of the master-apprentice tradition, makers involved with woodworking expose two opposite approaches by using either traditional or digital techniques.

Among all participants, 3 of them strictly refused to use digital techniques for the sake of traditional craftsmanship. Among these 3, 2 of them were observed to use power lathe which can be considered as a modern tool. Although use of power lathe is a relatively modern technique, it still provides a hands-on experience. These participants also stated that their main goal is improving their skills instead of making profit by selling the items they make. On the other hand, the participants utilizing digital methods stated that CNC routers provide opportunities for new product designs. Digital techniques provide advantages in fast and cheap production as well. Without a need for delicate crafting, any item can be produced in large quantities by laser cutters, standard CNC routers, and UV printers. Participants who
have acquired formal design or technical education have related their computer skills with maker practice and tend to use digital methods more. In general, these makers create drawings by digital techniques and modify these drawings relying on other digital mediums and techniques.

In this study, the relationships between the participants and craftsmen were examined with respect to their contact with master-apprentice tradition. Participants who directly interacted with craft masters tended to display high level of skill in craft. Knowledge resources prepared by craftsmen such as books and video tutorials provided indirect contact with the masters and are useful for makers who do not have technical education.

This study focused on the ways of gathering material based-skill oriented knowledge. Semi structured interviews were conducted with makers to examine knowledge and their educational background. According to the education and professional backgrounds of the participants, the acquisitions of knowledge about production techniques and the products they produce were compared. As a result, the makers who have acquired knowledge and skills during their occupational education are able to manipulate the material without additional training and become more active in the use of technology than the other groups. These participants can be regarded as the design/technical oriented makers since they received technical education or design education. The rest of the participants exposed two distinct motivations in performing craft; while some of the participants are more focussed on earning a living and making profit, the remaining participants were more focused on gaining hand skills. The skills-oriented group was likely to use hand tools. On the contrary, the profit-oriented group preferred using digital techniques for cheap and fast manufacturing. The idea of innovation was another aspect that was elaborated differently by the participant groups. Innovation was observed to be made in material, techniques and tools. As an example of innovation in material, eight of the participants combined wooden material with other materials such as metal, cork, paper, imitation leather, plexiglass, textile, stone and bones. For technical innovation, alternative uses of resin and epoxy on wood can be mentioned as well as self-customization of the tools according to specific needs of the makers.

References


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Rehashing Design Through Evolutionary Computation

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Abstract: Evolutionary computation has made its way into design curricula in the last two decades. However, questions remain on how evolutionary computation can be made more accessible to design students and its potential to transform design thinking and learning beyond optimisation. This paper examines how the formulation and implementation of evolutionary systems can contribute to students’ learning of historical and theoretical aspects of design. The paper reviews evolutionary computation in design and presents genetic algorithms (GAs) as a design tool. Opportunities are identified on how to teach design students to create and implement basic GAs. Strategies that can help design educators to identify and build on these opportunities are discussed. Design activities aimed at applying GAs to rehash the learning of historical and theoretical aspects of design are described.

Keywords: evolutionary computation; genetic algorithms; design learning; design thinking

1 Introduction

Design students and practitioners can formulate and implement evolutionary computational systems to generate design solutions that are suitable for specific contexts. Evolutionary computational systems can assist in the design of architectural solutions whose performance aligns with the characteristics of the local environment (e.g. wind speed, amount of sunlight, etc.) (Ercan & Elias-Ozkan, 2015). However, it is still unclear how evolutionary computational systems can extend the understanding that design students have on qualitative aspects of design solutions (e.g. an artefact’s meaning, historical relevance, etc.). In view of the above, this paper examines how the formulation and implementation of evolutionary computational systems may enhance the learning of design history and theory. To do so, Section 2 reviews approaches to evolutionary computation and describes Genetic Algorithms (GAs). Since the formulation and implementation of GAs relies heavily on a clear understanding of how their constituent parts interact, Section 3 presents strategies for physically representing a GA for design. Section 4 assesses how design activities that involve the development of basic GAs can enhance the understanding that design students have on the stylistic parameters of specific historical periods. Section 5 explores how GAs can assist the exploration of the concept of “innovability” and how in turn, such concept can be used to extend the scope of traditional GAs (Wagner & Rosen, 2014).
2 Evolutionary Computation and Genetic Algorithms

Evolutionary computation integrates principles from evolutionary biology and computer science to develop search heuristics and algorithms. Evolutionary algorithms perform search by evolving candidate solutions to problems. Currently, these techniques are used in design for optimising existing solutions and for producing new ones (Ercan & Elias-Ozkan, 2015; Petre, Sharp & Johnson, 2006). These two approaches are respectively known as evolutionary design optimisation and creative evolutionary design. Both evolutionary design optimisation systems and creative evolutionary design systems can be implemented by means of genetic algorithms (GAs) (Bentley, 1999). A genetic algorithm (GA) is an evolutionary computation technique where candidate solutions for a given problem are stochastically combined and evaluated in successive generations. Due to its combinatorial approach, GAs tend to produce solutions that are increasingly fit for the purpose defined in the evaluation function. The search for design solutions in a GA initiates from a number of randomly selected points in the design space. As a GA runs, regions of the design space are further explored combining randomness with guidance from the relative fitness of candidate solutions (Bullock, Denham, Parmee & Wade, 1995). A usual stopping rule for GAs is when the increase of fitness of new candidate solutions slows down, indicating a convergence to a region of good-enough solutions in the design space. Several techniques exist to prevent early convergence and to pursue an extensive exploration of the design space. Evolutionary approaches in design are distinguished between routine design where the fitness function and the design space are fully defined at the start state and remain unchanged, and creative design where the search process may transform the design space, the evaluation function, and even the problem formulation.

In its most basic form, a GA is composed by an initial population of candidate solutions generated randomly when the GA is initialized. Candidate solutions are usually represented as strings of information that form their genotypical expression. Genotypes are composed of N number of variables or solution features each of which contains a randomly allocated value or design parameter. The values or design parameters at each locus are referred as alleles and may be of different types including numerical, Boolean (on/off), and nominal. Together, all the design parameters contained in the genome represent the characteristics of a candidate solution (Mitchell, 1998). As an example, the genome of a computer keyboard may contain genes to represent the total number of keys, their size and the spacing, whether characters are engraved or printed, whether keys are lighted or not, the type and colour of materials, layout characteristics, whether it uses capacitive, mechanical or membrane switches, whether it connects wirelessly or not and if so the length of cable and type of connector, and even the key bounce rate. The genome of candidate solutions represent their structural description, whilst the evaluation function can include criteria of performance (Gero, 1990). This means that search can be guided by the phenotypical expressions of candidate solutions. In the case of keyboards, phenotypical expressions include ergonomic performance, design language or style, and the audible and tactile qualities of the typing experience.

Basic GAs operations include the selection, crossover and mutation of candidate solutions. The selection operator chooses pairs of candidate solutions within a population. Selected solutions may be referred as parents because they inherit some of their characteristics to the upcoming generation of candidate solutions. The higher the fitness of a solution, the more likely it is to be selected to pass its genes to the next generation. The genetic material of candidate solutions that are not selected as parents is gradually lost. Once parents are selected, the crossover operator randomly picks a locus and exchanges the substrings before and after that locus between each pair of parents. As a result of this, offspring are created by combining increasingly fitting genetic material. The mutation operator introduces novelty by randomly switching the value of design parameters stored in one or more locus of the genotype. The cycle is iterated with evaluation of solutions to produce new generations.

3 Learning Evolutionary Design

Design education relies heavily on physical interaction with models, materials, tools, etc. Through this interaction, students develop an understanding of design practice that would not be easily achieved with other approaches to learning (i.e. verbal, written, etc.) (Klemmer, Hartmann & Takayama, 2006). Because of this, tasks like computer programming that heavily rely on text and where physical interaction is limited may be less intuitive and present learning barriers for design students (Jacobs, Brandt, Mech & Resnick, 2018). In our experience, teaching design students to formulate and implement GAs is best achieved via four types of learning experiences. The first type is characterised by the learning goal of developing an understanding of what evolutionary experiences are and their potential applications in design. The second allows students to understand what GAs are, their main components and dynamics, and how they model design by evolution. The third type of learning experience enables students to build and link their understanding of design knowledge and design activity with the formulation and implementation of GAs and other evolutionary systems. In this process, students learn how GAs can support design practice (Belmonte et al.,
2014; Bernal, Haymaker & Eastman, 2015). The fourth learning experience seeks to develop programming skills and more broadly, computational thinking for design.

**Strategies for Evolutionary Design**

The learning outcomes described above can be achieved in design education via strategies that are compatible with how designers learn. For instance, design educators can select an everyday artefact (e.g. a pair of scissors) and ask students to develop a GA aimed at producing candidate solutions for such an artefact. As a preliminary stage, students can use visual diagrams and cardboard models to develop an analogic version of the GA. An example of an analogic GA is presented below. Figure 1 shows from left to right “generation g” that includes candidate solutions A to D. The genome of each candidate solution is shown above the corresponding image. The values at the different locus of these genomes represent the type and shape of handles and blades. Specifically, each position in genomes A to D encode a phenotypical feature expressed in this case by material (M), size (Z), colour (C), symmetry (Y), and shape (S) respectively. Solution A shows a genetic makeup indicating that its handle is metallic (M1), small size (Z1), blue (C1), symmetrical (Y1), and that its blade shape is straight (S1). Following this notation, solution B shown in Figure 1 is genetically encoded as {M2, Z2, C2, Y2, S2} and physically expressed by a metallic, medium size, no colour, symmetrical handle and straight blades. Solution C is genetically encoded as {M3, Z3, C3, Y3, S3} which physically expresses as a plastic, medium size, red, asymmetrical handle and curved blades. Solution D is encoded as {M4, Z4, C4, Y4, S4} and expressed by plastic, large size, grey and yellow, asymmetrical handle and straight blades. Notice that this one-to-one representation of genetic code into physical features is a rather basic implementation. Section 5 introduces genetic interaction to capture the more complex reality of physical design features expressing via the complex interaction between genes and the environment.

![Figure 1: Genetic encoding and Phenotypic expression of scissors design.](image)

Cardboard models can be used to physically represent genetic operators. Figure 2 shows a cardboard version of the selection operator known as roulette-wheel sampling (Holland & Goldberg, 1989). The parts that comprise the roulette are organized in subsets that are proportional to the level of fitness of candidate solutions A, B, C, and D. Assume that based on their manufacturing cost and cut precision, the fitness of these candidate solutions is: A=2, B=3, C=2 and D=1. The fitness of A, B, C and D has to be added (i.e. 2+3+2+1=8). The result of the sum is then matched to the number of parts that make up the roulette (i.e. 8=16). Finally, the number of parts of the roulette that correspond to the fitness of A, B, C and D is calculated using a rule of three. Once this is done, students can proceed with parent selection.
Figure 2. Cardboard model of roulette-wheel sampling operator.

Figure 3 shows the three GA operators of selection, crossover and mutation. In Selection, solutions CB and AB are paired up based on their level of fitness. Notice that genome D was not selected and thus, its genetic material will be discarded. In Crossover, a point is randomly defined for each pair of solutions. Substrings before and after this crossover point are exchanged between pair members producing two offspring from each pair. In Mutation, the value at a randomly chosen position or locus is changed. The right-most segment shows the new characteristics of individuals in “generation g+1”. Notice that cardboard models may be fabricated to physically represent the Crossover and Mutation operators.

<table>
<thead>
<tr>
<th>Genomes</th>
<th>Fitness</th>
<th>No. Roulette Parts</th>
</tr>
</thead>
<tbody>
<tr>
<td>A: M_{0} Z_{0} C_{0} Y_{0} S_{0}</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>B: M_{0} Z_{0} C_{0} Y_{0} S_{0}</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>C: M_{0} Z_{0} C_{0} Y_{0} S_{0}</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>D: M_{0} Z_{0} C_{0} Y_{0} S_{0}</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

4 Learning Design History through GAs

From the perspective of actor-network theory (ANT), designed artefacts are aimed at propitiating that daily events unfold in accordance to programs of action established by social institutions. Programs of action are usually deployed not through a single artefact but several. The ways in which people drive are jointly shaped by seatbelts, car brakes, traffic lights, traffic signs, speed bumps, roads, etc. (Latour, 1992; 2007). Thus, artefacts from a historical context may share a common design rationale. One aspect of designed artefacts that clearly reflects this idea is “design style”. Asides from integrating the components of an artefact into an overall pattern, style resolves conflicts among people’s shared values and concerns. For example, during the period between the two World Wars, industrialized societies tried to incorporate the looks and rhythms of industrial machines into daily life. Consequently, stylistic traits were transferred from industrial machines to everyday artefacts of the epoch. At the most basic level, style can be said to be the visual synthesis of two elements: shapes and lines. This is because both the proportion and decoration of designed artefacts can be described in terms of the interplay of these elements (Cranz, 2000).

Considering the above, design educators can organize design activities (Telenko et al., 2015) to develop students’ understanding and use of GAs. This can be done to design everyday objects (e.g. chairs) that reflect the stylistic parameters of specific historical contexts. These new designs can be assessed by contrasting them to taxonomies and catalogues of designs from that epoch. To formulate the fitness function of these GAs, students can revise historical
texts and documents, catalogues of products, photographs, etc. In addition to providing students the chance to familiarize themselves with the design style from different historical contexts, this may increase their understanding of how designed artefacts incarnate people’s values and concerns (Juez, 2002). A brief that can be used at the beginning of this type of learning activities is presented below.

**Brief:** Implement a GA that evolves an initial population of 20 randomly generated structures into design proposals for office chairs. Structures that make up the initial population should be made from sets of 20 to 30 cubes of the same size. When formulating the fitness function, keep in mind that the office chairs produced by the GA should match the stylistic parameters of the average American workplace of the 1950s. For a general overview of the American workplace of such time, review (Saval, 2014a; 2014b). Additionally, refer to product catalogues, furniture ads, magazines and movies from the epoch.

To evaluate active-learning activities as the one above, educators can compare the proportion of the solutions produced by GAs with the proportion of design solutions from the examined epoch. Additionally, educators can consider the structural similarity between GA and real-world design solutions. Structural similarity can be examined by contrasting the overall composition of solutions produced by GAs with the overall composition of design solutions from a given epoch. That is to say, design educators can look at whether solutions produced by GAs exhibit the same components as the ones that are characteristic of particular historical periods. A more detailed evaluation can be made by independently comparing the components of solutions generated by GAs with the components of real-world design solutions. Besides allowing students to get familiar with stylistic parameters of different epochs, active-learning activities with GAs can increase students’ awareness of other historical aspects of design (e.g. the role of materials and manufacturing technologies). To maximise learning of design history, work with GAs can be complemented with activities such as group discussions, poster making, etc.

## 5 Learning Design Theory through GAs

In this section, we refer to Wagner’s concept of “innovability” to illustrate how the use of GAs may enhance the learning of design theory (Wagner & Rosen, 2014). Innovability emerges from the organization of the design space. The design space has been defined elsewhere as the set of all the possible genotypes that can produce one type of design solution. Since differences between some genotypes can be very subtle, two or more genotypes can produce virtually the same phenotype of a designed artefact (Raman & Wagner, 2010; Wagner & Rosen, 2014). Genotypes that produce phenotypes that exhibit no observable differences are integrated in networks within the design space. These networks are referred as **genotype networks**. When navigating a genotype network, the slightest change in a design parameter (i.e. allele) can lead the search to a neighbouring genotype. Progressively, mobilization towards neighbouring genotypes can cause the search to switch from one genotype network to another. Once the switch between genotype networks occurs, phenotypes may exhibit entirely new characteristics. What this means is that sequences of changes that cause no observable or significant differences between phenotypes can still lead to major innovations (Wagner, 2011).

Analogic work with components of GAs may enhance students’ comprehension of the concepts above. For instance, design educators can select an everyday artefact (e.g. a chair) and ask students to represent such artefact as a genome. As an example of this consider genome “S”. Genome “S” is composed by $N$ locus that together regulate the characteristics of wood chair phenotypes. In contrast to the scissors’ genome presented in section 2, genome “S” does not constitute a one-to-one representation of genetic code into physical features. That is to say, in genome “S” physical features are not regulated by values at single locus. Instead, physical features are regulated by the interaction of values expressed at various locus. Figure 4 shows the section of genome “S” that contains the genes that interact to regulate three physical features of chair phenotypes: the length of the legs (LL), the angle between the legs and the seat (ALS), and the height of the backrest (HB).

![Figure 4. Section of genome “S” that contains genes that regulate LL, ALS and HB.](image_url)
Once the genome is completed, educators may establish different criteria for measuring fitness. Depending on the established criteria (e.g., comfort, stability, etc.), students can progressively modify the values of the alleles that regulate specific physical features. For example, if the fitness of chair phenotypes depended on the height of the seat, the genes that regulate LL would progressively exhibit values whose interaction results in phenotypes with longer legs. Sketches can be made to illustrate the effects that these changes exert on chair phenotypes. Notice that interactions of genes that regulate one physical feature may affect the values of genes that regulate other physical features. For instance, as LL increases, values at the genes that regulate ALS may be recombined or modified so that the measure of stability of chair phenotypes remain adequate. Trade-offs between sections of genome “S” can progressively lead to design solutions whose physical features drastically differ from those of archetypical chairs. At some point, these differences may be significant enough to characterise resulting designs as new types of solutions (a new species). Figure 5 illustrates how changes in the values of the genes that regulate LL, ALS and HB may gradually lead to a different type of design solution.

Figure 5. Gradual changes on LL, ALS and HB.

Active-learning with GAs may as well enhance aspects of design practice. For example, the logic for implementing crossover operators may be used during studio-based courses as a method for systematically combining design variables in order to produce novel solutions (Hybs & Gero, 1992; Smith, Smith & Shen, 2012). In view of the above, a set of guidelines to design active-learning activities with GAs would include:

- Design activities based on artefacts composed of few components that are connected in standardized ways.
- Design activities based on artefacts whose components can be organized in different ways to produce the same or almost the same behaviour.
- Design activities with GAs as part of larger learning experiences that include other approaches to learning (i.e. verbal, auditory, etc.).
- Consider how the logic to formulate selection, crossover and mutation operators may be linked with design practice and align the stages to formulate and implement GAs with the activities scheduled in studio-based courses.
- Consider how the assessment of the solutions produced by a GA can be used to revisit specific theoretical aspects of design.

Just as GAs can enhance the learning of design theory, design theory can contribute to extend the scope of GAs. One way to do so is to implement innovability as a measure of fitness. That is to say, parent selection can be based on the level of adequacy of current candidate solutions and that of their neighbouring genomes. In this approach, the fitness of each candidate solution would be established through a two-stage evaluation process. In the first stage, the adequacy of a genome is evaluated in relation to fitness criteria. Assume that the fitness of genome “S” is dependent on the amount of “1s” it exhibits at the section shown in figure 4. That being the case, the fitness of this particular instance of genome “S” would be 6. In the second stage, the value at the first locus of S is switched from 1 to 0 (or correspondingly from 0 to 1) and the fitness of such genome which can be referred as S1 is evaluated. The same process is repeated with the rest of the locus so as to evaluate the fitness of genomes S2 to S12. The average fitness of S to S12 is then calculated. Genome “S” is then assigned with a selection probability that is proportional to the averaged fitness. This approach to parent selection can enhance the results produced by GAs because larger regions of the design space are explored at each time. GAs that incorporate this approach to parent selection can be viewed as devices for systematically navigating the design space.
6 Discussion

This paper shows opportunities for teaching evolutionary design in ways that are compatible with how designers learn. Specifically, visual diagrams and cardboard models are examined as means that can make the formulation and implementation of GAs more accessible to design students. Notice that other low-fidelity prototyping techniques may as well facilitate the formulation and implementation of GAs and other evolutionary systems (e.g. agent-based models, neural networks, etc.). The identification of which low-fidelity prototyping techniques better suit the characteristics of the different evolutionary systems may be the topic of future research projects and is not addressed here. Opportunities to relate the formulation and implementation of GAs with learning on design history are also highlighted in this paper. In specific, GAs can be used to generate design solutions that reflect the stylistic parameters of specific historical periods. Likewise, the paper stresses how the representation of design solutions as genomes may improve the understanding that students have on the concept of innovability. Notice that a better understanding of the concept of innovability may be achieved by means of other evolutionary computational systems.

Complementarily, we argue that design theory can contribute to extend the scope of traditional GAs. To illustrate the above, we propose to implement innovability as a measure of fitness. This approach to selection can enhance the results produced by GAs because larger regions of the design space are explored at each time. Overall, we suggest that the development of computational thinking skills can enhance the learning experience of design students. Some general guidelines on how to design active-learning activities with GAs are presented. The effectiveness of these guidelines will be assessed in future studies within the classroom.

References


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Computational Design Tools and Education: The Smartgeometry Case

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Abstract: Computational design has brought in novel concepts to architecture and design disciplines. Computational design thinking has evolved due to the potentials of contemporary tools and methods. Experiential learning environments such as computational design workshops offer strategies for a better understanding of the contemporary needs of the computational design education. Smartgeometry (SG) is a computational design organization that operates through workshops of interdisciplinary teams. SG uses and teaches the state-of-the-art computational design tools and methods. Instead of teaching the novel computational design tools in an instructive manner, SG workshops focus on using the potentials of these tools through personal discovery and experimentation. Besides enabling responsive design outputs, tools for sensing, computing and materializing lead to various learning strategies such as learning-by-doing, interdisciplinary collaboration and community building by democratization. This study aims to unravel the impacts of the novel computational design tools and strategies on computational design education through an in-depth qualitative analysis of the SG workshops.

Keywords: computational design education; tools; interdisciplinarity; smartgeometry

1 Introduction

Computational design has been shaped by the synthesis of interdisciplinary knowledge, tools and methods. The intellectual foundation for the nature of computational design rests at a particular confluence of domains in fields ranging from mathematics, computer science and systems science to biology and philosophy (Menges & Ahlquist, 2011). Computational design has a critical influence on complex design problems in contemporary architecture. With the development of design tools and methods by the new technologies, architects’ and designers’ capabilities have been extended immensely (Peters & Peters, 2013).

Scripting is a critical skill for computational design. It is argued that design schools should ensure that all students emerge with sufficient scripting experience as scripting is an essential component of 21st-century design education (Burry, 2013). Scripting and tool-making are becoming essential forms of knowledge that have the potential of becoming the core knowledge, in research, education and practice of design (Oxman, 2017), not only as a technical ability, but also for deeper social aspects such as encouraging participation, supporting interdisciplinary collaboration.
and communication. Therefore, computational design courses that are realized through coding, designing and fabricating should be placed into primary focus, instead of marginalizing them in the design education curriculum.

Design studio is located at the core of the architectural design education (Schön, 1985). In contrast to instructive learning, which is based on explicit guidance, design studios enable experiential learning, or learning-by-doing. Architecture students bring their knowledge from different areas to work on specific design tasks. The design studio offers the potential to provide a multi-layered and enriching learning experience, where the ideas, positions and artefacts are actively realized rather than simply being described (Nicol & Pilling, 2000; McQuillan, 2005). This paper argues that computational design education can take the studio teaching practices as a model.

Innovative tools and methods are needed for certain strategies of computational design education. Methods such as collaborative working, interdisciplinary knowledge sharing and experimenting, and environments that encourage these methods can help students achieve better computational design skills. Besides, there are pedagogical advantages of using computational tools in project-based learning. Project-based learning is an innovative approach of learning through inquiry and working collaboratively to conduct research and create projects that reflect students’ knowledge (Bell, 2010). In project-based learning, authentic explorations are directed with the creative use of technology and tools. These educational strategies can be observed in computational design education as well.

In 2001, the Smartgeometry organization was established to integrate the contemporary advancements in technology into architecture through computational design by experimenting with tools and methods of various disciplines. In 2001, the main challenge of computational design in applied architecture was the modelling of complex geometrical forms, which gave its name to the organization. Over the years, Smartgeometry (SG) has evolved into a large community that biannually organizes an event consisting of conferences and workshops. Currently, each SG event hosts 10 workshops of innovative research projects. The workshops are called clusters that are organized by the cluster champions who are collaborative teams from academia and practice.

This paper aims to discover the impacts of the computational design tools, methods and strategies on the learning processes through a case study of the SG workshops. SG was selected to be studied because the SG workshops are interactive learning environments that can act as a model for computational design education. SG workshops are conducted by interdisciplinary collaborative teams with the state-of-the-art computational design tools. This workshop environment can help characterize the suitable conditions for creativity and innovation, and therefore has significance for the computational design education.

2 Methodology
For this research, SG workshops were investigated through a case study using the grounded theory method. Grounded theory is used to develop a theoretical understanding of an abstract analytical schema of a process (Creswell, 2007). SG workshops were analysed from multiple data sources, and the impacts of tools and the strategies on the computational design education were searched. Data sources include textual documentation and archival video records of the past SG workshops from the official website and related books and interviews with computational design experts from SG organization and first-person observation of the SG 2018 event in Toronto.

2.1 Data Collection
During data collection, two types of information sources were used. The first is empirical, in that information is gathered through participation to the SG 2018 event in Toronto. Semi-structured interviews with ten computational design experts that are involved in SG as directors, cluster champions and cluster participants were conducted. Interviews lasted 15-30 minutes, and the responses were audio-recorded, transcribed and open-coded. The questions aimed to understand the relationship between interdisciplinarity and innovations. In this research, the observations and the participant responses were interpreted within the framework of the learning practices of SG. Information on the interviewees and their experience on the related fields can be found in Table 1. The questions that were directed are as follows:

1. To what extent does interdisciplinarity have an influence on the SG workshops?
2. What is the relationship between interdisciplinarity and innovation in SG?
3. What are the potentials and impacts of the SG innovation on architecture?
4. Can you give an example of an innovation that SG has brought?
5. What are the critical concepts that are most important for a SG workshop?
The second data source is existing documentation on SG, which includes the textual documents on SG workshops and archival web-based records. Archival records are those compiled by SG, and include textual descriptions and audio-visual sources on the workshop content. Workshop objectives, processes, methods and information about the tool developments are presented in these sources by the cluster champions and participants. All the existing workshop video recordings which include visual and audio data from the website of SG (www.smartgeometry.org) were transcribed for data analysis. The details of the video recordings from the SG 2018: Machine Minds can be found in Table 2.

<table>
<thead>
<tr>
<th>Code</th>
<th>Role</th>
<th>Specialization</th>
<th>Experience (Years)</th>
<th>Duration of Interview(min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I-1</td>
<td>SG Director</td>
<td>Computational Design Visual Analytics</td>
<td>37</td>
<td>15.14</td>
</tr>
<tr>
<td>I-2</td>
<td>SG Director</td>
<td>Computational Design Mathematics</td>
<td>30</td>
<td>19.39</td>
</tr>
<tr>
<td>I-3</td>
<td>Cluster Champion</td>
<td>Architectural Design Computer Science</td>
<td>6</td>
<td>09.46</td>
</tr>
<tr>
<td>I-4</td>
<td>Cluster Champion</td>
<td>Robotics Computational Design</td>
<td>10</td>
<td>14.25</td>
</tr>
<tr>
<td>I-5</td>
<td>Cluster Champion</td>
<td>Building Performance Chemistry</td>
<td>16</td>
<td>05.45</td>
</tr>
<tr>
<td>I-6</td>
<td>Cluster Champion</td>
<td>Parametric Design Collaborative Design</td>
<td>18</td>
<td>10.53</td>
</tr>
<tr>
<td>I-7</td>
<td>Cluster Champion</td>
<td>Design Computation Cybernetics</td>
<td>10</td>
<td>09.40</td>
</tr>
<tr>
<td>I-8</td>
<td>Cluster Champion</td>
<td>Architectural Design Machine Learning</td>
<td>10</td>
<td>08.58</td>
</tr>
<tr>
<td>I-9</td>
<td>Cluster Participant</td>
<td>Interaction Design Spatial Cognition</td>
<td>26</td>
<td>13.36</td>
</tr>
<tr>
<td>I-10</td>
<td>Cluster Champion</td>
<td>Computational Design Athletic Footwear</td>
<td>15</td>
<td>60.01</td>
</tr>
</tbody>
</table>

Table 2. Information about the video recordings of the workshops from SG 2018: Machine Minds from SG website

<table>
<thead>
<tr>
<th>Year</th>
<th>Event Name</th>
<th>Number</th>
<th>Workshop Name</th>
<th>Theme</th>
<th>Duration of Video(min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td>Machine Minds</td>
<td>1</td>
<td>AI strategies for space frame design</td>
<td>Structural Exploration</td>
<td>04.45</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>Behavioral enviro[NN]ments</td>
<td>Adaptive space design</td>
<td>04.25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>Data mining the city</td>
<td>Innovative visualization</td>
<td>05.06</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>Fibrous timber joints</td>
<td>Structural Exploration</td>
<td>05.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>Fresh eyes</td>
<td>Machine Learning</td>
<td>04.39</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>Inside the black box</td>
<td>Innovative visualization</td>
<td>04.22</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>Materials as probes</td>
<td>Material research</td>
<td>04.52</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>Mind ex machina</td>
<td>Robotic exploration</td>
<td>05.16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td>Soft office</td>
<td>Robotic exploration</td>
<td>05.03</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10</td>
<td>Sound and signal</td>
<td>Acoustic exploration</td>
<td>05.08</td>
</tr>
</tbody>
</table>

2.2 Data Analysis

After data collection, categories and subcategories regarding the computational design processes were identified using an interpretative reading. The textual documents, video recordings, interview data and observations were compared and classified. Data is used to derive new concepts and themes through an explanatory reading.

3 Findings

From the data analyses and the open-coding of the interviews, it was found that the SG workshops have various strategies that affect both innovation and the learning process of the participants during the processes of tool making,
using and sharing. As opposed to instructive learning, SG workshops offer an experiential setting, where the learning process is accelerated by close interdisciplinary collaboration, accessibility to various computational design tools and equal opportunity between participants. The qualitative analysis about the SG event and its potentials for a computational design education is discussed around four main topics in this research, which are tools, discovery and experimentation, interdisciplinary collaboration, and democratization.

3.1 Tools
Findings from the interviews support that tools and tool making is very critical for the SG workshops and the SG community. Computational design tools for generating, visualizing, optimizing, sensing and materializing play a critical role for design research, experiential learning and interdisciplinary working. Participants in SG learn specific uses of computational tools in an innovative way for the research of their workshop. Tool learning establishes a scaffolding for the participants. In education, scaffolding is the assistance or guidance provided by parents or teachers, that aim to extend students’ current knowledge and skills towards independent problem-solving (Belland, 2017). Scaffolding during learning requires that the instructors offer students temporary support, increasing their skill acquisition and comprehension, which are essential to complete certain tasks. The high level of tool competency necessary for computational design calls for certain degrees of instructional support that are gradually eliminated as students feel competent and ready to take the responsibility to independently create design tasks. SG workshops, similarly, invest in both instructional learning through explicit guidance for tool usage and exploratory learning by allowing the participants to apply their computational skills and knowledge on creative design problems, further enhancing learning-by-doing. Although the exact share between instruction and exploration varies from one workshop to another, it can be argued that these two learning approaches critically complement each other especially for novice designers.

The tools explored and developed in SG vary with respect to the theme of the workshop or cluster. A wide range of topics have been covered, from structural form-finding (i.e. gridshell structures, agent-based structural design, design with physics engines, adaptive structural skins, form-active structures), material experimentation (composites, ceramics, bricks), parametric design optimization, data-informed design strategies (i.e. acoustical, urban, thermal, humidity data), data/form visualization, robotic fabrication/assembly, machine learning methods, and computer vision. Tools have a considerable part in experimentation, discovery, interdisciplinary collaboration and democratization. Firstly, tools initiate the process of discovery. Tools and the development of further tools are enforced in SG because they give better assets for exploring design in different ways (Interviewee 2). Moreover, building the right tools is the first step for discoveries, inventions and innovation (Interviewee 9). Secondly, these discoveries must be achieved by interdisciplinary collaborations, adapting tools and techniques from each other. Interdisciplinarity engages individuals with tools from other fields, where synergies are formed between techniques, methods, materials, borrowed from other disciplines (Interviewee 5). Thirdly, producing a community of tool-makers accelerates the communication which results in a democratized learning environment. Interviewee 2 supports that democratization has been achieved by the accessibility of computational design tools. From these findings, it can be stated that tools act as catalysers that bring computational design learning strategies together.

3.1.1 Responsiveness
Over the years, design products that interact with their environment have gained importance for SG (Interviewees 2&10). Sensing tools such as thermal cameras, heat sensors, light sensors and tracking tools for data collection have become more accessible, and are increasingly being used by the SG workshops. These tools allow the participants to be informed by their surroundings and learn different ways in which the collected data can be integrated into the design processes. The SG workshops that place responsiveness and interactivity to their centre provide new ways of interaction with the design product, which is achieved by data collection, data-based design and feedback loops.

Interviewees 2 and 10 argued that the significance of context, which means integrating the surrounding environmental and social aspects to the design, has increased in SG over time. Interviewee 2 explained that the dominant agenda of SG during its early years was to manipulate geometry, whereas a critical shift of focus took place recently, which involved the integration of environmental data, such as air, light, sound, atmosphere, humidity, behavior of inhabitants and urban flows. This can be attributed to a certain level of maturity that computational design has reached, which expanded its attention from mere form-finding to other factors that can inform design for both synthesis and analysis. For instance, in the workshop Micro Synergetics from the year 2012, when a user touches the responsive modules, light sensors sense the proximity of the users and through feedback, kinetic modules move (Micro Synergetics, 2012). In addition, the objective of the workshop titled Sensory Detectives from SG 2016 is to form a thermal environment that physically simulate the dynamics of heat, moisture and air within a modular pavilion that involves electronic sensors and augmented reality (Sensory Detectives, 2016). Another reason for the focus on
Responsiveness has been the increased accessibility of the sensing tools and the ease of interoperability between data collectors and data processors, according to interviewee 10.

Responsiveness has advantages for the learning process, such as increasing the participants’ awareness of the environment and their feeling of responsibility towards the context. Computational design has been long charged for being self-indulgent and stylistically driven, due to its initial fascination with complex geometries during the early 2000’s (Agkathidis, 2015). While computational form-finding continues to be a fundamental issue for architecture and design, responsiveness in design has great potential for performance-based architectural design in the way it considers environmental data as an inseparable part of building performative requirements such as the design’s environmental footprint, costs or occupant comfort.

### 3.1.2 Materialization

The tools for materializing in SG are usually technologies adapted from the industry and used during design and design research. Materializing design alternatives rapidly in small scales is made possible by the rapid fabrication tools provided by SG. The innovative use of tools for materializing has multiple advantages, from producing complex forms rapidly to grasping complex concepts of computational design. Materializing is supported by experiential education, constructionism, and critical pedagogy (Blikstein, 2013). Materializing tools and digital fabrication allow learning by doing in computational design education.

The creative use of materialization tools in the workshops enable abstract computational design concepts to be better learned by the participants. For instance, for the workshop titled Non-Linear Systems Biology and Design in SG 2010, the aim was to mimic the tissue formation by materializing complex and custom shaped modules and connecting them with cables. From similar past SG workshops, it was observed that participants had the chance to understand and internalize complex concepts such as emergence, automation and stigmergy by mimicking them with the creative uses of materialization tools.

Learning by doing is enabled in common practice in design studios. Materializing is a core aspect of computational design, therefore tools and methods for innovative processes of digital fabrication and rapid prototyping should be used by students for a better understanding of contemporary concepts and the translation from the virtual to the material by computational means. Creating such understanding is critical for computational design education and it can be achieved by involving projects where materialization is prioritized in a studio environment as SG.

### 3.2 Discovery and Experimentation

It has been widely argued that the pace of adopting new technologies for the building industry is slower than other industries. The large scale of the designed products, the high-risk associated with complex buildings and their permanence in time are considered as determinant factors in the avoidance of design experimentation. On the other hand, technological advancements show an instant impact on the small scaled design products. For example, a discovery in material science can be directly used in the design of a phone case or a sportswear product (Interviewee 10).

The avoidance of high-risk experiments in the practice of architecture does not necessarily hold true on architectural design education. Design education, as argued by Callicott and Sheil (2000) seeks out the unfamiliar, the unconventional and the methods of other disciplines. According to interviewee 7, SG carries low risk professionally and is a suitable environment for experimentations that lead to new discoveries. For instance, the objective of the workshop titled Mind ex machina from SG 2018 is to experiment with robots through customized tasks to discover methods for improving human-robot interaction during the design processes (Mind ex machina, 2018).

SG is a laboratory for exposing novel research problems with a small audience and experimenting collaboratively without knowing the outcome in advance (Interviewee 8). There is always the factor of curiosity of the un-known, although the tools, methods and research questions have been present before the workshops. Experimenting enables students to acquire their own experience and to synthesize this experience creatively during the design process (Willey, 2005). These findings indicate that design laboratories as SG are suitable environments for experimentation and discoveries in computational design education.

### 3.3 Democratization

SG is an environment where interdisciplinary groups are required to creatively solve complex design problems. Therefore, collaboration between all workshop constituents, including the participants, champions and even tools is
crucial. Equality between the participants and their accessibility to people and tools are important factors for the SG workshops. Equality enables respect of others and the confidence to contribute to the group work (Potts, 2000). In SG, because the participants are considered as equals, an environment based on respect and confidence can be achieved (Interviewee 8).

In the context of higher education, it is argued that the misdistribution of power between students and professors should be balanced in order to democratize the studio, which can encourage students to take on the primary responsibility (Dutton, 1987). SG workshops offer equal opportunity to its participants to contribute to the group work without a social or disciplinary hierarchy, and this improves communication. Since true dialog takes place only among equals, hierarchy in design education precludes the possibility of true dialog (Dutton, 1987). During the event, it was observed that the collaborative champion-participant relationship of the SG workshops has less hierarchy than the professor-student relationship of a design studio. This provides a better dialog between the contributors to the workshop, increases the responsibility of the participants, and improves the learning process (Interviewee 4).

The open plan layout of the physical environment within which SG takes place, points to the importance of interaction between different workshops. The visual and physical interactions between the participants from different workshops help increase their awareness of various design problems, tools and methods as well as design proposals. It was observed that participants are encouraged to visit all the workshops and be informed about other research processes that are happening simultaneously. Therefore, sharing of knowledge does not only take place in the workshops but also between workshops. Interviewee 8 contrasts this situation with certain design firms that do not allow any communication of their inventions with the outside world, which is limiting for the designers. SG is the opposite of such privacy, where sharing and learning are not limited. This accessibility of information contributes to the democratized environment of SG.

Interviewees concur that the computational design tools engaged a community of computational designers, and networking has gained importance. Due to the increased importance placed upon sharing and networking, computational tools have become more accessible. Sharing and community support has become the norm, which has major effects on the new generation of computational designers. When asked about the innovation that SG has brought, Interviewee 8 clearly stated that the SG community created a socialist environment where everybody is at the same level, and everybody can share any kind of tool and information. With this community, learning extends beyond the limits of the classroom towards a network of people exchanging knowledge and sharing their ideas and code. The interviewees agree that the creation of such a community and democratization of the new computational tools is one of the most significant impact that SG has brought to the computational design education.

### 3.4 Interdisciplinary Collaboration

Interdisciplinary collaboration has been identified as one of the most critical factors for computational design education and for SG. The gathering of people from different educational backgrounds who have different perspectives, ways of thinking and processes for developing methodologies, make them un-learn their existing knowledge, and start learning from each other (Interviewee 10). The interdisciplinary nature of SG enables the participants to learn more by sharing their individual skills and knowledge with the other participants (Interviewee 7). As such, disciplinary and personal competencies, knowledge and skills can be brought together, complementing each other towards interdisciplinary design, which is critical for computational design education.

Interdisciplinary collaboration is widely associated with creativity. The heterogeneous set of skills and experiences of members of interdisciplinary teams give rise to an enhanced capacity for creativity and novelty (Sutton & Hargadon, 1996). Interdisciplinary teams need to integrate knowledge from different disciplines to bring about innovative design outcomes. To integrate knowledge from different disciplines, complex design tasks should be set (Nicol & Pilling, 2000). Such complex design tasks are present in the SG workshops, and those tasks go beyond the limits of architecture. Interviewee 4 stresses that SG is an architectural event, but the workshops work on complex problems beyond the limits of architecture where interdisciplinary knowledge is critical. For instance, the workshop titled Nano-Gyroids from SG 2016 requires integrating knowledge from chemical crystallography and design (Nano-Gyroids, 2016).

In SG, participants can learn interdisciplinary collaboration, which can help them acquire a foundation in team working that will be beneficial in learning to communicate with specialists from other fields. Interdisciplinary collaboration accelerates the learning process by rapid sharing of knowledge, recognition of the limits of a single discipline, and approaching a problem from different perspectives (Interviewee 10). As computational design requires multiple perspectives, tools and methods, it is essential for computational design education to be interdisciplinary.
4 Conclusion

Strategies, environments and tools for computational design education is critical for architecture students to adapt to the technological advancements. The computational design processes and the impact of creative computational design tools in SG workshops were discussed in this research as a case for computational design education. The results of this study indicate that experimentations, interdisciplinary collaboration, democratization and tools have a critical role for learning computational design and enhancing computational design thinking. This study on SG has found that the aspects of computational design such as responsiveness and materialization are achieved by adapting, developing and customizing different tools for complex design problems by experimentation in a democratized environment.

This research also shows that SG workshops involve both instructive and experiential learning that support each other. This study concludes that computational design education should involve and integrate project-based learning and scaffolded instruction. Therefore, experimentation through complex design problems should be integrated in computational design education. SG also indicates that computational design cannot be taught around a single discipline as it is constituted with the involvement of different disciplines. The SG workshops, their creative proposals and innovative outcomes show that the education of computational design can be improved in an interdisciplinary and collaborative environment, where the tools are democratized and discovery through experimentations is emphasized.

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Mediating Cultural Values in a Multimedia Installation

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Abstract: This paper sets out approaches and trends in interactive and smart solutions designed to foster and promote cultural heritage through a multimedia educational approach. The research presented aims at envisioning novel strategies to facilitate learning by encouraging visitors to interact directly and physically with the heritage on display, and to communicate cultural messages. Analysing the interactions between the user and different media and their narrative potentialities, we describe an installation which allows visitors to meet a life-sized simulated hologram and interact with it. The project is set in the field of Human Computing Interaction (HCI), looking at the world of digital encounters and interactive systems based on embodied interaction, investigating if and how the designers, as a mediator between different media and tools, succeeded in achieving their aims and proving the envisioned user experience. Relying on user tests and direct observation, we discuss how the interactive exhibit and the digital character affected visitors’ behaviour, effectively capturing their attention and fostering interaction. Furthermore, we examine how visitors perceived the digital character and the gestures they asked them to perform, directly or indirectly, to trigger actions. In conclusion we generalize the results in terms of possible translations for teaching design basics in higher education.

Keywords: digital encounter; design; embodied interactions; cultural heritage

1 Introduction

Technology is constantly evolving and creates innovative experiences in the cultural sector. Using targeted messages, technology has the ability to provide content to an ever-growing audience, and museums and institutions have not missed the chance to experiment with this opportunity. Today, content reaches us everywhere. This concept is expressed well by the term ubiquitous computing, (Greenfield, 2006) coined specifically to indicate how ICT technology, which is found increasingly in new contexts and forms, will continue to affect daily life in unforeseeable ways. We therefore find ourselves in the midst of the panorama outlined by Mark Weiser, who over twenty years ago coined the term: his idea was highly precise in prefiguring the pervasive and invisible use of hidden technology that is “woven into the fabric of everyday life until it disappears and becomes indistinguishable” (Weiser, 2001).
The days of man-machine interaction seem so distant in comparison to user-device interaction, and with new tools we take a leap forward that is not only technological, but also speculative. This basic aspect has revolutionized our notion of interaction and has shaped the ways in which users can take advantage of or interact with content and installations. For this reason, the way in which digital systems approach the user is different; interfaces need to be easy and intuitive, and the interaction with them must be natural so that the user could focus on contents. User-centricity, one of design fundamentals, is one of the core values of the translation process, as information in digital-based systems needs to be translated from codes and instructions to visual representation and codified symbols (Baule & Caratti, 2017, p. 26).

Indeed, over the last decade the research on the link between the physical and the digital worlds has bloomed, giving rise to research fields such as tangible and embodied interaction. This situation is in sharp contrast with the past, where the physical/digital relationship was inevitably mediated by two distinct elements: the input device and the output device, the interactive space (keyboard, mouse) and digital processing space (screen). Conceptually and symbolically, this new field of human-computer interaction can be traced back to the abacus, which Ullmer & Ishii (2001) argue constitutes the true precursor of smart objects as both an input and output device.

Often, in the context of Digital Humanities, the discipline of Design has strong relationships with Translation Studies, as the designer needs to develop the idea and define, through the design process, a user experience that must be translated into languages consistent with tools and media he intends to use to achieve the desired effect. Translation has taken on an intercultural dimension and stands between different contiguous or related disciplinary fields. “The process that crossed translation theories has made plausible those interdisciplinary contact points that are the prelude to the construction of a translation paradigm that can be adopted by other study fields, and has multiplied them” (Baule & Caratti, 2017, pp. 14-15).

Design includes theories and practices that belong to related and contiguous areas that often translate themselves into material or immaterial artefacts. The design of interactive systems for the enjoyment of cultural heritage often deals with design specialties that are complementary and interrelated as product, interaction, service and communication design. Furthermore, the designer must interpret and foresee a user experience capable of transferring cultural contents in an effective and pleasant way. In this sense, Design as a discipline, approaches the cultures of translation as a mediator between different languages, in the creation of artefacts and communication systems that use different media and supports.

2 Body as a Mediated Interface

To design interactive installations, the designer-translator implements a series of practices to achieve the desired results (Caratti, 2017, p.141). In the case of digital encounters, through the user experience, he defines step by step a sort of script that the user and the system must follow. Like a director, he defines a sequence of actions and reactions to create a digital storytelling, in which the physical interaction activates multimedia contents. We could consider this script as a synesthetic representation built on correspondences between heterogeneous sensory data; in some artistic products, the synaesthesia is the result of transcoding operations that, although with different levels of definition, relate semiotic, sound, visual and sometimes tactile and gestural data (Ricco, 1999, p. 76). Different kind of sensors and bespoke code control and activate the system and sometimes the installation itself seems to have a life of its own acting independently and persuading the user to behave accordingly.

To contextualize these assessments, we analyse and discuss Leonardo Plays Leonardo. Milan. Life. Nature., an interactive installation about Leonardo da Vinci and his Milanese period that aims to introduce users to the world of the Master through three digital holograms of a human-sized Leonardo da Vinci who welcomes visitors and tell short stories dealing with (i) his Milanese period (ii) his life and (iii) his relationship with nature (Figure 1). Located in the cloister of Palazzo delle Stelline in Milan to highlight the genius loci, the spirit of the place where Leonardo lived and worked, the installation belongs to the domain of embodied interaction, which takes place when the human body itself is used as an interface (Dourish, 2001), and utilizes the presence of visitors and their movements to dialogue with technology, thereby generating engaging experiences potentially meaningful from an emotional point of view.
Digital encounters with important figures from the past or even life-size characters, such as the permanent installation at the Palazzo Ducale in Gubbio created by designer Paolo Buroni, offer an emblematic example of this. Thanks to holographic technology, Federico da Montefeltro comes to life, engaging in a brief dialogue with an angel in which he talks about interesting aspects of the building while recounting anecdotes from his personal life. Here, the technological system is completely hidden. Users have the impression to dialogue directly with the character, even though, given the physical separation between audience and the scene, in reality their position is more similar to that of audience members passively viewing a performance. In this case, visitors’ bodies are detected by sensors and they serve to activate the performance.

The same mode of implicit interaction is found in the installation Ripopolare la Reggia (Repopulating the Palace) by Peter Greenaway, which uses projections to populate the beautiful baroque palace of the Royal Palace of Venaria Reale. Visitors taking the eleven-room-long tour route are transported back into another era: in this case as well, full-scale projections fill the space with the personalities of the time: courtiers, squires, servants and musicians tell their stories to create a highly evocative user experience. The British director transports visitors to another era, casting them as passive spectators that interact implicitly with the projections which are activated by their movements. In comparison with the project at the Ducal Palace in Urbino, Ripopolare la Reggia offers visitors a less realistic feeling of having met real-life figures, but it does stimulate their attention and curiosity with an immersive performance that takes them on a walk-through time.

Studio Azzurro also takes up this idea of interacting with life-size figures in the Sensitive City (Studio Azzurro, 2010; 2011) installation at the Italian Pavilion of the 2010 Expo in Shanghai. About eight hundred people from different Italian cities move along on rear projection screens. When visitors raise their hand, the nearest character stops and speaks directly to them, describing his or her city. Here, places and fragments of memory are explored while images and drawings animate the background and enrich the story. Sensitive City thus introduces a fundamental component, namely that of explicit interaction between the user and virtual character, thus giving the visitor full control over the digital world. This world is depicted on the screen through continuous projections, apparently independent of the surrounding environment; nevertheless, a single gesture is enough to modify the interaction: by raising one hand, visitors are able to stop the citizens and become a part of their digital city. In Sensitive City, therefore, visitors are free to enjoy the content at their leisure, not as a passive user of multimedia content but as the author of a completely explicit interaction.

Another approach can be seen in the New Dimensions in Testimony project, which was born out of collaboration between the Shoah Foundation and the Institute for Creative Technologies (ICT) at the University of Southern California. This project puts young students in dialogue with Holocaust victims through seven different cameras and recordings that contain an infinite range of answers to questions typically asked of survivors. The medium used for the interaction in this case is the spoken word, a fact which makes the experience even more realistic. The distinguishing trait of this project lies in the ability of the digital character to understand the questions and respond accordingly, in
an appropriate and consistent way. By creating an interactive exhibition in which students can initiate conversations with Holocaust survivors, this project opens up an interesting perspective that neutralizes the temporal element. Even students of the future who arrive after the last survivor has passed away will still be able to interact and dialogue directly with survivors and reflect on all the information contained in a first-hand account of this kind.

The above, are just a few of many possible examples. Despite their differences, one commonality is the way that they hide technology behind the simulation of realistic encounters with digital characters that transport visitors to other worlds and eras. It is worth stressing that, in the first two cases, the interaction is implicit; that is, the presence of the visitor activates the content. In the last two, in contrast, visitors control the digital world by deciding whether to access it, thus creating an explicit interaction. Sensitive Cities as well as other projects by Studio Azzurro use the human body and its movements to create a gestural interface, thus allowing visitors to enter the digital world through embodied interaction. Embodied interaction thus fosters an encounter in which humans can interact with digital content in a natural manner. The technological device is shifted into the background, making room for its effects and bodily movements to take centre stage, replacing commonplace interactive devices.

3 System Description, Designers’ Choices and Users’ Perception

The interactive exhibition here discussed is characterized by a digital encounter with a life-size character, a gestural interaction, and an actor instead of a virtual character: visitors use gestures to interact with a holographic representation of Leonardo who discusses his life, work and relationship with nature through brief accounts. It is intended as a choreography meant as a scenic movement in which the user is an active part of the scene, so what must be designed concerns a series of behaviours of the end user who is both actor and author of the scene itself (Anceschi, 1992, p. 28).

The project Leonardo plays Leonardo entails internal dynamics that are both implicit and explicit. Physical movements activate the contents through implicit interaction and are also used to make navigation choices through explicit interaction. Indeed, when entering the cloister of the building, visitors catch sight, at a distance, of a man dressed in Renaissance-style clothing moving into and out of the three screens. Every time he enters the stage, he wears a different outfit and displays a different mood: sometimes he is thoughtful and wearing luxurious clothes, at other times he appears wearing work clothes and gives the impression of being very busy, still other times he invites bystanders to come nearer. When visitors approach one of the screens, Leonardo appears. He speaks Italian and asks the user to choose his or her preferred subtitle language: visitors can choose Italian by raising their right hands and English with their left (Figure 2). Once a language is selected, a first video begins to play, chosen randomly by the system from among the five contained in each installation. A brief introduction displays the title of the piece, then Leonardo appears and talks for about two minutes, addressing the bystanders directly. When a story ends, users can choose to listen to another one – by raising their right hands – or to end the interaction – by raising their left. All five of the videos use the same mechanics of interaction and, once they have finished, Leonardo kindly bids the user goodbye and begins moving in and out of the screen once again.

This short description highlights how interactions take place within the system: the first is an implicit interaction that is outside the user’s control, aimed at creating the element of surprise as if Leonardo were waiting for him or her. The other interactions – such as the choice of the language for the subtitles and of whether or not to continue – are explicit and entail user engagement.

The research discussed here is grounded in quantitative and qualitative data gleaned through diverse methods of inquiry. The first set of available data is the usage statistics provided by the system, which records every interaction performed at each of the three installations. The data collected provide information about the date and time of the interaction, the number of users, the number of videos watched and the language selected. We are not going to analyse here the quantitative data, but we like to point out the importance of gaining insights from users who tested the system. We conducted interviews using the think-aloud protocol (Someren et al., 1994; Dorst & Cross, 2001) with a consistent set of post graduate expert users, who were recorded while interacting with the system and then involved in an informal post-experience focus group. The same sample of users also completed a questionnaire designed to verify the consistency of the opinions they expressed in the interviews and focus their attention on the experience of use and how much they enjoyed it. Furthermore, direct observation of the aforementioned expert users as well as casual visitors allowed us to gain useful insights into the relationship between these people and the digital Leonardo.
Figure 2. Language subtitle selection approaching the right (for Italian) or left (for English) hand near to sensors while an explanatory graphic appears on the screen.

Three out of eight expert users expressed an opinion about the structure during the think-aloud session. All of them expressed aesthetic appreciation for the installation but two out of three would have preferred a structure more in line with the historical character. For example, R3 reported: “The frame is too rough, industrial and contemporary. I’d change the style, given the historic figure”. Indeed, from designers’ point of view, the project presented some difficulties, given its location in a cloister, one of which was the constant rays of light that made it impossible to conceal the technological apparatus. The aforementioned projects had environments enveloped in darkness, and therefore had no trouble hiding the equipment. Thus, we decided to turn a problem into an opportunity and create a very evident, high-tech and industrial sort of portal that would suggest a timeless space in which visitors could encounter Leonardo. Indeed, the edgy stainless-steel structure, greyish screen and clearly visible sensors were intended to create a marked impression of detachment between the contemporary structure and the historical character, dressed in Renaissance clothes. Evidently users did not pick up on the idea we wanted to evoke of a time portal or did not consider it relevant.

The eight expert users focused specifically on the digital character, which was designed with the aim of capturing visitors’ attention and making them feel as if they were face-to-face with Leonardo, in the flesh. The choices we made in order to convey this intended sense of realism were, first of all, to use an actor rather than a virtual character, secondly, to project him life-sized and, finally, to have the actor direct his speech towards the camera in order to maintain eye contact with viewers. All the expert users reported having experienced a sense of having a real person in front of them, addressing them directly; they particularly appreciated the realism of the digital character. In the think-aloud session R2 said “It seems the character is right in front of me” while R7 stated: “The interesting thing is that Leonardo seems to be a real person in front of me and telling about his works”. At the same time, our intention that the character maintain eye contact was appraised by evaluators, who report a resulting sense of interaction and intimacy. R1 said “it’s nice that the character looks in my eyes while he is telling the story. It seems to augment the interaction and the involvement”. R4 focused more on the intimacy triggered by the eye contact: “The real size character is ok, and it seems he’s talking to you intimately, with direct contact. I like the actor and that it seems he’s talking only to me”.

These results are confirmed by the questionnaires the respondents filled out following the experience. Indeed, they gave the feeling of interacting with a real person quite a high score (2 very high, 5 high and 1 average). The informal focus group that followed the test session further confirmed this impression even while adding an unexpected insight: every one of the users was confused by Leonardo’s appearance. That is, they expected to see a tired, old man with a white beard, as Leonardo is traditionally portrayed, not an energetic man in his fifties with a short red beard, as we imagined he probably appeared during his last period in Milan. Another point worth addressing is how users perceived interaction with the digital character. When designing the mechanics of interaction that were to have characterized the system, we decided to employ a mix of implicit and explicit interactions, both of which take advantage of the human body as an input system. The first type of interaction occurs without any intention on the part of users: they
simply pass in front of the installation and, in so doing, unwillingly trigger a reaction in the digital system, namely the whimsical appearance of Leonardo inviting users to act. This is an implicit interaction based on motion detection and aimed at surprising visitors and giving them the impression that Leonardo was there waiting for them.

The other kind of interaction is instead activated by deliberate gestures on the part of users: they must raise their right or left hands and approach the screen to choose the subtitles language (right hand for Italian and left for English) and to make the stories continue (right hand) or stop (left hand). The first kind of interaction, the implicit one, was easily understood by all the expert users, who were naturally drawn to approach the screen and surprised when Leonardo appeared and immediately made contact with them. Regarding this point, R6 states: “Entering the corridor I see three panels with a character moving. He attracts me. When I approach the screen a sort of contact is established, and Leonardo invites me to enter his life”. The second kind of interaction, the explicit one based on hand gestures, entails different considerations. All of the testers immediately understood the mechanics of interaction and appreciated them, as they made clear in the questionnaires as well. Indeed, the majority of expert users felt confident using the system (5 high confidence, 3 very high confidence) and they generally appreciated the use of the body to interact with it (4 neutral, 3 high, 1 very high), but four respondents complained that the degree of interaction offered was limited.

During the process of designing the system, we actually decided to limit users’ freedom of interaction in order to enhance the sense of having an encounter with a real person and empower the narrative approach. Just as would be the case with a real person, once Leonardo begins telling a story he carries it through to the end, without being interrupted. Furthermore, Leonardo – that is, the system – decides which story to tell, in order to simulate the behaviour of a sentient character as much as possible. This choice, and the motivations behind it, were perceived as limiting by expert users. However, R2 states “It’s interesting the modality of reaching out a hand to interact with the system, but it seems limiting the possibility of choosing only the language and whether to continue with the story or not”. In other comments respondents go further, suggesting other forms of interaction: R5 would have preferred to “choose the topic to better interact. It would be nice to have Leonardo asking questions and, by answering them, to get other topics”.

### 4 Mechanics of Interaction and Users’ Behaviour

The above comparison between the designers’ intentions and users’ perceptions and understanding highlights both problem areas and strengths in the system’s ability to fully communicate its meaning and how it functions. Nevertheless, in order to fully understand the agency of the designed system on users we must assess the capacity of the interactive installations to foster the “correct” behaviour. In other words, to understand if the designed system is able to translate the designers’ will in the installations and consequently to guide users’ behaviour.

Direct observation of the expert testers during the think-aloud sessions, as well as observation of other casual visitors, showed that almost all of them immediately understood how the system worked and behaved accordingly. In particular, the mix of implicit and explicit interaction proved to represent an effective means of engaging users gradually, as it is capable of attracting their attention and then fostering interaction. The whimsical and unexpected way Leonardo appears when user approach (implicit interaction) worked well to surprise them and kindle their curiosity. During direct observation, mainly in the first days of the exhibition, we noticed that most people stopped and listened to Leonardo and some of them decided to start interacting with the system. In other words, the system persuaded users to behave as they were expected to, namely to be intrigued by the digital character and to stop in front of it.

Once engaged in the interaction, most of the users followed the instructions provided by the digital Leonardo and used their hands to launch the narration. The presence of a person, albeit digital, who modelled the gestures users were asked to perform turned out to be very effective in avoiding incorrect actions and misunderstandings. These results are in line with what emerged from the tests with expert users and the questionnaires, as discussed in the previous section. Hence, from the point of view of interaction itself the system proved to be efficient in persuading users to act as we had foreseen: they were indeed attracted to the screens and did not encounter any major problems in the interactions. In terms of involving users in the interaction, however, the results were not as satisfactory: specifically, the aim was to retain their attention and convince them to listen to all five of the videos at each installation. Quantitative data gleaned from the system logs show that the vast majority of users listened to either one video or all five of the stories. Indeed, the percentage distribution is: 46% 1 video, 4% 2 videos, 4% 3 videos, 2% 2 videos and 43% 5 videos. Therefore, the data highlight two very distinct behaviours: on the one hand, there are users...
called by Leonardo to interact but evidently not very interested in the stories or bored by them, while on the other hand, there are visitors keen to listen to the digital character.

Direct observation as well as the test with expert users shed light on this percentage distribution. Specifically, we noticed that many passers-by were surprised by Leonardo’s appearance and drawn to interact but, once the story started, they immediately left: it is true that the three installations were located in a passageway and most of the visitors were not there to view the exhibit. Furthermore, the data show that a significant component of the interactions involving just one video were in English (about 25%), which is not surprising since the language spoken by Leonardo is Italian. R4 commented that reading the subtitles prevents the viewer from looking the character in the eye, and R6 added that it would be nice to listen to Leonardo in English. Hence, the design choice of maintaining a philological approach may have hindered non-Italian users from listening to all five of the stories.

Comments by expert users, on the other hand, may clarify why the majority of users listened to more than one video and a great many of them all five of the stories. R3 said that “the stories are not too long, enjoyable and not boring” and R5 added: “It’s nice to listen to his stories regarding nature... it’s both didactic and entertaining”. Other comments focused on the ability of the actor to retain viewers’ attention and the quality of the scenography. R6 said that “it’s nice the way the actor interprets what he’s reading or thinking or writing. I like his facial expressions and the scene props”. As a matter of fact, the quality of the scripts and the professional actor’s ability to interpret the Master played an important role in keeping visitors interested. Furthermore, comments highlighted a great appreciation for Leonardo’s costumes: R3 said that “the character speaks well and it’s nice that he changes clothes in the different stories” and R4 added “I like the change of clothes. It lets me understand that the setting changed”.

In an effort to summarise, we could argue that the mechanics of interaction – designed as a mix of implicit and explicit interaction – proved efficient in modifying users’ behaviour in accordance with the designers’ will but that the digital character played a fundamental role in communicating how the system functions and retaining viewer’s active interest.

5 Discussion

Leonardo plays Leonardo falls in the domain of Digital Humanities and Interaction Design and uses embodied interaction in an implicit and explicit way to let the user access cultural contents. To provide a productive and amusing experience, designers acted as a mediator translating the idea and the user journey according to languages coherent with tools and media used to gain a proper result in terms of usability and effectiveness. Languages used are different and affect not only interfaces and mechanics of interaction but even the physical appearance of the technical equipment. The use of the body and gestures, icons and text as well as video and audio are part of a flow which cross four translation typologies: intersemiotic translation as the transposition of sign systems to another sign system, synesthetic translations as the translation mode through different sensory modes, metatextual translation as the creation of an artefact of synthesis, transmedia and cross-media translations as the declination of products in the transition to digital that include a specific multimodal directorial practice (Caratti, 2017, p. 126-127).

The gesture-based system of interaction proposed was considered easy and enjoyable by all the users and the choice of making the digital character on the screen mimic the gestures to be performed was very effective in avoiding written instructions that usually accompany system based on embodied interaction. During the tests with users we observed that testers constantly referred to Leonardo as a real person with whom they were experiencing an authentic encounter. Furthermore, the questionnaires confirm that most users had the impression that they were interacting with a real person, standing before them in the flesh. Another point worth noting is that most users immediately understood how to interact with the system by imitating the gestures of the digital Leonardo. This aspect may seem secondary, but it is particularly relevant for systems based on embodied interaction (Dourish, 2001), which are usually rich in labels and other paratextual apparatuses intended to train users to interact with the system and inform them of how it functions.

Finally, during direct observation sessions we frequently identified behaviours that are typical of in-person communication. During sessions with a lot of background noise, several users brought their ears closer to Leonardo’s mouth to hear better, a meaningless behaviour given that the two stereo loudspeakers were very visible at the base of the system. Furthermore, we noticed that most users tended to maintain a distance from the digital Leonardo that proxemics (Hall, 1990) would define as personal – from 1 to 1.5 meters – and only drew nearer, to an intimate distance, in order to interact with the system. Moreover, observing the mechanics of interactions and considering users interviews and questionnaires, we could assess if the choices we made were consistent to our will, creating
“inherently persuasive” design products that embed and embody the arguments of the people who designed them (Redström, 2006) and are able to influence visitor’s behaviour. Despite these considerations, we can remark that digital characters such as our Leonardo, tend to stimulate behaviours that go beyond those fostered by common interactive systems, an aspect that deserves to be taken into due account by interaction designers and, in particular, by those involved in the teaching of design basics.

As a matter of fact, the results of the research here discussed, achieved through design (Findeli, 1998; Koskinen, Zimmerman, Binder, Redstrom, & Wensveen, 2011) of an interactive exhibit may be translated in the teaching of design basics. Looking at the field of interaction design in particular, our results can be generalized at different levels and become matter of discussion with design students. The translation of the user experience into a balanced mix of implicit and explicit mechanics of interaction is an example in this sense, as well as the employment of gestures as main interface. Gestures, indeed, ended up being real mediators of cultural values, since they allowed generic visitors to access cultural contents beyond linguistic issues connected to paratextual apparatuses.

Furthermore, the employment of a real size digital character was very efficient in catching and keeping visitors’ attention: a result to be taken into due account for future interaction designers that will face a world increasingly populated by artificial sentient intelligences, that someone is addressing as the new raw material of design (Antonelli, 2018).

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References


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Section 5

Contexts and Social Responsibility
Abstract: Many countries in the world have experienced the process of rural decline and revival, and China is no exception. School of Design of Hunan University began to pay attention to the rural issues, especially in the remote and impoverished rural areas as early as 2009, and started the New Channel design and social innovation project that aims to find a suitable design education method to participate in the rural revitalization and promote the sustainable development of the rural areas. After ten years of practice and research on design education for rural revitalization, we have accumulated a large number of cases and experiences. We have gradually formed a practical process of design education for rural revitalization, innovated the participatory teaching mode of design education, and constructed the teaching activity framework of design education for rural revitalization that is centred on practice. In addition, we have not only trained a large number of students with social responsibility and passion for the countryside, but also helped the villagers to increase cultural self-confidence and improve living standards in the process of promoting rural revitalization. However, the relevant theoretical research is in its infancy at present, and many problems are still left to be solved. We will continue to explore and research through the practice of design education for rural revitalization.

Keywords: rural revitalization; design education; participatory teaching mode; rural culture

1 Rural Revitalization

With the development of industrialization and urbanization, China has experienced two major rural construction activities in the past 100 years. In the first half of the 20th century, China’s political order was turbulent, and the countryside was on the verge of collapse. The rural construction movement during this period was advocated, guided and participated by some academic intellectuals (Hang-sheng & Ying-sheng, 2000). Many of them (represented by Liang Shu-ming and Y.C. James Yan, etc.) hold the view of educational improvement. They advocated that “China’s economic construction must start from reviving the countryside” (Shu-ming, 2011). They also tried to achieve national
reforge by promoting rural education. However, because of the inevitable limitation of their political starting point of reformism, the practical results were very limited.

Rural Revitalization in the New Era is a Rural Construction Movement focus on the rejuvenation of Chinese Traditional Culture. Or it can be said that this is a contemporary new rural construction movement marked by the cultural self-awareness and cultural self-confidence of the Chinese nation. In 2017, Chinese President Xi Jinping made a clear announcement on the implementation of the rural revitalization strategy for the first time in the report of the 19th National Congress of the Communist Party of China. Rural revitalization has become a national development strategy. The macro and micro environments of rural development have changed, and the importance and worth of rural development have improved, which has created conditions for rural revitalization (Jun, 2018). The upsurge of building a new socialist countryside has set off across the country.

From a global perspective, many countries have also experienced the process of rural decline and rejuvenation. For example, China’s neighbour Japan began to face the rural crisis in the 1950s, and later took legal measures to ensure that relevant policies were gradually revitalized (Bin, 2018). South Korea also launched the New Village Movement in the 1970s (Yi-qiang, 2017). France, Italy, the United Kingdom, the United States, Canada, and other countries also have achieved revival in rural areas through effective intervention policies according to their respective situations (Manxiu, Xiang-zhou, Lin-ping & Heng-shan, 2018). Their successful experiences are worth learning from. However, compared with other countries, China’s rural problems have both commonness and individuality. Therefore, it is even more necessary to follow the national conditions and step out of the road of rural revitalization with Chinese characteristics based on learning from the experience of other countries.

2 Practice on the Design Education for Rural Revitalization

With the lead of the government and the support of the policy, all sectors of society have actively participated in the contemporary new rural construction movement. Many colleges and universities in China have also engaged in rural revitalization from different angles.

As early as 2009, School of Design of Hunan University began to pay attention to rural issues, especially in remote and impoverished rural, and started the New Channel design and social innovation project which aim to find a suitable design education method to participate in the rural revitalization and promote the sustainable development of rural culture. In the past ten years, we have consistently adhered to the research and practice on design education for rural revitalization in many poor villages, and gradually formed a practical process of design education, i.e., cultural inspiration, traditional inheritance, transformation and innovation, fusion and generation.

2.1 Cultural Inspiration

“Culture still has not been commonly defined in the general language” (Xiao-tong, 1995, p. 57). Throughout the ages, many domestic and foreign scholars have made various definitions of culture. Malinowski (1944), a British social anthropologist, thought of culture as a unity of matter, society and spirit. He advocates going back to real life in order to understand people. Therefore, the practice of design education for rural revitalization in the New Channel projects has always insisted on combining literature research with field surveys and using sociological and anthropological methods to conduct comprehensive assessment and analysis of local cultural resources and poverty.

Taking Tong Dao Autonomous County as an example, it is located in the south-western part of Hunan Province and is a minority area dominated by the Dong ethnic people. Here are the splendid cultural heritage of the Dong people and the quaint and simple customs. However, it is a national-level poverty-stricken county, and the economy is extremely backward.

As shown in Table 1, it is the record of fieldwork conducted in several villages and surrounding cultural areas in the Tong Dao Autonomous County by more than 40 teachers and students from the School of Design of Hunan University. They divided into six teams to investigate rural culture according to different directions. During more than 20 days, the teachers led students to conduct door-to-door surveys in the area, eating and working with the villagers to experience the real rural life, understanding local culture and acquiring local knowledge in the local context. At the same time, the young generation of students also felt the poverty of the countryside and the hardships of their life. Only personal experience can shock the soul. The resulting sense of social responsibility will make them more eager to help poor rural people to lead a better life through design and to think about their future designer identity and career choices. We believe this is also very important in terms of design education for rural revitalization.
Table 1. Fieldwork record in Tong Dao Autonomous County from July 16 to August 6, 2009.

<table>
<thead>
<tr>
<th>Place</th>
<th>Investigation and Division of Labour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sociological research team</td>
<td>Population structure, mode of production, consumption patterns and social organizations, etc.</td>
</tr>
<tr>
<td>Movie design team</td>
<td>Digital records and protection of local intangible cultural heritage, original ecological music sampling, record new channel project, etc.</td>
</tr>
<tr>
<td>Environmental landscape home design team</td>
<td>Village landscape design, residential design, traditional folk house design, river clearing, children's game platform, etc.</td>
</tr>
<tr>
<td>Industrial design team</td>
<td>Creative products based on regional culture.</td>
</tr>
<tr>
<td>Visual design team</td>
<td>Collect, organize and reproduce traditional folk art and crafts (digital protection), children's art class, local brand logo, and packaging, etc.</td>
</tr>
<tr>
<td>Information design team</td>
<td>Investigate migrant workers, left-behind families, local communities, and social entertainment, establishing connections between local and external worlds in a variety of ways.</td>
</tr>
</tbody>
</table>

2.2 Traditional Inheritance

“Culture is a tightly-organized system. At the same time, it can be divided into two essential aspects: implements and customs. They can then further be divided into smaller parts or units” (Malinowski, 1987, p. 11). That is, culture has both material and spiritual aspects. For example, the brocade, national traditional characteristic architecture, etc., of the Dong ethnic minority in Tong Dao autonomous county, these are the material form of Dong people's traditional culture. But the handicraft technology, pattern composition, legends and stories, etc., are the spiritual form of their traditional culture. These are the crystallization of the knowledge, wisdom, and emotions of the Dong people. For the inheritance of traditional culture, we should pay attention to not only the tangible cultural but also the intangible cultural. These ethnologic wisdom and emotions are what we need to inherit in particular.

Therefore, it is especially important to lead students to learn and study traditional craftsmanship, techniques, and processes with local people who have traditional skills (especially the inheritors of intangible cultural heritage) in the practice of design education for social innovation. The local people are the holders and expressions of the traditional culture of their regional characteristics. They express what they see, think, and wish for life through their unique cultural expression and material carrier. The inheritance of traditional culture must return to the tradition at first. Do we need to understand how the traditional culture we are going to inherit is formed? How did people treat and utilize local resources in the past? What are the wisdom and emotions of traditional crafts, methods, skills, patterns and colours, etc.? We need to analyse and judge which ones can be utilized and improved under today's technological conditions, and which ones are restricted. We should guide students to explore these issues in the process of collaborative innovation design with local cultural holders, instead of staying on the surface of problems. Only by having a comprehensive understanding of the rural culture and internalizing it into our own knowledge system can we see the traditional culture with empathy. The photos in Figure 1 were taken in 2009 when we took students to the Tongdao Autonomous County for field research. Students learned brocade weaving from Tian-mei Su, the inheritor of the intangible cultural heritage.
2.3 Transformation and Innovation

In the 21st century, the value of local culture is no longer preservation, but the positive significance of constructing modern thoughts and spiritual levels, so that the fermentation of individual and regional culture can produce, and then achieve new development and application. The needs of people are changing, people’s ability is improving, science and technology are advancing rapidly, and culture is also developing dynamically.

The inheritance of traditional culture is quite similar to the growth and development of natural organisms. Natural organisms absorb external nutrients to maintain and develop life organisms and functions, but their genes have long-term stability, and are not easy to change. If we regard culture as a natural creature, then for the cultural, the recessive genes that control the cultural forms also should have stability. Therefore, we need to find its elementary cultural genes in the process of traditional inheritance at first. Then according to the current level of productivity and technology, we can appropriately improve, transform and innovate it to meet the production and living needs of modern people. In other words, we should treat traditional culture with the vision and thinking of development, add appropriate nutrients to the cultural, transform and create new cultural vitality.

As shown in Figure 2, these are the traditional brocade patterns of the Dong ethnic minority in Tong Dao autonomous county. And shown in Figures 3 and 4, these are the collaborative innovation design based on traditional brocade patterns of the Dong ethnic minority and weaving skills. They are joint works of the villagers who have traditional skills and our students. These students have gone to the Tong Dao autonomous county several times to follow the local brocade experts to learn and research the brocade weaving technology, and then combine the modern design concepts and production techniques to complete the innovative design works based on the traditional brocade weaving techniques. They recorded the process of Dong ethnic minority traditional brocade weaving, from cotton selection, spinning to row yarn, weaving brocade and so on. Then they studied the weaving skills of the traditional brocade carefully under the guidance of Tian-mei Su (inheritor of intangible cultural heritage). At the same time, they also tried to compare traditional manual weaving skills with modern machine weaving technology, hoping to find a balance between handicrafts and machine.
2.4 Fusion and Generation

Fusion and generation are the corresponding viewpoints in the simple dialectics of ancient China. It means that the combination of different elements can generate and develop all things in the world. Different things can fuse to generate more things. If everything is the same, the world will not develop anymore.

Fusion, it means that different and even opposite things fuse to interact and relate to each other, thus generate valuable new things. Therefore, in addition to the inheritance and development of the traditional cultural, we can also generate a new cultural form that is richer and more vibrant than the original cultural form through the fusion of new materials, new technologies and new methods. But at the same time, it is necessary to use the mechanism of generation -the cultural gene as the criterion of fusion. Once this criterion lost, it may deviate from the track of the original traditional culture and thus lose the meaning of cultural inheritance.
Figure 6. Three-dimensional design based on the traditional brocade pattern of the Dong ethnic minority (Ying He).

As shown in Figure 5, it is an attempt to explore the innovative design expression of the traditional patterns of the brocade in different materials, such as silica gel, ceramics, PVC, and silk. Figure 6 is a bold attempt to combine the traditional pattern and structures of the brocade with modern 3D printing technology. Taking the dragon pattern, phoenix pattern, bird pattern and octagonal pattern in the brocade as the prototype, the students have designed three-dimensional models based on the traditional brocade though combining modern 3D printing with traditional culture. The whole design is full of innovative spirit. Through extraction, reconstruction, overlapping and other design methods, according to a certain proportion, structural rationality, and optimal allocation principle, the brocade pattern of the Dong ethnic minority is decomposed into multiple horizontal and vertical small cubes. And then, through the flexible application of material properties, techniques, structural principles and understanding of the spatial structure, they are integrated into a poetic and rhythmic polyhedron. On these polyhedrons, each structure has a formal logic, meaning, and symbolic value, and each different polyhedron represents the different benedictions of the Dong ethnic minority.

3 Research on the Design Education for Rural Revitalization

“Design is a new knowledge structure system evolved by human beings for active adaptation to external causes such as the environment. It is the wisdom creation of human reorganization survival structure” (Klaus, 2016, p. 015-017). The formation and transmission of this new knowledge structure system need to be realized through design education, and it is continuously updated and iterated with the development of society and the advancement of technology.

3.1 The Shift in the Focus of Design Education

“The design has encountered unprecedented challenges in the past ten years. The focus of design has shifted from the design of tangible cultural to the intangible cultural level such as service design, information design, business model design, and lifestyle design, etc.” (Tie, 2017, p. 2). Therefore, the focus of design education has also changed with the shift of design focus.

Traditional design education mostly tends to use basic training and professional design training to enable students to learn how to build a multi-party communication bridge in commercial design activities to achieve design goals. In the teaching process, more focus is on the teaching of design skills, and the ecological, social, economic and political environments closely related to the design is less involved. Design education for rural revitalization is more socially responsible and pays more attention to the memory of the rural culture. It tries to link design with traditional culture, social responsibility, professional ethics, ecological environment, intellectual property awareness and so on, in a more meaningful way. It applies tradition to modernity and connects the past with the future.

“We have a moral obligation and responsibility for human companions and other lives. This obligation calls us to be a prudent manager of the natural environment that sustains and supports our existence” (Heller & Vienne, 2017, p. 33). Design is closely related to people’s needs and social needs. Therefore, designers have more social responsibilities than ordinary people. As a design educator, while teaching students professional design knowledge and skills, it is more necessary to guide students to understand design as a social force that cannot be ignored, and help them to establish a positive and active design concept, aware of their responsibilities, and also know how to carry it out.

3.2 Expansion of the Field of Design Education

From a historical perspective, design does have the power to change the world. In modern society, the talent of the designers has maximized. However, when we look at design from the perspective of social vision, its power is often overestimated in fact. We cannot expect a person’s design practice to realize all his social, political, spiritual, cultural and other ideas. Only an interdisciplinary team can achieve the real design needs of the world. Professionals from
different disciplines study, discuss and experiment with each other, through multi-disciplinary cross-complementation and planning adjustments.

Of course, the significance of interdisciplinary and cross-collaborative innovation lies not only in teamwork between different disciplines. It also puts higher demands on the designers themselves. Therefore, design education has higher requirements for a teacher. First of all, to cultivate students in becoming generalists, teachers should also be generalists to adapt to the multi-faceted needs of design education. Complete design education should extend to other disciplines such as sociology, anthropology, psychology, ecology, economics, and management.

3.3 The Innovation of Participatory Teaching Method
The so-called participatory teaching, that is, cooperative teaching or collaborative teaching, is opposite to preaching teaching (Jin-qi, Shui-ying & Chang-chun, 2000). Participatory teaching methods usually focus on the active participation of students throughout the teaching process, aiming to expand students' autonomy in learning, mobilize the initiative and enthusiasm of students' learning, and promote the development of students' personality and creativity. As shown in Figure 7, it is a general participatory teaching method model. This teaching method supports the formation of a teaching field that is conducive to knowledge generation between teachers and students. Teachers and students work together in forms of independence, equality, interaction and inquiry to break the traditional one-way process of transferring knowledge to students.

Different from general teaching, design education for rural revitalization has a more practice feeling. It is more focused on guiding students to use innovative design thinking to solve or help solve some rural problems, as well as collaborative innovation design with the participation of villagers. The villagers are the real holders of rural culture. Each participant has his own unique understanding of things because of the different environments and cultural backgrounds. They build a collaborative innovation design community based on mutual understanding and respect and thus get the chance to collision spark ideas.

As shown in Figure 8, it is a participatory teaching innovation model that is consistent with the characteristics of design education for rural revitalization. Teachers, students and villagers have formed a meaningful relationship in the process of participating in innovative design. Design knowledge, design methods, design thinking, and rural culture fuse together and internalization becomes the creative energy of each participant which should finally generate the design synergy.

![Figure 7. General participatory teaching method model.](image-url)
3.4 Construction of Self-Circulating Teaching Activity Framework

More than 2,000 years ago, Confucius, the great educator of ancient China, put forward the teaching framework of listening, seeing, thinking, learning and practicing. He believes that learning is a kind of cognitive activity. It requires more listening and seeing, combining learning with thinking, practicing and action. Nowadays, design education for rural revitalization puts forward higher requirements for teaching and learning. It pays more attention to students’ ability to participate in social innovation practice, cultivates talents with independent cognition, to enable them to think independently and make their judgments and choices through investigation and research. For the need of design education for rural revitalization, we summarized the design education practice of the decade and built a teaching activity framework based on the wisdom of the predecessors.

As shown in Figure 9 (left), teaching, learning, practicing, thinking and researching is the five elements of the teaching framework. Putting purchasing at the centre is because it is the fundamental way in which design education is involved in rural revitalization. In practice, the teacher passes on design knowledge, design thinking, and design methods for students. Students spontaneously learn and research rural culture and traditional handicraft (including intangible cultural heritage). And they will think deeply about how to use rural resources (culture, nature, society, etc.). They will naturally work in design innovation with the villagers, forming a collaborative innovation design community of equality and mutual assistance. Teaching, learning, practicing, thinking and researching is just like a self-circulating system. Each participant in the system is innovating. They work together to design products that not only inherit rural culture but also fit market needs. And they work together to build a sustainable rural society vision that meets both the needs of rural economic development and maintains rural ecological balance.

As shown in Figure 9 (right), rural culture is also the core of design education for rural revitalization. Design education for rural revitalization is to start with the understanding, recognition, respect, and love of rural culture. Rural culture generates by the rural natural environment, human environment, and social environment. It is the most important
Design Education for Rural Revitalization

resource available for rural revitalization. By participating in design innovation with the villagers, not only can cultural resources be developed and utilized to the maximum extent, but also the villagers' cultural self-conscious can be inspired, the villagers' cultural self-confidence can be enhanced. It is also conducive to promoting the overall revitalization of the countryside.

4 Conclusion

After ten years of practice and research on design education for rural revitalization, we have accumulated a large number of cases and experiences. We have gradually formed a practical process of design education for rural revitalization and innovated the participatory teaching mode of design education (See Figure 7 and Figure 8 for details). Compared with general education, design education for rural revitalization pays more attention to the participation of villagers, and the relationship between the participants is closer than the former. The educational process is open to all. The teaching space extends from the classroom to a broader field. Anyone who is willing to participate can join. Except for classroom study, teaching content also includes social learning and emotional learning.

And we have constructed a teaching activity framework of design education for rural revitalization that is centred on practice. All participants form a collaborative innovation design community based on mutual understanding and respect. Each participant (teacher, student and villager) has multiple identities, different knowledge structures and cultural backgrounds. They teach and learn from each other, think and research on how to make use of rural resources to solve rural social problems and promote rural revitalization.

In addition, design education for rural revitalization has more practical significance. We have not only trained a large number of students with social responsibility and the passion for the countryside, but also helped the villagers to increase cultural self-confidence and improve living standards in the process of promoting rural revitalization. Taking Tong Dao Autonomous County as an example, by the end of 2018, we have helped the villagers to create a local brand Suo Shuo, based on the inheritance and innovation of the Dong brocade culture, provided training to more than 300 traditional Dong brocade craftsmen, and sold more than 3,000 handmade scarves in total as well. The per capita net income has increased from more than 500 RMB in 2011 to 2,000 RMB in 2017.

In the future, as the driving force at the national level continues to increase, we believe that more and more people will devote themselves to design education for rural revitalization. However, the relevant theoretical research is in its infancy at present, and many problems are still left to be solved. We will continue to explore and research through the practice of design education for rural revitalization.

References

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Towards Community Centric Design in Cairo Informal Areas

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Abstract: Informal areas take up 65% of Cairo. Mansheyet Nasser -one of the biggest informal areas in Cairo- alone hosts more than 2,000,000 inhabitants. Several NGO founders feel responsible to create a model that fixes informal areas’ problems (such as education, employment and health). Especially since the 25th of January revolution, they have been doing their role in sustainable development. Currently these NGOs are responsible for providing opportunities that generate income for informal area female inhabitants. This study focuses on sustaining this income through community centric design. Moreover, the designer’s role was more of moderating between the informal area, the inhabitants and the NGO rather than designing only. Aiming the women could have sustainable income, the participants’ needs and communities were investigated using Kimbell and Julier’s (2012) Storyworld method. This resulted in three women sewing clothes that are sold using a well branded online store. A sample from the store’s target group were invited to participate in several participatory design workshops to create the chosen products. This action research draws attention to the impact of community centric design on socio-economic status in informal areas.

Keywords: community centric design; participatory design; Cairo; informal areas; NGOs

1 Towards Community Centric Design

Interestingly, the largest contribution of designers is to intervene in social problems trying to shape culture and environment of community as stated by the political scientist Herbert Simon that design is “changing existing situations into preferred ones” (Simon, 1972, p. 111). In this direction, when more focus is made on social, ethical and communal issues than on individual ones, values are more tangible, thus the shift from user centric design towards community centred design is achieved (Meroni, 2008). Moreover, Manzini explains social innovation should interplay between autonomous initiatives that create social enterprises. These entities grow better in a favourable economic ecosystem, which is the national institutions’ responsibility to provide. Besides when it comes to the design, designers are urged to prioritize recognizing existing social inventions and develop them into more effective, marketable, sustainable solutions (Manzini, 2015, p. 58). Therefore, branding and social media marketing strategy where taken into consideration in this research in order to create a lasting impact. This research focuses on achieving autonomy for
individuals through generating a social enterprise through NGOs, with the help of community centric design research and participatory design.

Innovation requires collaboration from multiple parties. Value framework is a method that supports shared value creation for people, organizations and society. When designing solutions for societal challenges such as unemployment, it is important to research the issues at user, organizational, and societal levels in an extended network of stakeholders. This can be conducted through brainstorming sessions with stakeholders to define new value propositions (de Bont, den Ouden, Schifferstein, Smulders & van der Voort, 2013). For example, when using Kimbell’s Storyworld method, we study a person as connected to lots of other people, organizations and things rather than as an independent without a history. An efficient Storyworld constantly raises the question “would it work for him or her?” (Kimbell & Julier, 2012). The social design process is adaptive to the situation it is used upon, therefore in this project, the processes described by Kimbell were used and altered.

Moreover, it should be stated that informal area residents are surprisingly innovative and committed to resolving their daily needs. According to Grigorovich (2008), the main problem with informal areas is it having many types of environmental risks due to the absence of urban services. But despite the problems the informal areas are best examples of raw improvisation, also of entrepreneurship and talent to generate revenue out of nothing. These informal areas occur due to typical obtrusion into places like cemeteries, rooftops and public lands that their inhabitants undertake as homes. Therefore, the urban poor can independently satisfy their needs with no outside help. Accordingly, they develop a system where they support each other through trading favours. And therefore, a possible solution is branding of products and positioning self-help activities as a tool to achieve complete independence (Grigorovich, 2008).

“Cairo is a chaotic megalopolis where life is characterized by extremes, both of tradition and of modernity. When people are asked what the city means to them, individual answers vary tremendously, depending on a person’s relationship to the place” (Kipper, 2009, p. 13). Informal areas cover more than 50% of Cairo’s landscape hosting millions of inhabitants, thus generating their own culture and habits. An example of the extreme characteristics mentioned above is the fact that some female inhabitants cannot afford to pay for their sick spouses and children but will not work because their traditions forbid women from working outside. They fear from what their community would think and say about them more than they fear for their children’s sickness. However, most of them have a lot of potential and would perform well when given a customized opportunity. Furthermore, it is unfortunate that Cairo lacks accurate statistical data about its informal areas, which makes it difficult for NGOs to calculate how far they have come and what more they need to achieve. There is little literature counting the number of women, men and children in each area, their health, educational and employment conditions. Therefore, NGOs that were founded after the 25th of January revolution started databasing this information.

2 Empirical Research

According to Mona Gado, informal areas lack many facilities. Therefore, unemployment leads young people to be involved in drugs and street gangs, resulting in insecurity for women and their families (Kipper & Fischer, 2009, p. 61). While collaborating with an already existing NGO, this intervention aims to raise the sustainability bar to the existing income opportunities provided by NGOs. Accordingly, after conducting interviews, informal area field visits with several informal area inhabitants and NGO representatives, the following was concluded:

- The poverty loop in Egypt is caused by either lack of education, employment, health care and/or over population. This a wicked problem that can only be treated yet not cured, through different design tools that enable NGOs to intervene sufficiently in some of the informal areas’ problems.
- Each informal area in Cairo has its own community characteristics and problems thus cannot have the same ways of design thinking.
- The designer working individually with the informal area inhabitants - even if experienced- is not as effective as working under the umbrella of an NGO that has been in the area for a period of time and has already gained the inhabitants’ trust.
- Most female informal area inhabitants opt for a better living in order to better provide for their children more than their husbands (who are most times involved in drugs as mentioned earlier).
- During the field visits, when these women were offered jobs, they refused due to their traditional constraints.
- Some of the women are already experienced tailors and/or are interested to learn the skill.
Due to these conclusions, it was decided to target female informal area inhabitants rather than males to ensure their commitment, and to focus the design intervention on providing them with a job opportunity that is accessible from home. Figure 1 illustrates the current situation under the supervision of NGOs, where income is provided, in addition to the sustainability provided by the design intervention under the umbrella of Community Centric Design resulting in a steady income for female informal area inhabitants.

2.1 Phase I: Research and Idea Validation

In this section an explanation of the design process phases is provided. This is where several methods overlap. In Phase I Inspiration and Ideation steps are explained. Then a second round of inspiration takes place by analysing the second stakeholder, which is the target audience. This is conducted using participatory design workshops.

2.1.1 Inspiration Round I Community Centric Research: Storyworld

The Storyworld method (Kimbell & Julier, 2012) is used to establish the current surroundings of the target group. This exercise was not only undertaken through observation, interviewing and field visits, but also through conducting focus groups with experienced members from different NGOs. It was deducted that the way of doing things might vary between one woman and the other, also from one informal area to another, yet the relations, connections and mental models are almost the same. In Figure 2, the primary connections to the participant’s close circle and the organizations she deals with are shown. Also, more emphasis is made on her regular habits and socializing activities. Her thought and self-perception give insight into the solution proposed. Most importantly, instead of her community’s traditions acting as a design constraint, they were rather considered as an inspiration for the solution along with her self-perception. These traditions acted as constraints to the solutions provided by the NGO members constantly. Finally, the model proposed was to provide the women with sewing machines in their homes and with patron designs to follow, and sell the products online to a higher socio-economical target group.

2.1.2 Ideation: Storyboarding

The Storyboard method (Kimbell & Julier, 2012) not only helps illustrate the proposed model but also the value proposition created through the intervention. It also highlights the before and after user experiences in a nutshell, thus provided us with unbiased understanding into implementation (Figure 3). It shows the steps from when the user surfs the web searching for a fashionable design, to when she ends up running errands between the tailor and the fabric shops to design clothing. Then after introducing the model, she instead purchases products that fit her needs from a well branded online store. The benefits of such an approach are that it saves time, money and effort for the target group, but on the other hand eliminates the testing experience.

2.1.3 Inspiration Round II: Ensuring Sustainability through Participatory Design

When using participatory design, the designer takes the role of the moderator, where he/she helps the participants express their exact needs. This method not only helps the designer to achieve better results as it shortcuts a lot of time spent on interviews and surveys, but also allows better understanding of the problem at hand (Martin & Hanington, 2012, p. 293). The use of participatory design in this project aimed to involve many stakeholders in the process of designing and implementing. It was not only used by the informal area inhabitants to produce the products...
but also by a sample from the targeted group to decide upon the designs providing discussions and feedback. In the following sections are some of the results of two of the conducted participatory design workshops.

### Storyworld

![Figure 2. Storyworld, centering user and community (Kimbell & Julier, 2012, p. 24).](image)

#### Relating and connections
- Priority connected to their children and husbands. Also their mothers and neighbors. They care for their children and parents, put their connection with their husbands in authorities.
- Location is always related to their environment, as they take their children and provide food, money and medical attention.

#### Mental model

**Who are they?**
- Name: Jamila
- Age: 26-34
- Gender: Female
- Children: 3-4
- Living Context: Rural
- Work: Housewife

**Note down your assumptions:**

**Self perception:**
- Believes the life potential of the men is limited.
- Believes that her children deserve a better life.

**What are they doing?**
- Constantly receives help from NGOs.

**Where are they?**
- Village

### Storyboard

**Use this structure to imagine a story about your user or customer as they engage with your offering**

**Your user in their daily life:**

- **Stage 1:**
  - User calls the web searching for fashionable designs
  - User sees designs that are appealing

- **Stage 2:**
  - User orders desired products
  - Within 3 days, the product is delivered to user

- **Stage 3:**
  - What is saved online can be purchased immediately
  - No actual testing experience of products
  - Time, money and effort are saved

**Your user interacts with your offering:**

- **Stage 1:**
  - User calls the web searching for fashionable designs
  - User finds brand’s advertisement

- **Stage 2:**
  - User orders desired products
  - Within 3 days, the product is delivered to user

**Figure 3. Storyboard, explaining a story of interaction between user and product (Kimbell & Julier, 2012, p. 28).**
Workshop I [Participants: Online store target audience - Objective: Narrowing down needs]

Once the Storyboard was created, more information was needed to better understand the existing problem. The workshop was held in order to generally discuss the problems with the online and offline shopping experience, and also to understand exactly how these problems made the participants feel and think. It also aimed to specifically discuss the problems with the product needs of this particular target group and their preferences. The discussion included understanding the problems with online shopping, clothing in Egypt and target group’s recommendations for a new product and service and the flaws of veiled clothing in Egypt. Around three workshops were held face to face, each took between 1-2 hours, they included veiled A class females ranging from 19 to 23 years old, who were interested in veiled fashion and open to new ideas. Some challenges included the following:

- They agreed on how most shops exhibited skirts that turn out to be transparent, open from one side, reveals a bit of the leg or too tight that it exposes body figure.
- The skirts and dresses exhibited are infrequent and trends between their peers, resulting in them feeling less unique wearing the same as their social group.
- In winter, international shops do not provide winter skirts or dresses, as unveiled girls normally wear pants for instance.
- Moreover, formal materials were very hard to find.

The discussion not only allowed the participants to express and share their struggles (which were similar), but also it shed a light on the fact that despite their clothing restrictions, they also aspired to feel uniquely dressed within their social circles. They constantly compare their wardrobes and scout the internet for new ideas. This gives insights on the branding and marketing strategy by which these products were to be communicated through social media. The marketing campaigns would grow their aspiration. In order to induce uniqueness in the products, the branding would not communicate purchasing for a cause which would encourage them to buy once. Rather it would communicate products that seem of value.

2.2 Phase II Implementation: Trials and Results in Different Informal Areas

In Phase II of the empirical research on ground trails were made to validate the idea and test the business model. The following are trials, errors and results in four different informal areas in Cairo. As per the Storyworld model presented earlier, the morals and cultures of the inhabitants had to be respected while communicating with them. And thus more caution was made while visiting them and several challenges were faced due to the authoritative relationship with their husbands. An example of this is mentioned in 2.2.3. However, the overall commitment of the informal area inhabitants involved in this project was always compromised due to their spouses’ control and the community constraints. Unfortunately, no research was made to thoroughly identify where the problem lies, as this appears to be a job for social sciences researchers. However, it was communicated several times that the spouses are either jealous of the NGO’s interest in their wives or perceive these interventions as disrespectful to their traditions.

After failing in each of the three first areas, feedback was collected from the target audience, however the areas of errors seemed obvious in some cases more than in others. And therefore, a participatory design workshop was held after collecting samples from Informal Area II.

2.2.1 Informal Area I: Batn ElBaara (NGO A)

An important aspect of this project is professionally teaching the informal area women to sew. Consequently, some research was done to find an appropriate place where they can learn. Finally, a workshop was contacted. It teaches sewing in 24 two-hour classes along two months. The coordinator between the informal area community and the team is popular in the neighbourhood and accordingly it was assumed that she could choose reliable women for the project. Ten women were identified for sewing. However, six of the ten sewing women changed their decision about joining the team, as their husbands did not approve. Accordingly, it was decided to train the four women hoping that they will train the rest. At the end of the workshop, these four women were only taught how to finalize clothing, rather than sew them from scratch. This was due to the NGO trusting the coordinator to actually choose the women herself. This resulted in wasting 5000 LE spent on this workshop. The main action that led to this trial’s failure was blindly trusting a coordinator from the community without interacting with the women.

2.2.2 Informal Area II: ElMatareya (NGO B)

In this trial it was decided to pursue an already established group of tailors, rather than teaching them the skill from scratch. NGO B was contacted and showed great interest in the project. They had a group of tailors in ElMatareya
informal area and they recommended working with two of their best women. Therefore, a number of samples were provided to produce trials. When the trials were assessed some comments were raised but it seemed acceptable to proceed. The assessment was held through a second participatory workshop.

Workshop II [Participants: Online store target audience - Objective: Customers’ product evaluation]

After several samples were done by the informal area inhabitants, a trial run took place to evaluate the products and test the customers’ responses. Another participatory workshop was held, where the products were exhibited from the participants to try out, discuss, assess and purchase. The team decided to sell the products in cost prices, as the aim was to test them. The batch included 55 pieces, which were not of very high quality. The visitors were also given colourful post-it notes to write down their comments even if they did not buy anything. As compared to the earlier workshop, this one had an exhibition setting to better view the products like a shop. On browsing the products, the participants were able to give more detailed feedback and suggestions. The fact that it was a participatory workshop and that most participants were already friends gave them a shopping experience when exchanging opinions. Furthermore, the NGO team members co-facilitated the workshop along with the designer, thus inducing more engagement.

Accordingly, more fabrics were bought and NGO B was asked to produce more samples with different sizes. The second time the trials were received the sizes were good but the initial problems were not addressed. Also there was a delay from the women’s side to deliver on time. Again, the team explained in more detail their feedback and gave NGO B more samples to produce but in vein. The products were not delivered on time and there was no consistency in the sizing. At this point the team has spent a total of 6000 LE on purchasing the materials to produce a total of 75 pieces. In this trial, money and effort was wasted due to not thoroughly investigating the tailors’ sewing skills from the beginning.

2.2.3 Informal Area III: Mansheyet Nasser (NGO C)

For the second time it was decided to contact a third NGO looking for better quality of work. NGO C was founded in 2011 right after the 25th of January revolution and the team also had good connections with its leaders. They were immediately interested to start working together. This time it seemed more convenient to NGO C’s team leader to actually take the team into the tailors’ homes to better explain the requirements. Three of the tailors seemed experienced enough to work with, the remaining two had no experience in sewing since all their work involved large traditional Galabeyas that had one size. One sample of a skirt was given to the first tailor, and two samples of two different dresses were given to the husband of the second tailor since he was running her small tailor shop. The products were supposed to be received after a couple of days but only the skirt was delivered on time -since it takes less time to do- but the dresses were not received. This was due to the tailor’s husband blocking communication for a couple of weeks and when he did, it was explained that he and his wife got a divorce therefore, the order stopped. It was difficult to encourage the participants to act professionally within the project, leading to this trial’s failure as well.

2.2.4 Informal Area IV: El-Konayesa (NGO D)

Finally, NGO D was found, it had a well-experienced sewing workshop in ElKonayesa and the Operations Manager was contacted. The team met to discuss the details and then visited the workshop to see the quality of the work. There was not an actual partnership as all promises were made on friendly basis. The Operations Manager explained that the collaboration is beneficial for her project as it will allow more women to participate in the workshop, thus finishing her other orders faster. The products received were of good quality as per the assessment by potential targeted customers.

2.3 Conclusion to Trials and Results in Informal Areas

To better understand the above-mentioned interventions, the below diagram was created to summarise the actions done and the reasons that led to failure.
Towards Community Centric Design: Cases in Cairo Informal Areas

Figure 4. Success scale of interventions (J.G. Attia)

The diagram illustrates the problems leading to failure in each trial along with the order of the above-mentioned trials. In the first intervention in Batn Elbaara, the approach of recruiting inhabitants that have no knowledge of sewing whatsoever was the main reason of failure. This along with the trusting of a mediator from the community who has misjudged the women’s commitment to the project. In the second intervention in ElMatareya, the approach was amended to selecting a more experienced woman and focusing on one only and not many at first. However, the selected proved incorrect due to the woman’s inexperience in standardizing sizes. Furthermore, in the third trial in Mansheyet Nasser, more research was needed about the woman’s marital problems. According to community centric research done earlier, it was deduced that the husbands have an authoritative role, therefore leading to this trial’s failure.

Finally, the reason the fourth and final trial has succeeded lies in the edge of the Operations Manager’s monitoring the quality of the sewing herself. Not only did she have 20 years of experience as a tailor who taught and managed the rest of the women, but also, she had already established a strong relationship of trust between the tailors and their families. The Operations Manager understood their daily struggles thus gaining their trust. This research began by centring the community, but it is concluded that this is not enough, collaborating with a trusted member from the community is a must to implement the initiative at hand. Although the collaboration with the Operations Manager was crucial for the intervention’s success, however identifying this need of collaboration took place due to the use of the Storyworld tool. In this case, in order to design for the community, one must collaborate with a communicating party. Moreover, understanding the community’s needs along with the customer’s needs using participatory design workshops, helped empathize with the stakeholders and is therefore one of the main pillars that lead to the final success.

3 Impact on Some Stakeholders

The main criteria by which the results are measured is not only the output made by the project but also the impact on the informal area inhabitants’ and the NGO members’ mindset. Therefore, the following sections explain the impact made on both stakeholders.

3.1 Impact on Informal Area Inhabitants

The aim at the beginning was to support these inhabitants with sufficient continuous income to provide for their families. Before the intervention, the informal area inhabitants would sew a Galabeya for 2 LE to their neighbours, after working with them, they get 30 LE per piece, which approximately takes a maximum of two afternoons of work. They also developed a sense of quality control since the NGO does not take their products unless the quality is assured. Moreover, these women not only now encourage their daughters to learn and work, but also help and teach each other the craft in order to share work together as a community.

3.2 Impact on NGOs

Another aim of the project was to change the way NGOs think and perceive the solutions to unemployment in informal areas. At the beginning of this project, the NGO was about to implement the following projects in the informal area: vegetables or chicken selling on the streets. But after the project was initiated and this continuous income way of thinking spread among the NGO members the following projects were developed instead: Crochet Online Shop similar to the clothing idea, and Motorcycle Academy supporting male inhabitants with motorcycles to work as food deliverymen. Restaurants complain about behaviour and reliability problems from the deliverymen. Therefore, the idea is to collect men from informal areas and train them and provide them with motorcycles and...
become a hiring company for restaurants. The NGO members now believe in the importance of validating not only their idea but also their knowledge inside the informal area. They also understood the importance of allowing design to intervene in their process, more than just for campaigning.

4 Conclusion

Cairo’s communities are complex to understand, starting from individuals to families and ending with organizations and informal areas as a whole. Finding magic bullets that solve all wicked problems is not an objective social designers and NGO members should aim for, rather they should break the complexities into smaller problems and work around the circumstances with specific sustainable solutions. These complex informal communities might seem alike, yet have variant traditions, beliefs and most importantly trends, therefore each require a customized solution. Unfortunately, bigger older NGOs have induced traditional methods of development, thus creating resistance when introducing innovative approaches to smaller NGOs and informal area inhabitants. These methods oppose to achieving autonomy for informal area inhabitants, as they simply support them with food, health supplies and in some cases money without providing a long-term solution. And therefore, instead of them being independent, they rely more on NGOs. However, in this paper, NGOs are the main pivot, the correct NGO must be chosen to coordinate with. Without dedicated committed NGO members in the process, the project would simply become a regular short-term research. For the designer, the role is more of a facilitator, therefore regularly coordinating with experts rather than digging into research without any previous experience is highly beneficial. Also identifying several possible experts is necessary, since different organizations for instance have different mindsets and problem-solving approaches. Therefore, investigating several parties and then deciding which ones to collaborate with will save time and effort. Continuous experimenting with different inhabitants from several informal areas should not be considered a failure, as the aim is to provide a model that could fit not only the inhabitants, but also the solution that the designer is capable of providing.

The integration of community centric design as a thorough process while designing for the poor, not only helps the designer think of better solutions for the community but also allows more impact on the community rather than on the individual alone. During the interviewing process with the NGO members, several complained from the informal area inhabitants’ constraining traditions that sometimes cause the members to lose hope on some cases. And in other cases -when the designer works alone without the help of the NGO- he/she might implement a design that solves the income problem but causes other problems within the community, like marital conflicts within families, which on the long run will repel inhabitants from such initiatives. Moreover, Kimbell and Julier’s (2012) Storyworld method acts as a tactical tool when implementing community centric design as a strategy for research. Studying the relationships between the individual and his community creates a sense of empathy during the inspiration phase. It is believed that community centric design and the Storyworld method should come hand in hand when designing for the poor in specific, due to their many advantages. Although, this study will not claim the instant success of community centric design techniques, however when investigating countries with limiting cultural constraints it is needed. Cairo informal areas have proved to be mostly driven by the cultural expectations. And consequently, most design interventions must study the community’s needs, wants and aspirations before defining the problems to address. As per one of the NGO experienced members, it is always shocking to learn about how much the informal area inhabitants follow their community’s rules despite their needs.

Inclusion of both parties within the community is challenging due to the mistrust between the individuals and the NGOs. Most community members regard NGOs as a party to abuse through constantly asking for more financial support. That said, at the early stages of this research, some initial trials were conducted on male informal area inhabitants, however they were not interested. It was then deduced that due to the pressure made by the community’s expectations, they simply gave up on being the main supporter of their families. Some NGOs reported that the husbands either spend their time socialising or abusing drugs. Most of these communities do not believe in gender equality, thus the financial support is entirely the male’s responsibility. Due to their limited resources and lack of education, this responsibility turns into a burden that the husband can no longer fulfil. Therefore, it was decided to shift the intervention’s focus on females due to their interest and despite their cultural constraints. In other words, in this conservative society the role of the woman doesn’t involve financial support of her family since her role is to maintain the household. Her role as a supporter can only be accepted by the society if performed with her house such as crafting crochet, sewing clothing or home accessories or cooking for others. Starting by the small discovery of the producing product from the informal area inhabitants through participatory design. Therefore, based on these results tailoring a profession that suits their skills and aims that it becomes a mean to provide for her family.
Towards Community Centric Design: Cases in Cairo Informal Areas

Finally, designers should believe in the importance of learning about fields around design that maintain its sustainability. A designer's role might seem easy to those who work around them, but when working with social design and social entrepreneurship, the designer must be aware of the finance, marketing and operations of the entire process. As Papanek said in 1985: “being on the side of the social good”, designers ought to be more effective towards their communities. Furthermore, designers seeking social change should pursue learning to deal with NGO members with opposing mindsets. Evidently, dealing with informal area inhabitants is quite challenging but dealing with NGO members' ideologies might in some cases be more challenging, especially in Cairo where design is not well comprehended. On the other hand, most NGOs involved in this research reported creating discussions with the female informal area inhabitants that promote education, contraception and employment for females. It seemed easy to convince the females about these ideas however they were forced by male figures inside their homes to do the opposite. The previous example is strong proof of the importance of community centric design that should also go hand in hand with the social sciences. Yet, it is argued that designers should learn to acquire managerial skills to provide better results for their communities. Designers in this context, are not only managing the design process but also, they are managing the stakeholders and their community related problems.

References


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Familiar Strangers: Enhancing Underground Travel Experience through Digital Screens

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Abstract: Facial expression is the most effective way in which humans display their emotions. Such expressions play a significant role in social communication in humans because they transmit social signals about the mental and internal emotional state. This paper addresses an important issue of the underground travel in Istanbul, the lack of social interaction which is also a reflection of negative psychological impact of metropolitan life on individuals. Underground travel is a daily routine of a remarkable number of people in Istanbul and it is an isolating experience for most. Moreover, people living in big cities are exposed to risk factors originating from the physical environment contributing to increased stress. The core aim is to enhance the user experience of commuters for a more enjoyable journey by using the contagious effect of smiling, which is the simplest gesture, and face detection technology as game strategy for passengers to enjoy. A combination of qualitative and quantitative research methods was used to gather information about the underground travel experience of the passengers and determine what interventions might encourage social interaction during their commute.

Keywords: social interaction; facial expression; face recognition; underground travel; mood enhancement

1 Introduction

Two of the fundamental issues for a good urban life are mobility and social inclusion. Mobility plays a major role in our daily commute to/from work or school, and we became part of the transport system itself. However, people living in big cities like Istanbul are exposed to risk factors originating from the physical environment contributing to increased stress. Metropolitan cities have also impact on psychology and mental health of people. Simmel (as cited in Bridge & Watson, 2010) focuses on the reaction of modern people to the intensification of internal and external sensual stimuli in the city and how they protect their mental health from the effects of constantly changing environment. He states “Instead of reacting emotionally, the metropolitan type reacts primarily in a rational manner. (...) Thus, the reaction of the metropolitan person to those events is moved to the sphere of mental activity that is least sensitive and furthest removed from the depths of personality (p. 104).” He uses the concept blasé to define the dullness of people who live in metropolitan cities. He thinks that blasé outlook is the consequence of the psychological conditions which the
metropolis creates. Milgram (1972) also defines those individuals who do not know and do not interact with each other but share some common attributes like interests, occupation, location, etc. as familiar strangers. In most crowded cities passengers prefer to use public transportation as their daily commute to spare some time. Istanbul has become one of the fastest growing cities in the world and the demand on cars has increased rapidly along with the growing infrastructure of the city. However, traffic congestion is one of the main reasons people in Istanbul prefer using public transport such as metro, over private owned vehicles. We investigate how metro passengers in Istanbul reflect that blasé outlook, based on the findings of our observations. Metro is a place where the human interaction is limited even during rush hours and passengers mostly do not react to external stimuli. As Simmel (as cited in Bridge & Watson, 2010) states, the effort to reduce the number of possible human interactions is a result of modern city living conditions.

The industrialization of modern societies in todays’ world are highly affected on reducing the traditional ways of communication among individuals. The cities of the world need more specific spaces that fulfil the socio-cultural relationships of the people (Mamaghani, Asadollahi & Mortezaei, 2015). Social and architectural theorist Marco Casagrande developed the term urban acupuncture as he perceives the city as complex overlapping energy flows in multiple layers. These energy points can be treated as healing stress-relief areas of the city once they are identified. In this research we examined metro environment as acupuncture points for commuters to relief part of their stress, enhance their moods and encourage social interaction while commuting. A century ago, Charles Darwin and William James suggested ideas “that facial expressions are not just the visible sign of an emotion, but actually contribute to the feeling itself” (Goleman, 1989). This theory states that physiologically facial expressions can create emotions on its own; however, it is still not more powerful than thoughts or memories for triggering emotions. This theory has gained stronger evidence by researchers over the last decades. In one of the studies made at the University of Michigan by psychologist Dr. Robert Zajonc (cited in Goleman, 1989), there is definite evidence where facial action can actually lead to change in mood. Furthermore, according to scientific research, smiling releases happiness hormones like dopamine, which in return makes the person happy simply by smiling. Based on these results we developed a concept using face recognition technology which encourages passengers to smile and enhance the user experience of commuters for a more enjoyable journey by using the contagious effect of smiling. This form of social interaction can increase the overall mood in the metro and provide a middle ground for all users of all backgrounds and nationalities to communicate with each other.

Social interaction is the process of reciprocal influence exercised by individuals over one another during social encounters. The expected result of this proposal, the increase of social interaction, can be either social contact, which is the mental connection between persons or groups, and does not require the physical proximity, or communication (Goffman, 1959). We assume that this research may lead to further studies on nonverbal communication patterns in the underground travel which can have the potential for attitude change in a positive way. A set of features will be described which together form a framework that can be applied to any concrete social establishment, be it domestic, industrial, or commercial. The transformation of micro-level actions and interactions into macro-level interactions is identified as a key challenge for the further progress of this research.

2 Understanding Emotions and Facial Behavior

While making a study about mood during commute in the Netherlands, researchers found that long distance commuting results in lower wellbeing of the commuters. The study was analysed in the context of which 5000 participants recorded both what they had done in the previous day and how happy they had felt during these activities. This method allows comparison between how the same person feels at home and during their commute, which eliminates the selection effects. The results were given in detailed charts that showed it is not the commuting time that depresses mood, with precise combinations of commuting time and commuting mode. The study showed increasing travel time can sometimes enhance the travel mood if using bicycle or walking. (Lancée, Veenhoven & Burger, 2017).

An interesting topic closely related to our proposal is gamification, which is commonly known as using game methods in a non-game environment as well as introducing competition and social activity into behavioural interventions. The goal of gamification is to apply the benefits of game play -competition, achievement, collaboration- to ordinary non-playful activities (Stables, 2018). This combination provides a new experience for metro users in Istanbul. Gamification is often tied to new digital technologies, especially smart phone apps. Interventions that currently use gamification include road safety and travel demand management initiatives. Yen, Mulley, Burke and Washington (2016) explore gamification in transport sectors, provide a basis as to why and how gamification may be most useful, and synthesize current practice regarding the range of interventions offered this far in public and active transport. They did research
Familiar Strangers: Enhancing Underground Travel Experience through Digital Screens

on various case studies that suggest the use of awards programs to encourage commuters to ride during off-peak hours in order to decrease the pressure on transportation during peak hours.

İmre and Çelebi (2017) developed a composite index to measure the comfort levels of commuters using public transport in Istanbul. This index is helpful to understand the passengers’ choice of transport mode in different hours of the day, and can be used to predict passenger behaviour in public transport usage. It may accordingly be used as a tool to better plan and operate transportation networks.

Lyons, Jain and Holley (2007) reported that in a 15-minute rail trip, the most frequent activities among passengers were window gazing/people watching (29%) and reading (27%). Watts (2008) also suggests how passenger time is not a simple flow but a percolation, and how these passenger times coalesce in train carriages to form communities. The findings of his research show that a short trip seems not to merit any special activity to make it more meaningful, so train passengers engage in passive occupations. Our aim is to increase the quality of time they spend on metro by providing an interactive environment that enhances the overall mood. This is the reason why we are using the windows which turn into digital screens with playful filters instead of an act which requires active participation of the passengers.

There are several attempts to enhance underground travel experience, such as the research done by Nunes, Galvao and Cunha (2014) that proposes a framework aiming to unify public transport passengers’ collective intelligence through crowdsourcing, using their mobile computing devices and dedicated web services. This project is based on passenger participation in the urban public transport. There is a mutual relationship between the operators and passengers because passengers share information and benefit from rich real-time data which ease their journey. Also, operators benefit since passengers are also content creators, they can gain access to rich customer generated data. Another previous work on city and happiness focuses on public spaces. Quercia, Schifanella and Aiello (2014) worked on discovering the short and pleasant route between the current location and destination. Counting metro as a public space, our goal is to enhance the underground travel in Istanbul by increasing the interaction among passengers through face recognition technology.

3 Methodology

The aim of this research is to enhance the overall mood in Istanbul Metro and the underground travel by providing passengers an interactive environment. This study is based on two methodologies: the first is observing the commuters’ activity and their facial expressions during their commute, and the second is collecting feedback from the users through surveys. Facial expression is the most effective way which humans display their emotions. We rely on measurements of people’s emotional experience in the underground travel and use those measurements to enhance the travel experience. The activities of the passengers and their nonverbal communication patterns during the travel are observed in this study. It is discussed that those activities are the key factors that shape travel experience and is explained why the underground is an interesting environment to study in this respect. In the first phase of the research, the methods used are observation in combination with the literature review. Later, those facial expressions of the underground passengers are documented and recognized into eight categories, which are: anger, contempt, disgust, fear, happiness, neutral, sadness, and surprise through our observations to have a comprehensive emotion map in Istanbul subway. The second method in this research is making a chart of the most common activities in the metro to record and observe an estimation of these activities, which are: using mobile phones, talking, reading, and doing nothing or watching screens.

4 Data Analysis and Findings

Each section shows the results of our research methods and evaluated in detail. We used three methods: Observation, Survey and Evaluation. In observation we found that most of the time commuters were not doing any activity during their journey. Then we conducted a survey to have a better understanding of the situation in the metro and to allocate the problems. As a result of the comparison of these three sections, some similarities and correlations are discovered and discussed in the evaluation. The major findings are about the general mood of passengers in the metro, their tendency to interact with other passengers, the most performed activities during travel, and their favorite videos playing on metro screens.

4.1 Observation

We made observations in two metro lines; the M1A line and M2 line (Appendix A). For each line there were seven observations done over a period of two weeks during weekdays and weekends at varying times within the day. The
results from both observations show that majority of the time people are doing nothing compared to other common activities. The results also show that generally people are more social by the end of the day or on weekends. Figure 1 shows the average of all observation results of each metro line. Figure 2 shows the overall mood of commuters while in the metro, which was divided into eight categories: anger, contempt, disgust, fear, happiness, neutral, sadness, surprise. Most people show neutral emotions on their facial expression, this finding helped us assume that passengers could be encouraged to participate in social game activity to enhance their mood.

![Figure 1. Left: Meta-chart for weekdays observation for M1A metro line. Right: Meta-chart for weekdays observation for M2 metro line.](image)

4.2 Survey

The survey which aims to gather information about the underground travel experience of the passengers was conducted over a period of two weeks. The participants who are daily commuters of Istanbul metro were sent a link to the online survey (SurveyMonkey.com™). 41 participants completed a form including questions about their activities and general moods during their commute, and also their thoughts about interaction in the metro environment. The survey results reveal that short trips which take up to 30 minutes represent a common daily routine of the majority of the participants (58%). Underground travel experience is defined as tolerable by 40% of the participants, good by 25%, boring by 17.5%, difficult by 12.5% and enjoyable by 5%. The activities which are performed while traveling are analysed according to the results of the third question of the survey. Based on the observations and the objective of the research, three types of activity are defined and included in the survey: reading, using mobile phone, and watching screens/others. According to the results, mobile phone usage is more frequent among underground passengers (45%). The percentage for watching screens/others is 30% and for reading it is 25%. With this question, it is aimed to reveal the possible triggers which can persuade passengers to be involved in a social act in the metro. In the fourth question, participants are asked how they define their general mood in the metro and the most selected option is neutral (80%). 10% of the participants, selected sad, 5% of them selected angry and other 5% selected happy. The reason for putting four emotion categories is that they are the most observed ones among passengers and also the most detected emotions through face recognition software. Results of fifth and sixth questions which are shown in Table 4 and Table 5 show that passengers do not feel uncomfortable while interacting with other passengers.
but still they do not interact and prefer to engage in passive occupations (using mobile phone, watching screens). In the last question of the survey, results shown in Table 6, the favourite videos that are currently playing on the metro screens are asked. According to the results, cat videos (32.5%) and tutorials (32.5%) are the favourite videos of the passengers. Videos about history facts are also selected by 22.5% of the participants and event announcements are the favourite videos of 12.5% of the participants. By asking this question, it is aimed to receive the data which can lead the design process because to learn what passengers react to and are interested most in the metro are important while designing a participatory experience.

4.3 Evaluation

According to the results of the observations we did, passengers do not experience any type of social interaction in the metro environment most of the time. Moreover, survey results show that although participants feel comfortable while interacting with other passengers, they prefer to engage in a passive occupation and do not interact. In his study, Thomas (2009) investigates the social environment of public transport and reveals that seating layout of public transport forces people into an intimate distance with strangers, causing social discomfort. Psychologically, people tend to avoid eye contact in crowded situations and try to find a focal point to fix their gaze on in order to feel more distant from others. Considering this point of view, we observed metro commuters’ activities and came to a conclusion that they engage in the activities such as watching the screens, playing mobile games or listening to music, in order to avoid eye contact which may cause social discomfort. These activities are the mental barriers of commuters which result in social isolation in such crowded environments. Thomas’ (2009) study proves that the interaction among the passengers such as talking or positive body language, reduces the level of social discomfort, whereas defensive strategies do not reduce discomfort, but form a negative relationship with social interaction, which helps perpetuate a socially stagnant atmosphere. These findings can be beneficial in designing underground travel services that enhance passengers’ experiences even during off-peak hours. Moreover, since the survey results show that the most attractive videos playing on metro screens are cat videos and tutorials, motivation factor should be carefully selected and designed.

5 Design Proposal

In this proposal, we adopted persuasive design approach which is a design practice based on social and psychological theories and aims to influence people’s behaviors through a product or service. Fogg (2009) suggests that there are three important factors in his behavior model for persuasive design: motivation, ability and triggers. In the context of persuasive design, motivation is the reason for performing an action, ability is the required tools to perform that action and trigger is what pushes user to perform the behavior now. All these three factors must occur at the same time for the target behavior to happen. Our target behavior here is to encourage people to smile in the metro, which we assume will increase the interaction among passengers and enhance the overall mood of the metro. Smiling requires less physical ability but a serious level of motivation in the metro, because it is an environment in which each passenger’s face can seem blasé. Moreover, it is posited in Thomas’ study (2009) that pro-social behaviors, such as smiling, and acknowledging other passengers with greetings are a precondition for a successful interpersonal interaction. In order to motivate people to smile, we analyzed the elements of motivation which Fogg (2009) states and used pleasure as the motivator to make people respond immediately to what is happening. Moreover, Fogg (2009) divides trigger into three: spark, facilitator and signal. The most appropriate trigger for our target behavior is spark because it works best when the ability is high but the motivation is low. Cart-Load-O-Fun (Toprak, Platt, Ho & Mueller, 2013) is a game proposal for trams that was made and tested in Australia by a group of researchers. Their design focuses on providing physical play for passengers using the handles as game controllers, which in return provide support for the individual while the tram is moving. In the findings of their research, the passengers playing the game were seen communicating with each other verbally while playing the game, aiding each other in the form of giving directions. Players who were strangers also showed social communication, which show the potential that social games have in reframing a social space. The researchers also note that they were rejected by majority of the passengers to participate in the game; their reasons were being too tired, too old or in a hurry. However, some standers by were encouraged to try the game after watching others play with excitement and learning how to play as well. Passengers also felt time pass faster and the journey ride shorter while they were playing the game.

Furthermore, one of the major obstacles that prevent people from interacting with public displays is social embarrassment (Brignull & Rogers, 2003). In order to have social activity in public, people are more likely to engage with public displays if they can easily interact with it and pick up the pace. Therefore, the design must be kept simple and without any instructions in order to encourage people to use it. The design must also allow people to move freely around it, some could be onlookers and some are participants. One way of achieving this is to design ways of encouraging people to cross the thresholds from bystanders to participating individuals without feeling forced to be
engaged with it all the time. Once this threshold is crossed, participants might be more committed when they realize the effortless involvement with this interactive screen. The form of interaction needs to be very lightweight and visible from a distance, easy to do and most importantly not embarrassing if someone commits a mistake. Participants can self-learn instantly how to interact with the screens with the least amount of instructions. They need to be able to simply walk up and use it, having watched others do the same. The interface needs to be clear to the person, so that their interaction with it will be a low commitment activity that will be quick to do and enjoyable.

Based on the results of our research we made a design proposal that could enhance the mood in travel experience. Since the objective of our design is to be accessible to all individuals, the user interface can be easily understood by all ages with minimal instructions. The system could be installed on a screen in the metro wagon, which is placed on one of the window areas. A camera installed above the screen will detect the face of at least two people then reflect their image onto the screen to grab their initial attention (Figure 3). The reflection of these individuals is shown on the screen along with a flashing smiley emoji to encourage them to smile. The purpose of this design is to trigger the act of smile in the individual. This experience can have positive impacts on people, such as self-confidence, feeling happy, relieving stress or mood boosting.

Since the user interface is familiar to most people of all ages, it could increase social interactions between individuals, therefore, breaking the language barrier and increase social inclusion. In Figure 3 Left, there are two reflections on the window, which belong to the passengers sitting on the other side of the metro wagon. One smile is detected through face recognition software and as a response, a smiley face figure appears in colour. The software detects the other passenger’s face too, but since the smile cannot be detected, the smiley figure is shadowy. Figure 3 Right shows how the screen looks when two people smile.

6 Conclusion

We have presented an interactive game design for metro passengers. The purpose of the design is to be inclusive to all commuters and encourage social interaction. The interface also encourages smiling in public domains which in return have various benefits to health and psychology. This study was made during the Design for Social Innovation course, which is part of the design education curriculum at Kadir Has University with the supervision of Assoc. Prof. Dr. Serkan Bayraktaroğlu. The research can be further developed in the future and aid researchers in their domain, we therefore believe our studies can be a valuable initial exploration into this exciting field of digital interactive games for public transport.

References

Familiar Strangers: Enhancing Underground Travel Experience through Digital Screens


About the Authors

**Güler Akduman** was born and raised in Izmir, Turkey. She is a student of Master in Design Program and a Teaching Assistant at Kadir Has University. She obtained her BA in industrial design at İzmir University of Economics. Her research interests centre around the intersection of inclusive design and social innovation.

**Yumna Mohammed Ali** is an Iraqi raised in the United Arab Emirates where she also got her Bachelor’s degree in Interior Design at Ajman University. She is currently enrolled in the Master in Design program at Kadir Has University. As a designer, Yumna aspires to provide design solutions beneficial to minorities in the society.
# Appendix A: Observation Template

<table>
<thead>
<tr>
<th>Activity</th>
<th>Number of people</th>
<th>Time 1am</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Saturday</th>
<th>Sunday</th>
<th>Number of people</th>
<th>Time 2am</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Saturday</th>
<th>Sunday</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleeping</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Walking</td>
<td>0</td>
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<td></td>
</tr>
<tr>
<td>Using Mobile Phone</td>
<td>2</td>
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<td></td>
</tr>
<tr>
<td>Watching Screens</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>

**Figure:**

Weekend Observation

- **Morning:**
  - Sleeping: 2
  - Reading: 4
  - Talking: 5
  - Using Mobile Phone: 4
  - Watching Screens: 2
- **Evening:**
  - Sleeping: 2
  - Reading: 2
  - Talking: 4
  - Using Mobile Phone: 3
  - Watching Screens: 2

- **Total:**
  - Morning: 11
  - Evening: 9

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Güler AKDUMAN, Yumna MOHAMMED ALI
Appendix B: Survey Results
Learning Through Industry-University Collaboration: Observation of Product Innovation Cases Targeting Low-Income Communities

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Abstract: Poverty is one of the most significant problems faced by humanity. Today, a significant number of the world’s population, known as the bottom or base of the (economic) pyramid (BoP), lives on less than $1.90 daily income. Various stakeholders take part in a range of efforts aiming to solve this multi-faceted and complex problem. Among these efforts, innovative product development has gained acceleration in the last two decades with the contribution of private sector actors. Yet, the challenges in practice force these actors to embrace the problem area creatively. At this point, university collaborations offer creative and inspiring ways of approaching the world’s complex problems, including BoP initiatives. Nevertheless, despite the rising expectations from collaborative practices, only a minority of ideas are achievable. This study examines four collaboration cases targeting BoP communities, which took place between a global household appliances company and two academic institutions in Turkey. The examination is grounded in participant observation of the collaborations and the researcher’s field notes in four diaries. The study sheds light onto the industrial partner’s objectives and expectations from the collaboration. It presents barriers in the realization of student ideas and proposes enablers to overcome these barriers.

Keywords: design for the bottom/base of the pyramid (BoP); innovation; new product development; participant-observation; industry-university collaboration

1 Introduction

The world has been facing complex problems. Being one of these problems, the level of development remains unequal around the globe. Despite the efforts to improve quality of life and wellbeing of low-income communities, at least 736 million of the world’s 7.7 billion population live under $1.90 a day (Worldbank, 2018, p.1). These communities are described as the bottom (or base) of the (economic) pyramid (BoP) (Prahalad, 2005). They experience problems regarding their basic needs, such as accessing clean water and constant electricity (United Nations, 2018).

A wide range of actors plays a role in the solution of the problems faced by low-income communities. Among these efforts, innovative product development has gained acceleration in the last two decades with the call for private actors to contribute to the problem domain (Hammond & Prahalad, 2009; Prahalad, 2005). Companies, start-ups, and social innovators aim to address social problems with product innovations, however, the challenges in practice force these actors to approach the problem area in a creative way.
Academic student projects are seen as a source of creativity and inspiration in the solution of the world’s complex problems, and as part of efforts aimed for people living at the BoP. These projects may usually address problems related to people’s access to clean water, food, energy, healthcare, and education (Kandachar et al., 2009a; Kandachar et al., 2009b; Kandachar et al., 2011; Kandachar, 2012; Viswanathan and Sridharan, 2012). They aim to bring business partners and academy together to alleviate poverty and develop the BoP strategy for mostly underserved countries (Kandachar et al., 2009a). Student projects that took place at Delft University of Technology (TUDelft) are some of the examples of academic collaborations which form basis for building academic knowledge about the BoP problem context (Kandachar et al., 2009a).

Although the search for conceptual student projects comprises the majority of scouting practices, only a limited number of projects become alive. This research aims to find answers to:

1. How do industry-university collaborations take place for the BoP initiatives?
2. Why do the realization rates of student projects remain low for the BoP problem context?

## 2 Methodology

In order to answer the research questions, this research examines the industry-university collaborations of a global household appliances company. It embraces four collaborations that were carried out with two academic partners in Turkey. The collaborations took place as part of the company’s ideation efforts for the African market and aimed at mentoring students to develop innovative product concepts that address the basic needs of the BoP communities in Africa.

### Table 1. Description of the observed university collaboration projects

<table>
<thead>
<tr>
<th>Case number</th>
<th>Project description</th>
<th>Project profile</th>
<th>Student count</th>
<th>Number of acquired ideas</th>
<th>Project execution</th>
<th>Stakeholders</th>
</tr>
</thead>
</table>
| Case 1      | Developing innovative product concepts for leveraging the quality of Nigerian BoP. | 3rd year students | 41 students | Acquisition of 2 ideas | October 2016 - January 2017 | Industrial partners:  
- Project leader  
- UX researcher  
- Food and mechanical engineers  
- African experts  
Academic partners (ITU):  
- Academicians  
- 3rd-year industrial design students |
| Case 2      | Developing innovative product concepts for improving practices of Nigerian BoP related to washing laundry. | 4th year students | 49 students | Acquisition of 4 ideas | October - November 2016 | Industrial partners:  
- Project leader  
- UX researcher  
- Mechanical engineers  
- African experts  
Academic partners (METU):  
- Academicians  
- 4th-year industrial design students |
| Case 3      | Developing an alternative cooking concept for the BoP communities. | Graduation project | 1 student | Utility model registration by METU Technology Transfer Office | February - May 2018 | Industrial partners:  
- Department manager  
- UX researcher  
- Engineers  
Academic partners (METU):  
- Academicians  
- A 4th-year industrial design student  
- METU Technology Transfer Office |
| Case 4      | Developing an innovative food drying concept for the BoP communities. | Graduation project | 1 student | Utility model registration by METU Technology Transfer Office | February - May 2018 | Industrial partners:  
- Department manager  
- UX researcher  
- Engineers  
Academic partners (METU):  
- Academicians  
- A 4th-year industrial design student  
- METU Technology Transfer Office |
Learning through Industry-University Collaboration: Observation of Product Innovation Cases Targeting Low-income Communities

The collaborations were initiated with Istanbul Technical University (ITU) between May 2016 - January 2017 (Case 1), and Middle East Technical University (METU) between August - November 2016 (Case 2) and December 2017 - May 2018 (cases 3 and 4) in a timescale including planning, execution and assessment of the collaboration projects. The observed cases involved a 3rd year studio project at ITU (İTÜ Kurumsal İletişim Ofisi, 2017), a 4th year studio project (METU Department of Industrial Design, 2017) and graduation projects at METU (METU Department of Industrial Design, 2018). The details of the collaboration projects are given in Table 1.

The researcher observed the collaborative process by following the complete participant observation methodology. The observation took place between February 8th, 2016 and August 9th, 2018. During the time of the observation, the researcher worked in the company as a UX researcher at the Innovation and Technology Management department in Turkey and supported product development and collaboration activities of Corporate Innovation department in Germany for the projects targeting the BoP communities. Between these dates, the researcher was involved in two product development and four university collaboration projects. The researcher mediated the communication between the academic partners and the stakeholders within the organization: academicians, students, project leader/department manager, the project team, engineers and African experts from several departments. Meanwhile, she carried out complete participant observation of the university collaborations and conducted semi-structured interviews with industrial and academic collaboration partners to formulate their collaboration objectives (Figure 1).

The researcher noted the facts and insights from these collaborations by keeping a work log and four diaries in English and partly Turkish. Note taking took place before, during and after an event, related to industry-university collaboration projects. Content analysis was applied to the diary contents to find answers to research questions.

The diaries contained information about:

- Date
- Project timescale
- Meeting information
- Stakeholders involved
- The tasks and their subtasks
- Impressions/notes about students’ research and ideas
- Students’ questions and needs of information
- The product development team’s expectations from student projects
- Academicians’ expectations from the project
- Challenges faced
- Sketches/frameworks developed during the projects
3 Results

3.1 Collaborations to Support the Product Development Process

Describing the company’s product development process is a necessary step in explaining the expectations from the academic collaborations. By being involved in the company’s two product development cases, the researcher observed the company’s product development approach for the BoP to have five steps: i. strategy development, ii. scouting, iii. ideation, iv. prototyping, and v. production (Figure 2). These phases showed non-linear and iterative characteristics.

![Figure 2. The observed product development processes](image)

The company carried out several product development and collaboration projects simultaneously to build the know-how about the problem domain. Industry-university collaborations took place to accompany these projects depending on the project strategy and the needs of the departments. The collaborative projects targeting the BoP communities, primarily informed scouting and ideation phases of diverse product development projects. The following table presents how product development process phases were shaped during the collaborations.

<table>
<thead>
<tr>
<th>Phases</th>
<th>BoP product development processes</th>
<th>Industry-university collaboration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategy development</td>
<td>Planning and decision-making about the project and its management.</td>
<td>Taking action to collaborate with an academic partner on the BoP theme, which would inform the product development practices.</td>
</tr>
<tr>
<td>Scouting</td>
<td>Scouting information about user accounts to inform market segmentation and value proposition.</td>
<td>Collecting/validating insights about user characteristics (people’s needs, problems, ways of living and daily behaviours) through student projects.</td>
</tr>
<tr>
<td>Ideation</td>
<td>Generating the pool of product concepts through internal and external collaborations.</td>
<td>Gathering the pool of innovative student ideas and acquiring the ideas that pass the strategic assessment.</td>
</tr>
<tr>
<td>Prototyping</td>
<td>Prototyping the product concepts and evaluating them based on their performance and other criteria with strategic importance.</td>
<td>Preparing the product for mass manufacturing.</td>
</tr>
</tbody>
</table>

3.2 The Stakeholders and Their Role in the Collaborations

The observation of the collaborative process revealed information about the departments and contributing stakeholders. The stakeholders in the company were identified as the problem owner, mediator and other departments, along with the manager/the project leader, African experts, engineers, and the user-experience researcher (Figure 3).

- The mediator department was in charge of the university collaborations, did planning and mediation of the university collaborations. The department formulated the company’s needs by communicating with other departments, turned them into substantial projects and found partners to collaborate internally or externally.
- Problem owner department wanted to carry out university collaboration on a specific theme and contacted the mediator department for this purpose in Case 2. Mediator department was also a problem owner in cases 1, 3 and 4.
- Being affiliated to the mediator department, the manager (project leader in cases 1 and 2) made decisions about the collaboration’s initiation, project confidentiality, and themes. They ensured the collaboration was effective, and when needed, they communicated with internal stakeholders for sharing technical knowledge with academic partners.
- Experts and engineers contributed to the collaborations by sharing technical or user-related knowledge. They also took part in the assessment of student ideas.
- The user experience researcher, being a Ph.D. researcher in the same academic domain at METU, mediated communication between the company and the university and supported the user-centred research process of
Learning through Industry-University Collaboration: Observation of Product Innovation Cases Targeting Low-income Communities

students with the knowledge of the BoP communities in Africa. Besides, she coached industrial stakeholder for mindset development in human-centred and industrial design approaches.

Meanwhile, three stakeholders were identified in the university setting:

- Academicians were the decision-makers about the project topics, the project profile (e.g., studio year and studio team), period, and students’ rights. Additionally, academicians guided students’ idea development.
- Students worked on an industrial design problem for academic achievement in an academic time span and context.
- University official body (e.g., METU TTO) examined the confidentiality agreements of the company and managed the application process of intellectual property rights by following the official requirements and regulations.

**COMPANY**

- Dept. B (Problem Owner)
- Dept. C (Experts)
- Dept. D (PR)

**UNIVERSITY**

- Dept. A (Problem Owner or Mediator)
- Project Team
- Manager / Project Leader
- UX Rar.

**Academicians**

**Students**

**University Official Body** (e.g., TTO)

**Figure 3. The stakeholders of the collaboration projects**

### 3.3 The Flow of Operations During Collaborations

The collaborations’ operational flow was observed to involve five steps: i. the planning and project initiation, ii. students’ user research and need formulation, iii. pre-jury assessments, iv. final jury assessments, and v. prototyping of the acquired ideas (Figure 4).

**Figure 4. Company’s flow of operations regarding the collaboration phases.**

The collaborations were aimed to carry out with academic partners having a long-standing background of industry-university collaborations (Evyapan et al., 2006; Şatır & Leblebici-Başar, 2008; Börekçi & Korkut, 2017). With this intention, the industrial partner contacted two academic partners. Several meetings took place in the planning step in order to set the expectations from the projects appropriately. This step had crucial importance in transparent communication of the project objectives and the resources regarding the duration, labour, confidentiality, intellectual property rights, student mentoring capacity of the industrial partner and sharable technical knowledge. Meanwhile, the industrial partner suggested a number of project themes to the academic partners. The academic partners decided on the project profile considering the academic objectives and characteristics of the project. As the objectives of each studio (e.g., junior, senior studios) differed in terms of gaining students a set of skills, the match between
these skills and the project objectives were emphasized by academic partners. The difficulty of the project theme was another consideration in formulating the project profile.

The collaborations were aimed to start once the project’s objectives were communicated, the project profile was decided upon, and confidentiality and intellectual property rights procedures were resolved. The following table shows the stakeholders and their objectives, which needed to be communicated during this step.

**Table 3. Objectives of the stakeholders**

<table>
<thead>
<tr>
<th>Stakeholders</th>
<th>Industrial Stakeholder</th>
<th>University</th>
<th>African BoP communities</th>
</tr>
</thead>
</table>
| Objectives of the Industrial Stakeholder | 1. Increase revenue through market growth  
2. Increase innovation power                                                                 | 1. Build a long-term research and development network with over-achiever universities in Turkey  
2. Acquire ideas and expand the idea pool  
3. Scout creative ways of thinking and doing                                                                 | 1. Develop products that will address the needs of the BoP communities  
2. Increase African people’s familiarity with the brand  
3. Create and sustain the business with Africa                                                                 |
| Objectives of the University  | 1. Carry out collaborations with a global company  
2. Empower students through commercialization of ideas  
3. Develop a long-term research agenda with the industrial partner, and publish academic research | 1. Gain students the designer skills by carrying out a studio project about a valid design topic  
2. Increase the number of patents and utility models  
3. Enable students to participate in the design competitions                                                                 | Contribute to the solution of the global and social problems                                                                 |
| Needs of the African BoP communities | Buy affordable and durable products that perform well in the context of Africa | -                                                                 | Increase their families’ life quality                                                                 |

Despite being involved in a wide range of industry-university collaborations in the domains of engineering, the members of the mediator department had carried out neither industrial design collaborations nor collaborations for low-income communities, before. Having a background in industrial engineering and specialization in industrial design, the UX researcher was asked to mediate the communication between the industrial and academic partners on the grounds of t-shaped expertise (Brown, 2005). The UX researcher aimed to ensure common grounds for communication by taking part in project formulation, writing design briefs, and sensitizing the industrial and academic stakeholders for each other’s expectations (Figure 5).

During the planning of the collaborations, the academic partners raised their concerns regarding the lack of direct contact with the user group, which might impact students’ research and empathy processes. To this, the industrial partner informed students about the problem domain. In cases 1 and 2, the UX researcher and the project leader made a presentation about Africa and shared their holistic understanding obtained through field observation, expert opinions, and research (Table 4; Figure 6). Following this, African employees carried out half-a-day workshops to mentor students about human-centred approaches and product concepts’ perceived usability. For cases 3 and 4, the UX researcher mentored students to build empathy with African people throughout the semester by weekly meetings. Moreover, the students were invited to the industrial partner’s office for sharing non-confidential knowledge.

**Table 4. The components of the holistic knowledge shared by the industrial partner**

<table>
<thead>
<tr>
<th>Research Type</th>
<th>Information Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field Observation</td>
<td>The insights of employees who have visited Africa</td>
</tr>
<tr>
<td>Expert Opinions</td>
<td>The insights by African employees</td>
</tr>
<tr>
<td>Market Research</td>
<td>Key non-confidential insights from the market research</td>
</tr>
<tr>
<td>Academic Research</td>
<td>Scientific knowledge about people, needs and behaviours</td>
</tr>
<tr>
<td>Secondary Research</td>
<td>The information obtained from secondary resources such as google search, blogs, and video channels</td>
</tr>
</tbody>
</table>

In all cases, students were mentored for their ideas’ technical feasibility by the department manager and the engineers from various departments. The mentoring began in parallel to the preliminary design research and problem identification and continued as the product concepts emerged and were revised. The number of engineers from contributing departments varied depending on the project theme and the necessities of the collaboration. For instance, Case 1, having a broader theme of increasing quality of life of the BoP communities, resulted in a wide range of design suggestions that needed to be mentored and evaluated by engineers from various backgrounds and departments. Conversely, during Case 2, technical feasibility was evaluated mainly by mechanical engineers.
During assessments, academic studies pointing at the product development considerations for the BoP context were reviewed (Van Boeijen et al., 2013, p. 37; Castillo et al., 2014; Whitehead et al., 2014) (Figure 6, the rightmost picture). However, the considerations were not appropriately utilized due to the industrial partner’s prioritization differences. The emphasis was on the technical feasibility, and the overall assessment approach was grounded on expert opinions primarily for the concepts:

- technical feasibility,
- patentability,
- innovativeness,
- manufacturability,
- durability,
- efficiency,
- perceived human-centeredness and usability,
- context fit,
- aesthetical appeal and novelty,
- projected manufacturing costs, and
- projected product price.

A group of employees including the department manager/the project leader, the UX researcher, engineers from other departments and African experts (only in cases 1 and 2) assessed student ideas for acquisition potential. In Case 2, the final jury took place with the participation of an international group of employees, whereas in the other cases, department manager/project leader and the UX researcher participated in the juries, and the assessment by engineers continued from preliminary to final juries. The project’s confidentiality was a significant concern during cases 3 and 4; the decision of the acquisition had to be given before the final jury since the projects became public.

The final step was the decision of acquisition. In cases 1 and 2, the product concepts, which passed the strategic assessment of the company, were acquired by the industrial partner with the purpose of incorporating them into the company’s product development agenda for Africa. After the acquisition, the products were prototyped and assessed for effectiveness. All product concepts needed either technical improvements or further research and development before preparing them for mass manufacturing.
3.4 The Objectives of the Industrial Stakeholder

Three objectives were identified during the observation of the collaboration practices. They are elaborated in the following sections.

3.4.1 The Long-Term Relationship with Universities for Building a Learning Network

Forming a network is a vital action in embracing complex problems. In the observed state, the primary goal was to build a learning network that would shape the company’s long-term value chain.

The network involves three nodes, each of them being the stakeholders of the industry-university collaboration: i. the company, ii. university and iii. African BoP communities (Figure 7). The objectives of each stakeholder determine the expectations from the collaboration. The sustainability of the network is achieved through the fulfilment of these objectives. The learning for designing for the BoP strengthens the network sustainability.

![Figure 7. Industry-university collaboration forms the network](image)

This long-term network was an opportunity to become familiar with the curriculum so that the expectations from future employees would be appropriately set, and employees’ skill sets could be defined accurately. In addition to this, the organization gained knowledge about academic institutions’ fields of expertise, the academics working in the domains carrying strategical importance for the company, and identified potential employees among bachelor’s, master’s and doctorate students. For instance, a 3rd year design student, whose idea was acquired by the company during Case 1, was later on employed by the company as a project student.

3.4.2 Industry-University Collaboration as a Source of Creativity and Ideation

The organization approached the student projects as a source of creativity and ideation for innovation. The researcher observed that the industrial partner associated creativity with out-of-the-box thinking and designerly skills. These keywords were frequently mentioned by the department manager during cases 3 and 4. On a closer examination, these qualities happened to be in relation with students’ human-centred thinking, the concepts’ aesthetical appeal, and forms’ simplicity.

The industrial partner prioritized students’ out-of-the-box-thinking concerning the way users’ needs, behaviours, and real context were translated holistically into the product design. In addition to human-centeredness, the industrial partner paid attention to students’ unique approaches to products’ working principles. The students were mentored...
Learning through Industry-University Collaboration: Observation of Product Innovation Cases Targeting Low-income Communities

to avoid a technology-driven mindset and to adopt a back-to-basics approach due to resource-constraints of Africa. This resulted in students’ exploration of the alternative energy generation principles and incorporating them into their designs. This was the most evident in Case 2.

Moreover, designerly skills were characterized by the visual simplicity and the appeal of form, colour, and/or material. For example, in Case 3, the student embedded traditional patterns into his design, which was appreciated by the mentors (Figure 8).

![Figure 8. Traditional patterns applied onto the product part’s surface, adopted from METU Department of Industrial Design (2017, p. 811)](image)

3.4.3 Industry-University Collaboration as a Source of Inspiration and Scouting

The organization prioritized not only product development skills but also students’ ways of approaching the problem area. Students’ skills to deal with problem complexity were paid attention to, given that students were unfamiliar with designing low-cost and off-grid products for distant cultures and the BoP context had resource-constraints. Case 1 provided diversity in terms of inspiration. Respectively, students’ secondary research skills were paid attention to since the understanding about African culture was determined by it and the insights from this stage informed problem identification and conceptual designs.

During the preliminary jury of Case 1, a student presented an organic material-based water filtering technology as the foundation of her product concept. She mentioned that she had reached this filtering method through an academic literature review. Although the product concept raised concerns about usability, the way the student approached the problem context was appreciated.

3.5 The Barriers in the Realization of Student Projects

Realization potential of student ideas is comparatively low once the number of product concepts are taken into consideration. The researcher observes three aspects that cause barriers to the realization of ideas.

3.5.1 Cultural Differences

The access to information about the BoP communities was a challenge given that students’ only tool for data collection was secondary research and not observation. Furthermore, the quality and accuracy of the information gained from secondary research were questionable. To overcome this, the industrial partner supported students with non-confidential information obtained through various research channels (See Table 4). Nevertheless, students’ cultural differences were observed to influence their approach to concept development. This caused a barrier in products’ fit into the BoP context, such as replacing the practice of carrying on the head with backpacks in several student projects.

3.5.2 Confidentiality Concerns and Intellectual Property Rights (IPR)

Knowing that the objectives of the industrial partner were to develop affordable products for Africa, the industry-university collaborations were carried out to inform the scouting and ideation practices of the company. Student projects which would pass the company’s strategic evaluations in the long-run were to be mass-manufactured. Therefore, student projects’ patentability gained increasing importance through the course of collaborations. The expectation of patentability resulted in keeping project topics and progress confidential until the industrial partner communicated their decision about which student projects would be acquired. Meanwhile, the industrial partner researched the conceptual products’ patentability and innovativeness, however, collaboration durations were a barrier in achieving a complete review.
3.5.3 The Difficulty of the Assessment

Student projects were assessed by the industrial partner’s stakeholders, mainly engineers, regarding projects’ acquisition potential. The UX researcher sensitized the assessors with industrial design approaches, student presentations, and different levels of detail and concept quality across the cases. Nevertheless, the challenges that emerged during the experts’ assessments were observed as:

- Projects being grounded on the principles in which feasibility assessment may require long-term research and development projects (Case 1).
- Concepts not necessarily being human-centred, however, having usability as the main concern with improved parts or additions, which contradicts with the low-cost strategy of the company (cases 1 and 2).
- Limited diversity among student projects due to constraints in the off-grid working principle (Case 2).
- The difficulty of product value assessment for patentable and non-patentable qualities (cases 3 and 4).

3.6 The Enablers of the Realization of Student Projects

Based on the insights gained from the observation of the processes, the following directions are suggested to improve the industry-university collaboration practices for the BoP.

3.6.1 Appropriate and Timely Feedback

During observation of the cases, feedback was identified as an enabler of the learning process regarding better communication between collaboration partners and effective project outcomes. Appropriate, timely feedbacks can contribute significantly to the learning process of students. In this, feedbacks provided by the mentors (department manager/project leader, UX researcher), engineers, and experts play an important role.

The feedback between the project team and academicians is also as valuable as the former on the grounds of ensuring the objectives. By this means, the industrial partner learned about collaborating with industrial design departments. On the other end, the academic partners learned about the objectives of the company and embraced a complex design problem.

3.6.2 Creative Sessions Facilitated by the Problem Owners

Collaborative design practices provide opportunities to overcome cultural differences and align the expectations of stakeholders. For example, the involvement of the African experts in students’ critique sessions during cases 1 and 2, was observed to create a positive impact about building empathy with African context. Besides, it gave a chance to convey the message about the industrial partner’s objectives more effectively. Therefore, facilitation of creative sessions by the problem owners is believed to empower students’ skills related to the understanding of the African people.

Additionally, by creative sessions, students can be empowered for their out-of-the-box thinking skills. The researcher observed that most of the students’ user research was followed by the review of do-it-yourself solutions and start-up products targeting Africa. This was limiting students’ ways of thinking into a narrower solution space. On the other hand, in order to empower creativity, problem-solving skills can be facilitated before conceptual product development. For this purpose, students can be introduced functional problems and parameters which they could creatively embrace. The back-to-basics thinking can be encouraged through stimulation of creativity, especially regarding the working principles. To make it happen, creative problem-solving techniques can be reviewed, and toolkits for functional analysis can be designed.

3.6.3 Business Mindset

Business development is an integral part of product development. Moreover, the complexity of the BoP problem context makes it crucial to embrace product concept and business model development simultaneously based on human-centred insights. The business mindset was observed to be the missing element of industry-university collaborations for the BoP. Knowing that designers are increasingly taking part in business development with their designerly ways of thinking, further collaborations can be formulated to include business development perspectives.

3.6.4 Interdisciplinary Project and Team Formulation

Interdisciplinary team formulations may ease reaching the objectives on the grounds of increasing creativity and inspiration potential and making the project assessment convenient for the industrial partner’s stakeholders. Formulating industry-university collaborations as projects, to which students from different backgrounds contribute, may benefit collaborations regarding facilitation of multiple points of view. With the participation of students from the fields of industrial design, mechanical engineering, and business management, the project outcomes would be
more applicable. Moreover, giving place to students from fundamental sciences (e.g., physics) and materials engineering, the project outcomes would yield out-of-the-box perspectives and working principles. Availability of social sciences students (e.g., sociology) would provide opportunities to gain awareness about cultural differences and give meaning to distant geographies’ cultural patterns. Therefore, rather than seeing design as a complementary creative process of engineering, approaching it as a team effort would yield impactful results.

4 Conclusion

Designing for the BoP constitutes the majority of product development practices due to challenges in designing with the BoP communities. Among those practices, university collaborations require a significant amount of effort. The collaborations give novice designers (students) an opportunity to contribute to one of the world’s most complex problems with their designerly ways of thinking. On the other hand, the realization of student projects remains a challenge.

This research provided insights on four industry-university collaborations in the context of product development for the BoP communities. Through the examination of the diaries regarding the notes taken during the long-term complete participant observation of the industrial partner’s product development and collaboration process, and by applying content analysis to them, this research presented the objectives, barriers, and enablers of the collaboration projects. The observed cases represented the first industrial design collaborations of the industrial partner’s mediator department and its project team. They took place as part of the BoP learning process to inform the industrial partner’s scouting and ideation process.

The collaborations formed a learning network between the industrial partner, academic partners, and African people. Meanwhile, the flow of operations became touch-points of collaboration stakeholders, which would impact the sustainability of the network once the objectives were communicated clearly during these touch-points. Through these, the industrial partner learned about how to set the expectations from industry-university collaborations with industrial design departments and gained familiarity with differently formulated design practices, such as studio project and graduation project, project scope and theme, and industrial design approaches and visual presentations. Collaborations provided a channel of creativity, which contributed to the ideation practices of the industrial partner. Besides, the collaborations gave an opportunity to inspire the way the industrial partner’s stakeholders approach the BoP context. Whereas, academic partners gained familiarity with the practices of the industrial partner and students gained skills by embracing a complex design problem.

Observation of the collaborations revealed that the barriers in making this happen were the cultural differences, which impacted students’ concept development. Besides, the emphasis on finding innovative working principles influenced the assessment processes due to research and development requirements. Additionally, low-cost and off-grid product concept development was a challenge due to its limiting effects on the solution space. Moreover, the assessment of a project’s value was recognized to be a difficult aspect. Finally, confidentiality, due to student projects’ patentability through the collaborations was also revealed as a challenging issue.

The barriers could be overcome by formulating the student projects diversely and providing students with timely and appropriate feedback. In this, facilitation of creative sessions where the focus is more on problem-solving rather than product development, inter-disciplinary mindsets which extend the solution space, and concept development together with a business mindset, are necessary.

5 Limitations and Further Research

The study aims to fill the gap in the body of knowledge regarding the industry-university collaborations for the BoP context. Although this research is limited to the observation of the collaborative practices of one company due to operational complexity of observing multiple companies at once, it forms a valuable source to discuss the dimensions of collaborative practices for the BoP problem context. Nevertheless, the duration of the observation and the number of cases observed based on their differences in practice, enrich the outcomes of the research. Further research could be carried out with multiple companies working on product development for the BoP.

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Facing a Phytosanitary Emergency through Transdisciplinary Approach of Systemic Design

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Abstract: Nowadays the designer is called to face increasingly complex problems and multi-faceted challenges of great importance. This factor leads designers to redefine the boundaries of their profession through interaction with other scientific and humanistic disciplines, in order to integrate a holistic view of reality and achieve higher degree of results completeness. A transdisciplinary approach and the dissemination of research outside academia become important aspects of this new professional perspective, which encourages the designer to investigate new areas of research and collaborate on several levels with specialised stakeholders in different branches of knowledge. The purpose of this paper is to describe a concrete case of interaction between different disciplines - in the frame of Systemic Design - to eradicate the complex problem of the Olive Quick Decline Syndrome in Salento (Apulia, South of Italy). This phenomenon caused by the progressive proliferation of the pathogenic agent Xylella Fastidiosa, has compromised the environmental, economic and socio-cultural sphere of the territory and has solicited the attention of international authorities and institutions, such as the European Food Safety Authority (EFSA). The paper explains the methodology and the results of a concrete Systemic Design project applied to infected territory.

Keywords: systemic design; phitosanitary emergency; holistic approach; transdisciplinary approach; prevention strategies

1 Introduction

Although designers carry out one of the oldest professions, very few critics still today consider them beyond the general idea of a professional involved in the production of a form and function of a product/service. Instead, nowadays, the designer is asked to face problems that present an ever-increasing degree of complexity. Facing large-scale challenges - which often include social, environmental, political and economic issues - they have embraced a new perspective that involves dialogues with other disciplines. In this way, design becomes a sort of mediator agent among languages, visions and cultures. An example of this transdisciplinary operational approach is provided by a
concrete case of Systemic Design approach in the resolution of a complex and multidisciplinary challenge, such as the contrast of a phytosanitary emergency.

2 Introduction of the Case Study: The Application of Systemic Design to the Agricultural Scenario of Salento (Apulia, Italy)

This study started in August 2016 during the research developed for a Master’s Thesis project in Systemic Design at the Politecnico di Torino. The aim of the thesis was the prevention of the Olive Quick Decline Syndrome (OQDS), a disease caused by the spread of the pathogenic agent Xylella Fastidiosa which still today affects the olive trees in Apulia, a region of Southern Italy. The challenge was to tackle an agro-scientific topic using the methodology of systemic design research for a better reading of complexity. First, we addressed an environmental, economic, historical-cultural and anthropological study analysis. From the beginning it was necessary to organise meetings and brainstorming sessions with local professional figures related to the biological and agro-scientific sector. This phase was essential to increase data collection in the subject territory. Subsequently, the emerging relationships between the collected data were traced, with the aim of creating specific graphic maps that guided the planning phase and the joint interventions in the territory.

Olive Quick Decline Syndrome in Italy

The European and Mediterranean Plant Protection Organization (EPPO) classifies Xylella Fastidiosa as a quarantine pathogen, due to its ability to kill plants. According to the Council Directive 2000/29/EC, every indication of its presence on European territory obliges the member state to adopt drastic measures of eradication and containment. This microorganism, present for the first time in Italy, is extremely widespread in America, especially in Costa Rica, where it generally infects ornamental plantations. There are several subspecies of Xylella Fastidiosa, but the one that affects the Italian olive trees is the Pauca Subspecies, responsible for the Olive Quick Decline Syndrome (EFSA Panel on Plant Health, 2016). In the case of Salento, its diffusion is strongly related to the action of the vector insect Philaenus spumarius (Almeida, Altamura, Bosco, Cavaliere, Cornara, Dongiovanni, Palmisano, Porcelli & Saponari, 2016).

The first symptom coincides with a partial yellowing of the leaves, followed by a desiccation that tends to progressively extend to all the branches of the plant, leading to complete death (Figure 1). However, to understand the gravity of this phenomenon, it was necessary to investigate the importance of olive tree cultivation at the national level: today, in Italy there are almost 250 million olive trees, of which 60 million belong to Puglia. Of the latter, 11 million belong to Salento. In 2016, there were 2 million olive trees affected by OQDS, currently those at risk are more than 10 million, only one million less than the total number of olive trees present in Salento. In 2017 the voices of the institutions were different: the European Union called for targeted eradication and new investigations, the European Food Safety Authority (EFSA) reiterated the importance of investigating the presence of concomitant factors in Xylella, while the Scientific Community, especially Pietro Perrino, Director of the Germplasm Institute of the National Research Center, in Bari (Puglia, Italy), stated that the trees had become susceptible to bacteria, due to the use of wrong agro-technics and chemical inputs aimed at increasing production. In November 2017, more than 250 phytosanitary experts met in Palma de Mallorca (Spain) to share the latest scientific developments for the contrast of Xylella Fastidiosa. It was the largest Scientific Conference in Europe on this issue, aimed at finding a coordinated international effort to stem a problem that for the first time has been defined as global.

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2 More info about the development and spread of OQSD in Apulia can be found on the official website: www.emergenzaxyylella.it

3 All documents published by the European and Mediterranean Plant Protection Organization (EPPO) on the spread of Xylella Fastidiosa in Europe can be consulted on its official website: gd.eppo.int/taxon/XYLEFA/reporting

4 Many information has been gathered through the selection, analysis and comparison of numerous national newspapers, in a period extending from August 2016 to January 2018. Being an extremely current subject, all the data related to it are updated constantly. For this reason, the data shown in this article may already be obsolete.

5 More info about the results and topics addressed in the conference on the official website of the European Food Safety Authority: www.efsa.europa.eu/en/events/event/171113
3 Olive Quick Decline Syndrome as A Wicked Problem: The Importance of Transdisciplinary Systemic Approach in Research of Design Solution

The systemic designer works to reach a clear understanding of a phenomenon, and evaluating the future repercussions at environmental, economic and socio-cultural levels. In most cases, the concerns of institutions have focused on the huge repercussions that the phenomenon has had on the local productive sector, totally neglecting the progressively developed social and cultural consequences. For this reason, an important challenge has been the attempt to make tangible the way in which a pathogen is able to damage the territory on several levels, compromising the material culture, the sense of identity of the local population, but above all representing a threat on a national scale. Moreover, a further difficulty has been the communication with a community characterized by different cultural backgrounds. In fact, the dialogue with figures belonging to the local administrative scenario has been fundamental for the dissemination of research. Likewise, interaction and comparison with other scientific and humanistic disciplines such as biology, agronomy, anthropology and sociology have been indispensable. In order to understand the actions of the designer in such a multidisciplinary context, it is good to start from an assumption: the expansion of Olive Quick Decline Syndrome in Apulia represents a complex problem, without defined limits. As such, it consists of a set of smaller but articulated issues. In this context the discipline of systemic design and that of systems theory have operated as an instrument for decoding such complexity. According to Rittel (Rittel & Webber, 1973), complex problems, defined as wicked problems, cannot be treated with a conventional approach. The case of OQDS, understood as a multi-disciplinary topic and not as a mere disease of olive trees, presents in all its aspects the typical characteristics of a wicked problem. In fact, there is no clear formulation of the phenomenon: it is difficult to trace its rigid limits, as they would be subject to continuous change and redefinition. For the same reason, it is not possible to define with certainty what are the correct actions to be taken by the designer (Jones, 2014). Moreover, being a problem with limited foreseeable consequences, as long-term visible, there is no range of reliable solutions and immediate proof of the effectiveness of the experiments to be undertaken to contain the problem. Most likely, the greatest difficulty lies in the uniqueness of this type of problem that, as in the case of Salento, places the designer, agro-technical professional and community in front of a situation of uncertainty. In this complex scenario, the systemic designer does not want to replace the role of agronomists and researchers in the agro-technical sector, but aims to collaborate with them. The purpose of this transdisciplinary approach is indeed the understanding of a complex phenomenon that is not limited to involving the agricultural context. In this way, the OQDS is dealt with in a unitary way, in its diversity, not only theoretically, but with an operational approach in which the borders between the disciplines collapse.

4 Systemic Design as a Reading Tool of Phytosanitary Phenomenon

In order to fully understand the negative effects of the Olive Quick Decline Syndrome for Apulia, a meticulous scenario analysis was carried out, using typical methodology of systemic design, therefore investigating the areas of the economy, natural, anthropological and social sciences. In fact, it is possible to define systemic design not only as a design tool, but also and above all a very effective tool for reading the complexity. Within this project, the methodology of analysis pursued has provided for three basic steps (Figure 2):

1. DATA COLLECTION
   Data collection on the territory, about its productive activities, its culture, its traditions, its geographical features, etc. This collection was made by reading texts and publications on the Salento area, but above all through repeated inspections and interviews with local professionals. Finally, between December 2016 and
February 2017 a questionnaire was administered to a sample of 110 citizens of Salento in order to understand the local opinion about the phytosanitary emergency in progress.

2. ASSESSMENT OF INTER-CONNECTIONS
After a data collection conducted by compartments, separating economic, environmental, anthropological, socio-cultural data, an evaluation of the connections between the different sectors was carried out. This has allowed a clear detection of the interdependence between all the elements that make up the territory.

3. REALIZATION OF GRAPHIC MAPS
Conscious of the identified interconnections, a graphic visualization of the present relations among the territorial elements was realized. These graphic maps have made tangible the numerous links between all the social, environmental, economic and cultural components of Apulian territorial system.

![Figure 2. Methodology adopted in the systemic analysis of the Apulian territory (by authors).](image)

Going into more detail, it was essential to evaluate the relationships among olive oil sector, Salento and Italian national territory. Olive growing has always been one of the major productive activities of the Italian agri-food scenario: in fact, Italy is the second largest producer of oil after Spain, with an annual production of 467,000 tons, 538 cultivar and 41 Denominations of Origin Protected (DOP). In Italy, Puglia is confirmed as the top producer with 1.8 million: the olive production of Salento has contributed to this record, producing about 35% of the apulian oil and 10% of the national one with about 97.000 hectares of olive groves, 65.730 olive farms, 358 olive mills and 75.000 producers⁶ (ISTAT - Istituto Nazionale di Statistica, 2010).

However, the links between olive trees and Salento do not extend only to this sector of production. They involve an extremely varied cultural scenario, characterized by rural architecture, typical dishes, tourism and more generally, by a material culture handed down by a people of olive growers and currently still strongly rooted (Figure 3). In the past, the flourishing olive-growing activity has allowed the construction of thousands of underground oil mills that can still be visited, rural buildings such as shelters, fortified farms and small chapels. Extra-virgin olive oil dominates the local cuisine made up of the products of the earth and on which the Messapian, Greek and Byzantine traditions have had a very strong influence. The union of such a strong culinary culture and the presence of these suggestive places, have allowed Salento to develop a typically rural tourism, thanks to the majestic presence of thousands of ancient olive trees. Through a systemic reading, which evaluates the relationships between the components and the properties emerging from them, it has been possible to demonstrate how all the territorial aspects to which the olive tree is linked are inter-dependent elements that cannot exist and perpetuate the one without the other.

So, what could happen if the olive trees were lost due to the spread of the Xylella pathogen?

Removing the element represented by the olive crop within the graphic maps, it was possible to verify which relationships and territorial elements of various entities could be compromised if the QOIS seriously destabilized the olive oil sector. Just think that nowadays there are more than 2 million infected olive groves. This number has allowed thousands of eradication and a massive use of chemicals that have contributed to the alteration of the habitat of native species and the reduction of 50% of production. As a consequence, there have been very strong repercussions on the economic and social system. The generation of a deep crisis in olive oil cooperatives led to the closure of 450 farms, the relocation of entrepreneurs and hundreds of layoffs. For this reason, the community of Salento has been forced to reinvent itself through new activities far from the local ones. Through the relationships drawn in the typical

⁶ The numerical data on Italian olive production have been extracted from the 6th General Agricultural Census carried out in 2010, in Italy. This census is repeated every ten years and highlights the structure of Italian agriculture, fundamental for the definition of new development policies. The next census will take place in 2020. More info on the official website: censimentoagricoltura.istat.it
representations of systemic design, it is possible to understand how an apparent small perturbation belongs to a single sector of the territorial system, in this case the agricultural one, can represent a much wider disorder. But what was the real origin of this phenomenon? Through a close comparison between systemic design and the agro-scientific disciplines, a contemporary reading was conducted, pursuing a further analysis of the agricultural system and of the inputs used in it. According to ISTAT Data, in 2008 the province of Lecce was the most polluted among the Apulian province. Through various inspections conducted by systemic designers and agro-technical experts and through the use of the same methodology previously exposed, it has been possible to trace the critical issues of the local agricultural system, to which high-impact agronomic practices have caused a general instability of the local micro ecosystem. As a consequence, not only Olive Quick Decline Syndrome has spread, but also a larger block of parasites, which in an extremely weakened agricultural system have found the ideal condition of proliferation.

Figure 3. A synthetic example of a graphic map of the Salentinian territorial system based on the culture of the olive tree. This type of maps can reach much greater levels of complexity (by authors).

5 Transdisciplinary as an Operational Approach: The Collaboration between the Systemic Designer and the Agro-Technical Professionals

In order to face this phytosanitary emergence, the actions pursued on the territory were mostly abatements and invasive attempts to eradicate the insect vector. As designers, readers of a complex scenario in which to plan a socially and environmentally sustainable solution, it was correct to carry out surveys in the most debilitated areas, interacting with local farmers, knowing their skills and their independent experimentations. Through this field research it was possible to divide these interventions into two categories. The first category includes the use of copper sulphate, iron sulphate and hydrated lime, solutions that have led to a further weakening of the plant, with temporary and weak signs of recovery. Instead, the second category has predicted completely natural practices with surprising results. Getting in contact with local farmers has allowed the creation of a network of contacts that are profitable for research purposes. In this context collaboration with local professionals, agricultural experts and biological inspectors

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7 According to the national report of the Institute for the Protection and Environmental Research (ISPRA) on the presence of pesticides in Apulian waters, between 2011 and 2012, 175 toxic substances were detected, showing a wide contamination. In fact, according to ARPA PUGLIA Data, Puglia is the fourth in Italy for pesticide use, with a threshold of 155,000 quintals of plant protection products used. The situation is equally alarming in the herbicide sector: in 2008, the same region used 2,904,419 kg of product, of which 573,465 only in the province of Lecce.
(recognized by the Ministry of Agricultural, Food and Forestry Policies) was born. Through the comparison of their knowledge, it was possible to conduct independent experiments based on the logic of systemic design, according to the principle care of nature with nature. These figures are united by a strong belief in agriculture without poisons and in practices belonging to organic and biodynamic agriculture. Highlights to be respected were the attention to the natural rhythms of vegetation and the evaluation of local resources. Therefore, through the territorial reading performed previously, it has been possible to evaluate the local resources and their medical properties, rediscovering ancient methods of care belonging to the past traditions of Salento.

The first treatment started in October 2016 and involved the use of garlic, caper and thyme. Through a collaborative study, the beneficial properties of these typical products of Salento were rediscovered, evaluating especially their bactericidal and antibiotic properties. The administration of thymus was fundamental: in fact, being an expectorant, it stimulated the passage of polyphenols inside the lymphatic vessels of plants, an action generally counteracted by the presence of Xylella Fastidiosa. Between March and August 2017, two parallel treatments were stratified: one based on propolis (coming from local beekeeping activities) to promote self-defense of plants and one based on colloidal ionized silver, a further powerful bactericide. The experimentation was conducted on 41 olive trees affected by OQDS, located in a plot of the village of Galatone (Province of Lecce, Apulia, Italy). The first treatment was administered to all specimens, while, in the case of subsequent stratification treatments, the plot of land was divided into the northern area, treated with propolis, and the south area, treated with silver. In July 2017 the experimentation was strengthened with a treatment based on hydrogen peroxide, administered by radical route to counteract the anaerobic properties of the soil. Finally, after about three months, a fourth soil polluting treatment was undertaken. It is based on zeolite, a volcanic mineral that not only enriches the soil, but also represents an excellent substrate for the activity of new beneficial microorganisms. The signs of recovery were amazing: it was possible to notice the suspension of drying, the reduction of the fall of the leaves, but above all the generation of fruit buds and new superficial shoots, which led to the development of new branches (Figure 4). Moreover, during the fruiting period, the olive fruits did not show any signs of desiccation or fall, representing perhaps the most interesting result. Beyond colloidal silver and hydrogen peroxide, which represented a strong support for experimentation, all the elements used represent resources widely present in the local territory. After about two years of cadenced natural treatments, today the plants show a wonderful self-defense capacity and a good fruiting, resisting the continuous attacks of the pathogen agent Xylella Fastidiosa. These outcomes represented the result of adopting a transdisciplinary approach in understanding and addressing a multifaceted problem such as that of the OQDS.

They demonstrate how this approach, going through different disciplines and escaping from any sectoral categorization at the same time, can lead to results of superior validity. In fact, they demonstrate not only the solution to the problem itself, but also that of the complications that revolve around it. However, this general outcome is only possible through a capillary understanding of the question taken in analysis and of all its implications. Through a transdisciplinary approach, the flexible planning capacity of systemic design not only leads to a functional and sustainable project, but also to a coordination of the efforts made by all the figures involved, mediating different

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8 Biodynamic Agriculture is a form of alternative cultivation compared to traditional agriculture. It was elaborated by the esoteric philosopher Rudolf Steiner and is considered in greater balance with the terrestrial ecosystem. It incorporates the concept of Organic Farming and is characterized by a holistic approach that considers the soil and the life that develops on it as a single system.
6 The Five Principles of Systemic Design Applied to the Protection of a Disrupted Territory

The five principles of systemic design (Bistagnino, 2011) represent the cornerstone of this transdisciplinary design process, but first of all, they were indispensable tools for the pursuit of a wide phase of research and analysis. The methodology adopted within the project phase has addressed these five elements in a very specific order (Figure 5).

Firstly, an evaluation of the relations between the components of the territorial system was pursued, assessing the importance that the cultivation of the olive tree has for Salento. These relationships are not only present in the landscape sector, but they also have very strong connections especially with the local economic system, also involving the social and cultural level. The second fundamental principle was the analysis of output and input. By evaluating the output of the local agricultural system from which the perturbation began, it was possible to trace the input. The evaluation of the output and its critical aspects was essential for the evaluation of undeclared inputs, harmful to humans and the agricultural system. For this reason, a backward path was made, supported by numerous inspections, by listening to the local small farmers, but above all by the direct vision of alarming toxic administrations on the crops. In this case, the reference output is complete unproductiveness of the olive sector, hence the origin of a disease that is difficult to eradicate. In this way, it was possible to understand that incorrect starting input are not only identified in the abuse of weed killers, pesticides, chemical fertilizers, but also in the general adoption of harmful agronomic practices. The third principle is the positioning of man at the centre of the project. If design means planning starting from the needs of the user and evaluating the inadequacies of everyday objects and services, within the systemic approach this concept is strengthened. In fact, the territory is the maximum example of product, service or strategy that man has designed and constantly modified for his own well-being (Norman, 2004). Thus, the territory becomes a tangible example of a project whose designer is not the individual, but the community that lives in it and develops through it. This project aims to reduce the social costs suffered by the population of Salento, linked to the spread of a constantly expanding disease. The systemic designer does not seek the solution to the problem in the community, but through it: listening to the voice of the wisest farmers, digging in the old local peasant traditions not written in books or on the web, welcoming different disciplinary languages through comparison with biologists, agrarian experts, anthropologists, etc. The fourth principle pursued is represented by acting locally, from the micro to the macro (Bistagnino, 2014), starting from the territory to treat and protect the territory itself. In fact, in this project it was fundamental to integrate concretely into the agricultural scenario and to collaborate fruitfully with agricultural experts who operate according to the principles of systemic design. Therefore, the importance of a transdisciplinary approach emerges: indeed, the systemic designer does not work individually but through a multi-disciplinary working group.

9In the epilogue of the book Emotional Design (2004), Donald A. Norman states that a space can be transformed into a place only by its occupants, reiterating that what a designer can do is only provide them with the necessary tools. The concept of territory and territorial development is fully reflected in this statement. In fact, every man or community of individuals manipulates his environment or territory so that it can better meet his needs.
Nowadays the comparison with figures that still operate according to ancient local agricultural traditions, respectful of the Earth and its times, is not obvious. Thus, only through this collaboration was it possible to support a territorial project based on biological experiments, which a designer cannot face and manage alone. The disciplinary contamination, collaboration, and joint research are the key to projects that require holistic and flexible solutions, with permeable limits. In this case study, with the support of local professionals, the designer evaluated the local resources and their beneficial properties. Except for the case of hydrogen peroxide and colloidal ionized silver, elements allowed in organic farming, all the elements used in the experiments carried out come from Salento. Garlic and caper are widely cultivated locally; thyme is an aromatic shrub that in Salento, as in most Mediterranean areas, develops spontaneously and in large quantities. Propolis used in subsequent treatments was also recovered from the local beekeeping sector. This research wants to communicate a very strong message that is the concrete possibility of modifying the contaminant input in natural input, in order to design a program of self-defence and prevention not only for plants but also for the health of local citizens, who are victims of persistent chronic diseases caused by an increasingly industrial agriculture. Working with propolis, garlic, thyme and caper in this area of south Italy has strengthened the existing relationships and has generated new opportunities for interaction and cooperation between local actors and production activities at risk. Finally, the fifth principle is that of self-generation, reacting to damage and perturbation through tools and resources from the territory. In the case of the Olive Quick Decline Syndrome talking about a recovery plan is not exactly accurate: in fact, having certain and lasting results takes a very long time, with the risk that everything is thwarted by further natural phenomena.

However, talking about a prevention system is certainly more correct. In this case, prevention means acting directly through the use of local natural resources and only in some cases of resources from outside, in order to defend the plants, the soil, therefore the overall environmental system, preventing the spread of harmful phenomena. Using local resources means implementing the network of relations between different productive activities of the territory, reinforcing the latter’s ability to react to the presence of a disruptive input.

![Figure 6. Hypothesis of interaction between local activities and resources. It has been elaborated through the methodology and transdisciplinary approach of Systemic Design (by authors).](image)

The hypothesis developed in this path of transdisciplinary systemic design is a broader holistic project (Figure 6): in fact, by enhancing the Mediterranean forest, where thyme and essences are useful for bees’ activity, beekeeping would strengthen considerably. Indeed, currently bees are strongly threatened by the conspicuous reduction of useful essences and the huge use of pesticides. In this way, the production of propolis would increase for the purpose of preventive treatments, and consequently the restoration of thyme honey, a typical local product almost lost, could be feasible. A greater production of propolis and wild thyme would represent the possibility of extending this prevention plan to other agricultural crops threatened by Xylella Fastidiosa, in order to have an overall strengthening of the agricultural sector. In addition, the administration of propolis as a plant phyto-protector, would promote pollination, showing an effective attractiveness to bees, so there would be benefits also for the activity from which the same propolis originates.
7 Conclusion

The purpose of this article is to present to the design community, the results of an Italian case study that has adopted a theoretical and operational transdisciplinary approach in solving an environmental problem, connecting the sphere of design, that of the agricultural sciences and finally, that of socio-anthropological sciences. The results obtained from this planning attitude, typical of systemic design, have led to the development of a systemic model of care and prevention of Olive Quick Decline Syndrome, based on local cultures to be revalued and on ancient local traditions. This model wants to become a real help for all local olive growers in difficulty due to the spread of this disease. For this reason, following the experiments carried out, the Mayor and the Municipal Administration of Leverano, one of the small towns of Salento (Puglia, Italy) invited the team of several figures involved in this research project to disseminate the results obtained to the local population. The conference was held on 7 December 2017 at Community Theatre and witnessed the speech of systemic designers, design historians, agricultural experts, agronomists and farmers. The aim of this meeting was to make open source the tested treatments, also welcoming a new and more intense comparison through the active participation of additional professionals in the agricultural field, administrators of environmental associations, farmers and local olive cooperatives. In its complexity, this project becomes testimony to the extreme potential of a transdisciplinary approach in the field of systemic design and its dissemination. In this way, the obtained design result acquires completeness and greater effectiveness. Educating in design does not just mean teaching students and researchers of this sector, but also communicating to a heterogeneous public outside the academic world, the potential of a flexible and permeable discipline, able to create mediation between languages and skills. Therefore, by becoming a testimony to the validity of the transdisciplinary approach in the project act, the case study presented in this article is intended as an incentive for a new design education, which involves a greater disciplinary contamination and a constant dialogue between different backgrounds both in the meta-design phase and in the planning phase. Only through this permeable aptitude for the project, future generations of designers will be able to respond to complex problems of a different nature which will require a shared decoding and operational effort.

Acknowledgements: Extreme gratitude is addressed to Dr. Antonio Caputo, agricultural engineer and biological inspector, through which it was possible to enter the local agricultural sector, with a more attentive and aware look. His figure was of great support during all the on-site inspections. Finally, a sincere thanks is directed to the agricultural technician Andrea Specchia and his collaborator Antonio Marzo: they have accepted to accompany us in this path with enthusiasm and passion, sharing their experiments, their ancient knowledge, their efforts, but above all their strong belief in agriculture without poisons.

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Taking the Culture out of the Lab and Into the Office: A “Non-Lab” Approach to Public Service Transformation

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Abstract: Over the years, innovation labs have come and gone in public sector organizations. At Immigration, Refugees and Citizenship Canada, one low-key, co-design project over-delivered on client insights, service experience improvements and operational efficiencies. This case study shares one department’s success in embedding human-centred design into organizational culture by: competing against graduate design students, co-designing across the organization (from call agents to policy, immigration officers, and communications), creating a design project alumni community, and adhering to rigorous measurement and experimentation. The case study will share opportunities and challenges that emerged from the process of embedding human-centred design (via a “non-innovation lab”) into the department.

Keywords: innovation; service design; culture; organizations

1 Introduction

Public sector organizations engage with citizens through their services and other offerings, and, as a result, have to consider the user in their service design, as well as build on user relationships and innovate to exceed client expectations. Governments, in response to a growing demand for innovation (be it, transformative, engaging, more efficient or responsive services) have begun to engage with human-centred design as part of a structured innovation process to rethink service delivery. Many of these approaches to user-centric design involve design research skills and specialized, multi-disciplinary teams; primarily constituted in the form of innovation labs that are heralded as means to help organizations see policy and services in a new light. While we commend this move towards greater involvement of design in helping improve user experiences and government services in general, we argue that these measures may not go far enough; to change organizations one must change the culture of how decisions are made, and policies developed. At Immigration, Refugees and Citizenship Canada (IRCC), one low-key, co-design project over-delivered on client insights, service experience improvements and operational efficiencies, building a case for creating internal capacity which led to the creation of the Client Experience Branch with an embedded design team division.

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within it. The following case study will show how this process has unfolded, and why it has proven to be effective in having deeper impacts on organizational culture change.

2 Innovation and User-Centricity in Public Sector Organizations

Governments are currently dealing with a growing demand by citizens for services that reflect their needs and put the user1 at the centre of service delivery, instead of having processes and regulation leading the system. Today we live in a world of services with a growing expectation that public services mirror the ease and individuality of private sector offerings; this pressure on government organizations to deal with growing fiscal austerity while innovating new solutions creates what Rittel and Webber have termed “wicked problems” where the planner cannot risk being wrong, and the problem description suggests one specific solution (1973, p. 166). Public sector organizations have a mandate to serve all of the public while enforcing the legislation that governs their policies and programs. While there is capacity to change programs and policies, the requirement to continue offering programs while working to improve them means public servants must “change the wheels while the vehicle is moving”; sustaining mandated services, procedures and policies adds to the challenge of innovating new approaches (OECD, 2017, p. 15-17).

Governments use policies and programs to effect positive change in the lives of citizens, yet the challenge is to see the impact that those policies ultimately have on the services that citizens encounter on the front lines. Those services are often the measure by which citizens judge their government’s effectiveness, and the challenge for policy makers, then, is to work through how policies might be received through those services (Chambers, 1983; Kershaw, Dahl & Roberts, 2016). Governments are tasked with efficiently delivering programs and services that will compare to private sector offerings, despite three key differences (Bemelmans-Videc, 1998; Kershaw et al., 2016). First, businesses can choose their customers, but government agencies must provide service access to the entire eligible population and ensure none are excluded. The second challenge lies in the fact that while businesses tend to have more centralized authority, government authority is more dispersed and that can impede the implementation of innovative services. Finally, businesses are accountable to their shareholders but public sector agencies must follow legislation and protect the privacy of citizens; public trust is a critical component of service delivery in the public sector which encourages an over-emphasis on security and non-user centred services to ensure that these duties are fulfilled (Carter and Belanger, 2005). All of these responsibilities and intricacies of public sector policy, program development, implementation and delivery make for a wicked problem, because the government, ultimately, is responsible for what it delivers. That responsibility is taken very seriously by the public servants fulfilling these mandates, making them necessarily cautious in what innovations they may put forward over time.

Over the past several years there has been a growing use of design thinking and service design methodologies to help governments with developing new, implementable solutions to policy and program challenges they are facing. These methodologies emphasize, to a greater or lesser extent, elements of co-design, where the users of the product or service work with designers through the process of developing new approaches (Sanders & Stappers, 2008). In the co-design approach, the design researcher becomes more a facilitator and the participants are “users who are experts of their experiences” (Sanders & Stappers, 2008, pp. 12-13). The key ingredient for doing co-design is creative acts of making, from probes and toolkits to help find and understand data to making prototypes to articulate solutions and issues (Sanders & Stappers, 2014). Within public sector co-design, there appear to be two dominant methods that are used: punctuated co-design projects and innovation labs.

Punctuated co-design is marked by a mix of experience-based co-design (EBCD) that often uses intermittent design workshops and toolkits to help users or organizations use design research techniques to develop new solutions.2 Dispersed approaches like those of EBCD tend to emphasize short-term connection with users and service providers during the pilot phase that gets feedback and then leads to the design teams moving off to design and then meeting up again to share the information. One key impact is that teams will often shorten the cycle to save money and time but having only small-scale changes (Donetto et al., 2014; 2015). This approach to sporadic co-creation also mirrors a standard government policy development consultative process, albeit with more evolved engagement tools.

One challenge to the EBCD approach in government is the lack of design (or innovation) capacity and expertise. A growing number of governments around the world (at the federal-level to municipal) are establishing public service innovation labs as a means to ignite change in policy and service design; examples include Nesta’s guide to innovation

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1 The user, in this case, is defined broadly to include the client, staff or allied service partners.
2 Some examples include the King’s Fun free toolkit download for health care services or the IDEO and Nesta kit for public service re-design (Donetto, Pierri, Tsianakis & Robert, 2014; Donetto, Pierri, Tsianakis & Robert, 2015; Kershaw et al., 2016).
Taking the Culture out of the Lab and Into the Office: A “Non-Lab” Approach to Public Service Transformation

labs and the UNDP accounting for innovation lab use in national governments (Bazalgette & Craig, 2017; Kershaw et al., 2016). Gryszkiewicz, Lykourentzou and Toivonen (2016) define an innovation lab as “a semi-autonomous organization that engages diverse participants – on a long-term basis – in open collaboration for the purpose of creating, elaborating and prototyping radical solutions to open-ended systemic challenges” (p. 84). Innovation hubs can be a stand-alone organization that is shared by different ministries (such as MindLab in Copenhagen) or even an independent charity (such as Nesta) that promote the use of collaborative and user-centred design focus in public sector programming (Puttick, 2014; Puttick, Baek & Colligan, 2014). These hubs typically involve bringing experienced design teams together with users and service providers to work on problem definition and solution. Innovation labs, by virtue of their semi-autonomous nature, are seen as being able to encourage users and providers to work in physical and virtual spaces to break out of homogeneous cultures that inhibit effective problem-solving and unique solution generation (Gryszkiewicz et al., 2016).

Service design problems are wicked ones because they are not just products but the interaction of service providers, users and organizations, making it difficult to anticipate how the service will be received and modified through use. Service designers must be able to scale up and out with their understanding of the broader system that services fall within as they also deepen their working with and within the organizations themselves (Sangiorgi, 2009). Working with the organization or community directly to help with the sub-phases of envisioning, experimentation and strengthening approaches helps improve stakeholder support for and understanding of risks and expectations. One example is the MyNeighbourhood project in Milan that built collaboration between students and elderly residents to develop social media and restaurant partnerships that proved successful; costs were kept low and the ability to make mistakes and recover added to the robustness of the approach (Rizzo, Deserti & Cobanli, 2016).

Bailey and Lloyd (2016) note that the potential to use design thinking to move beyond the hierarchical structure decision making could work, but only if the designers can create good ideas that can be landed in the policy sphere. We argue that this is only the first step, because just as the broader system of the organization cannot be divorced from the services it provides, the means of change for that organization cannot be separated from the core assumptions that underpin its values and behaviours. To move beyond peripheral changes, a service designer must help the organization to challenge fundamental assumptions and build a new vision, and that culture change requires a sustained working within the organization itself – to move from designing for to designing within (Junginger & Sangiorgi, 2009). One such approach has been developed in the Canadian government over the past year and a half, and is the subject case study that will illustrate this different approach of making a framework for cultural change.

3 Case Study – Building Service Design into IRCC

Immigration, Refugees and Citizenship Canada (IRCC) is responsible for the family sponsorship process which enables Canadians and residents to sponsor family members’ immigration to Canada. The spousal sponsorship is a legislated and regulated program that requires the administration of forms and documentation requirements, fees and criminal background checks as part of the application process. While intricate, this application process is necessarily thorough because the Immigration and Refugee Protection Regulations clearly specify that all family relationships must be defined and documented, that all documents must be available at the time of entry and that the application must contain particular features. Complexity surrounding the definitions and implementation of the forms, coupled with the need to provide consistent service across all forms of application (online or on paper) highlights the challenge to innovate new forms of service.

Early in 2016 IRCC undertook a short-term service design project to examine the family sponsorship experience. This Family Class Design Challenge (FCDC) was supported by designers from the Privy Council Office’s Innovation Hub (Hub) to lead the IRCC group in a human-centred design process. To deliver on the project, the department gathered 15 individuals from various touch-points through the organization (from call centre agents, to processing officers, to policy analysts, to communications), at various levels, with the goal to gain insights on the needs of clients navigating the services and organizations involved. All of the participants from IRCC were de-ranked and worked together as a group in order to encourage the free-flow of information and ideas.

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3 An example of the basic guide and its instruction is listed at http://www.cic.gc.ca/english/information/applications/guides/5525ETOC.asp
4 In particular, Divisions 1 and 2 of the regulations, listed at http://laws-lois.justice.gc.ca/eng/regulations/sor-2002-227/FullText.html
The Family Class Design Challenge was a four-week (full-time) design project for all the participants; each week devoted to particular stages of problem finding, problem framing, and problem solving. During the problem finding stage, participants worked in the field to interview newcomers, legal clinics, appeals tribunals, front-line staff and immigration community centres in action. They also conducted participant observations at call centres and at an immigration processing centre, observing staff review applications. This exposed the participants to client (e.g. newcomers), partner (e.g. community organizations), staff, and expert (e.g. legal, academic) narratives and broadened their perspectives on the issues surrounding the family sponsorship experience.

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trading Cards</td>
<td>Participants introduce themselves to the group using an icebreaker card set.</td>
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<tr>
<td>Assumptions Parking Lot</td>
<td>Design exercise that prompts individuals to write down their preconceived ideas, thoughts and feelings about a subject and then put them aside—or park them—in order to see a topic anew.</td>
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<tr>
<td>Directed Storytelling</td>
<td>Directed storytelling enables a group to gather rich stories of lived experiences from each other, using prompts and framing questions from facilitators.</td>
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<tr>
<td>Document Analysis</td>
<td>Document analysis is a qualitative research method for reviewing and/or evaluating printed and electronic documents, in this case IRCC Family Class Sponsorship materials.</td>
</tr>
<tr>
<td>Stakeholder Mapping</td>
<td>Stakeholder maps used to visually consolidate and communicate the key constituents of a complex system—in this case the spousal sponsorship application process—setting the stage for human-centred design.</td>
</tr>
<tr>
<td>ATONE Observation Technique</td>
<td>An ethnographic research technique, ATONE stands for Actors, Touch-points, Offering, Needs, Experience.</td>
</tr>
<tr>
<td>Intercept Interviews</td>
<td>Intercept interviews are opportunistic short interviews conducted in selected areas specific to the design brief. The aim is to intercept individuals before, during and after their interaction with the product, or service, in question.</td>
</tr>
<tr>
<td>Expert Interviews</td>
<td>Interviews with key information holders—in this case academics, immigration consultants and lawyers—to quickly gain key insights into content and context.</td>
</tr>
<tr>
<td>Extreme User Interviews</td>
<td>Extreme users are those on the extremes of the user spectrum. Speaking to extreme users sparks creativity by exposing researchers to outlier and emergent cases, issues and opportunities.</td>
</tr>
<tr>
<td>KJ Technique</td>
<td>A facilitated exercise in which a group lists their observations onto Post-It notes, collects them as a group, organizes them by relationship, and establishes group priorities through individual voting.</td>
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<tr>
<td>User Profiles</td>
<td>User archetypes developed from intercept interviews with clients.</td>
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<tr>
<td>User Position Map</td>
<td>Generating a map by plotting of individual clients against a 2X2 matrix with axes derived from the qualitative research.</td>
</tr>
<tr>
<td>ERAF Systems Map</td>
<td>Entities, Relationships, Attributes, Flow (ERAF): A map to clarify relationships between elements within the system.</td>
</tr>
<tr>
<td>Affinity Map</td>
<td>Thematic clustering of the Post-It notes generated from the KJ Technique.</td>
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<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Reverse Brainstorming</td>
<td>Reverse brainstorming prompts questions that first generate increased problems or criticisms (reversal techniques) rather than solutions. These problems are then further reversed to brainstorm solutions for the new problems, and in this way draw out even more creative ideas.</td>
</tr>
<tr>
<td>Design by analogy</td>
<td>Reasoning by analogy is to revisit a problem with the goal of looking for similarities between it and other already solved problems.</td>
</tr>
<tr>
<td>Design Criteria</td>
<td>Design criteria are the explicit goals that a project must achieve in order to be successful.</td>
</tr>
<tr>
<td>Design Principles</td>
<td>Written statements, generally in the form of imperatives, that serve as guidance during decision-making in the ideation phase.</td>
</tr>
<tr>
<td>Concept development</td>
<td>The purpose is not to judge the feasibility of solutions but instead to generate ideas regardless of their practicability.</td>
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<tr>
<td>Concept Matrix</td>
<td>A tool to facilitate the concept evaluation and selection process.</td>
</tr>
<tr>
<td>Prototyping and Iteration</td>
<td>Rapid prototyping of concept ideas to quickly test them with the advantage of immediate stakeholder feedback, and the ability to adapt and re-test ideas on the fly.</td>
</tr>
<tr>
<td>Storyboard</td>
<td>The visual sequence of the specific use case, or scenario, coupled with a narrative.</td>
</tr>
<tr>
<td>Scenario Development</td>
<td>Stories and context focused on identifying the what, who, how, and why behind the behaviour of the given user, or client, in a scenario, for example a spousal immigration sponsorship applicant.</td>
</tr>
<tr>
<td>Role Playing</td>
<td>The participants themselves perform a hypothetical experience of the service, program or product solution.</td>
</tr>
<tr>
<td>Live prototyping with users</td>
<td>To test the feasibility and viability of an idea, participants stress test prototype solutions with real users.</td>
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During the problem framing stage, the Hub design team worked directly with the FCDC participants to take those fieldwork experiences and analyse them to frame the problems; four major methods/visualizations were used to make sense of the data gathered: User profiles and User Position Mapping (Figure 1); Entities, Relationships, Attributes and
Flow Systems Map (Figure 2); Affinity Maps (Figure 3); and a tabulation and count of various “Client Pain Points” (Figure 4). For the problem-solving stage, the Hub designers introduced a variety of methods to elicit abductive thinking and prototyping. Over 100 ideas were generated during the ideation phase; selected ideas were prototyped and shared with current and former clients and organizations to help test their applicability and ensuring that the ideas were developed into practical concepts that could be applied. In total, during the four-week project, 25 different design methods were used (Table 1).
In addition to the Innovation Hub led (internal) team, the lead designer of the Privy Council Office’s Innovation Hub was also teaching a Masters of Design course at OCAD University and used the family class re-design as the student’s term project. The result of the FCDC was the presentation of five solutions directly to senior management; the fact that the IRCC team was competing against OCAD students who were looking at the same issue added weight to observations of similar issues, as well as encouraging the creation of the best ideas. The first “Dragon’s Den” was very successful, as all of the ideas were well-received by senior management.
Prior to the design process, a common IRCC misconception was that the length of processing time would be the biggest irritant for the client; yet it ranked as the 15th most important pain point. More important was the anxiety evoked by the process and the burden of being separated from one’s spouse. Interviews suggested that clients understood that the process could be long but appreciated communication that indicated that things were proceeding forward; this was a focus for the FCDC team during the ideation phase.

All five solutions (and more\(^5\)) were implemented to some degree at IRCC, however two notable solutions bear mentioning; the first involved creating a text messaging service that would generate a barcode that an applicant could attach to their application – this barcode could be scanned when the package was received, sending a text letting the applicant know IRCC had received it. The second solution, the “Phone Hug” changed the reception message on the phone to a more friendly tone and empowered service agents to answer case status inquiries for all spousal applications. The piloting of these two solutions provided measurable impacts on client experience and operational efficiency. The text from the mailroom solution, though it had a small rate of uptake by clients, had a very high (near 100%) client satisfaction rate. The “Phone Hug” had an operational impact within a few months of implementation, with same day call rates falling by 30%, as well as an improved client satisfaction rate, as shown by the rise in positive unsolicited messages (from 25% of all messages to over 60% of all messages).

After the FCDC there was a strong boost in morale among the participants who were now design alumni and were champions for their ideas and this approach to developing solutions for public sector services; developing a strict experimentation protocol to test piloted solutions further supported the mandate of IRCC to improve client services and efficiencies. IRCC launched the “Blueprint Employee Innovation Fund” that would put aside money for the development of any employee’s suggestions for improving service; the judges for any suggestions would not be senior management but drawn from the design alumni to make this a bottom-up approach to improving program delivery. The success of the FCDC led to the next design challenge to examine the Citizenship Grant program (CGDC); the goal was now to do the same kind of user-centred design as before, but with two new design hires (a human-centred design researcher, a graphic designer) and one contract employee (a design facilitator), constituting emerging in-house capacity within the organization. Again, the design project was four weeks in duration, drew participants from across the organization, and utilized a similar set of design methods.

Driven by rigorous measurement protocols, IRCC was able to show demonstrable outcomes in client satisfaction, operational efficiency and staff engagement towards client-centricity, and build a case for the creation of internal capacity. In January of 2017, IRCC used these results to develop in-house capacity and launch a new Client Experience Branch (CEB), providing the senior management leadership and coverage that would show that this was to be at the core of the organization’s operations. By establishing a new in-house Service Insights & Experimentation (Pier SIX\(^6\)) Division as part of CEB, IRCC provided both the dedicated staff with expertise in qualitative, quantitative and design research skills. Having dedicated staff to support the policy and program support of the organization, with outreach services that would be accessible to all within IRCC, shows both the organization’s commitment to co-design principles and the capacity to experiment and measure to quantify values of changes made. In addition to the design capacity and service policy responsibility, the CEB also houses responsibility for the Client Support Centre (e.g. the call centre), a major client channel for service delivery. Being embedded in the organization means that Pier Six can feed service policy and, in turn, have a real influence on the Government of Canada’s service policy; this firm commitment by IRCC shows that this is meant to be a real framework for culture change and innovation.

IRCC could have chosen to set up an innovation lab structure to service its organization directly; this is the approach that has been used quite successfully by organizations like MindLab in Denmark, or the Alberta Co-Lab that assists provincial departments in developing better policies.\(^7\) This IRCC Lab could have had its own separate space, separate rules of operation that allow it to maintain the separate/integrated nature that labs require to maintain design innovation and push change and innovation. It could have reported directly to the Deputy Minister\(^8\) and had broad powers to change policies and procedures in consultation with departments at IRCC that were experiencing trouble. Being able to bring in the design team to every challenge and carry out much of the work in-house would have sped up much of the solution generation and fostered perhaps more radical innovations. The challenge, however, would be

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5 Regular (non-design challenge) employees took it upon themselves to trial ideas that address client pain points that were surfaced in the presentations.

6 “Pier” is a reference to “Pier 21” a major immigration landing port for over one million Canadians over the decades, while “SIX” is the abbreviation for “Service Insights and eXperimentation”.

7 This issues are raised by Alberta CoLab here: https://medium.com/the-overlap/the-alberta-colab-story-2d409ecf747c

8 The most senior bureaucrat in the department.
how to ensure the deep culture change in the organizations beyond depending on the lab for a space to design, and take that mind set back into the everyday work of the office.

Despite the dominant trend of innovation labs in public and private sector organizations, IRCC chose to value culture change over ideas by investing in creating a dedicated unit for human-centred design and experimentation, staff it with experts in social work, anthropology, design, data science and behavioural science, and embed it within the CEB to provide the senior management leadership and coverage. IRCC established the Deputy Minister led Client Experience Committee within the Ministry to ensure that the insights gained through Pier Six and CEB’s client-centred research are continually communicated to the highest levels of the organization and can be embedded into new service policies. So, the emphasis is on culture change from the bottom up (with engaging IRCC departments and individuals directly) as well as top down with senior management briefings and discussions.

Because the Service Insights & Experimentation’s mandate is to design with employees and not merely conduct its own design research, the employees become the champions of the client and the ambassadors of the process throughout the department. In only one year, there are almost 50 design alumni and approximately ten human-centred design or experimentation experts within the organization – up from an original zero when the family class design challenge was launched. Furthermore, each design challenge project culminated in video presentations shared across the organization, and viewed by over a thousand employees.

While still in its infancy, the move towards a culture of client-centricity is gaining momentum. This is immediately noticeable by the establishment of a new Deputy Minister chaired client experience committee, and that design project “Dragon’s Dens” have become popular events at the department for staff to attend. Furthermore, design projects have adopted new layers of complexity, such as two inclusive design projects with vulnerable and at-risk newcomers, and a policy (not service) design project; this signifies a tacit approval to use human-centred design to tackle a broader range of problems within the department.

4 Discussion

The field of service design has emerged over the past two decades to address the function and form of services from the user’s perspective and better understand how people perceive and receive those services (Buchanan, 1992, p. 12-14). Service design has done a very good job of understanding how people navigate service offerings, through the use of a variety of methods from ethnographic observation and interviewing to creating journey maps and servicescapes to map out how services interconnect and where touch-points and pain points can be located (Clatworthy, 2011; Lee, 2011). The elements of service design typically touch upon the shifting of perceptions and aesthetics, touch points and sequencing of services and the relationship to the customer, often with the goal of ensuring that clients have a better experience (e.g. Parasuraman, Berry & Zeithaml, 1991; Lo, 2011).

The strength of design is its emphasis on practice and the use of iterative approaches to developing solutions; when applied to public service design through co-creation, the designer frequently works as a catalyst and facilitator to help public servants develop ideas (Camacho, 2016). By forcing word-oriented policy makers to use visualization techniques and drawing out journey maps and generating narratives of client experiences, designers can help facilitate a reframing of problems (Boer, Donovan & Burr, 2013). Co-designing can help improve the collaboration between different stakeholders and help better targeted solutions while fostering mutual understanding of challenges and approaches to problems in an organization (Siodmok, 2014). As Kershaw et al. (2016) note, most civil servants want to make a positive difference in the lives of citizens, and engaging directly with them can help them feel more connected with their roles in government as well as the people they serve.

This case study highlights the realization of these benefits of co-design – through all of the design challenges the use of methods like journey mapping and creating personas to highlight newcomer experiences served to help IRCC participants better understanding and share their insights on the deeper problems at work in some service offerings. Bringing together of experienced IRCC staff with design researchers also ensured that ideas generated were made with the deep tacit knowledge of program officers, policy makers and operations specialists who understand intimately the challenges and possibilities within IRCC; this made their solutions ones that “they can land” (Bailey & Lloyd, 2016, p. 8). By testing ideas with service providers and front-line staff, design challenge participants gained valuable feedback but also built further goodwill with those organizations that could see how seriously IRCC took their comments.
Punctuated co-design approaches do a good job of spreading the methods of design and getting people in an organization to talk more with one another; the problem is in the full execution of the methods without the sustained contact with designers and compressed time windows. As Donetto et al. (2015) saw in their review of EBCD approaches, nearly half of those who used the methods on their own omitted steps and tended to use small-scale approaches with short time windows to address immediate problems. The lack of consistent support by designers and restrictions for scope meant that many of the EBCD participants struggled to understand what co-design really meant and were hesitant to push too hard for radical changes in their organization (Donetto et al., 2014).

Innovation labs, by contrast, have the strong design researcher ability built into their teams that can work together with users to work in physical and/or virtual spaces to push problem-solving and unique solutions (Gryszkiewicz et al., 2016). The challenge for innovation labs is two-fold: first, to fully impart that design research capacity/culture shift into the organization they are assisting with, and, second, to ensure that the changes are then fully implemented and tested once the project is over. Innovation labs tend to be focused, like punctuated co-design, on developing solutions to problems; so while innovation labs can help with generating new ideas, and dispersed methods of design research can help with getting people within an organization talking more often, they can fall short of being able to change how an organization looks at, and deals with, fundamental issues underlying how they work. This does not mean, however, that all innovation labs fail to impact the culture of the organizations that they work with, for there are different forms of innovation labs with varying degrees of influence. One notable example is the Policy Lab that works closely with different departments of the UK government to help build ethnographic research and visual thinking capacity with the organizations through close co-design workshops and on-going relationships (Kimbell, 2015).

In addition to building new skills, there is also a need to support the emotional changes that are associated with organizational transformation. Engaging users in the process of change can help them both understand and accept those changes as necessary, as Gover and Duxbury (2017) found in their study of a hospital restructuring, as well as facilitate the sharing of critical fears and doubts about the process of change (Kearney & Siegman, 2013). Organizational change, then, must have both the cultural change that creates conditions that permit failure, open discussion about feelings and concerns, as well as the ability to challenge the status quo. These principles of allowing for failure, acknowledging emotions and providing tools to challenge the existing solutions are at the heart of the IRCC design challenge approach. By mixing up teams by skill sets, de-ranking the participants and pushing fieldwork with users and service providers, followed by visual research techniques and building solutions that can be tested, Service Insights & Experimentation helps civil servants to break down internal barriers and believe in change. Prototyping, in particular, serves to push a more active approach to meaning making and engaging with ideas, a safe place to play with possibilities (Sanders, 2013; Schrage, 2013). Competing against graduate students helps to push the development of new ideas but also serves as a litmus test that conceptions of the problem do have a common framing. Finally, being part of the IRCC organization means the design team must follow the same restrictions and understand the specific needs of the department, making it easier to encourage the building of not just fanciful solutions, but ones that the challenge team can land.

Because the design challenge approach requires a strong commitment by the departments and personnel involved by releasing participants from their regular duties for a full month while they engage in the design research process in constant contact with the in-house Service Insights & Experimentation design team, there is the time to really dive into the work of designing. The participants have many opportunities to try and fail at their ideas, while being supported and encouraged by their peers as well as the design team. This immersive environment allows for the freeing of participants from their old conceptions, like an innovation hub, but with a sustained engagement and true co-design of the solutions to participant and end-user identified issues. This approach, we believe, provides the start of the cultural change to the organization; the first change is in the participants themselves. At the start of a challenge, we ask that people share their thoughts and assumptions about the process: many indicate at the start that they worry that the process might be “just another make work project” that “won’t go anywhere”. Those same individuals, by the end of the challenge, end up often being the greatest champions of the process, having seen that they can identify new client pain points not previously considered by IRCC and that they can generate concrete solutions to those problems. In presenting directly to the most senior management, thus by-passing one or two levels of approvals, the participants are able to show those with the power to authorize change what change would work and why. We have also seen how senior management responds to the concepts, in sharing their observations of broader mandates that they are entrusted to fulfill – this sharing back with the design teams has fostered a new respect for the challenges being faced and the commitment of the organization to change its culture. This decouples risk aversion and allows for radical, client-centric ideation that is experienced not just by the design alumni, but by those senior executives who take part. It also serves to humanize the institution that the participants and judges serve, by sharing an understanding of challenges and fostering communal spirit of change (Douglas, 1986).
There is the further fact that the relationship between the design alumni, Service Insights & Experimentation and the rest of IRCC does not end with that presentation; it is only the start of an on-going process of sharing, testing and implementation of pilot projects. The unit has taken great pains to serve as facilitators of the work of the design alumni, insisting that the solutions are stepping stones to new ideas by the members of the organization. By providing the background knowledge, material understanding and methods for visualizing and conceptualizing information, Service Insights & Experimentation helps participants to realize their ideas. By teaching these methods and reinforcing the ability of other members of IRCC to use and conduct design research projects of their own, while being available for support (through avenues like weekly “Ask Me Anything” visitations to the unit, among others) sustains the interest and ability in using human-centred design to inform new programs and procedures.

This case study highlights many of these strengths, by developing a human-centred design process that brings participants from across the organization from different branches and different levels in the hierarchy. Indeed, the original FCDC was supported by an innovation lab, however, the creation of Pier SIX, embedded within the Client Experience Branch with its clear mandate for change, and the explicit continuation of the immersive four-week co-design approach indicate a marked break from the typical innovation lab model. The co-design approach, in particular, emphasized a building of shared culture of innovation and change, presentation of ideas to the highest authority and a commitment to on-going testing and development of solutions beyond the design challenge. By using employees within the department as the main designers within the project (with Pier SIX staff being facilitators), the co-design approach put equal weight on idea generation and culture change. Finally, having senior management leadership and coverage to engage with the broader policy and operations implications of these innovations helps to drive culture change forward through the organization.

The use of innovation and design research methods in the public sector is a growing trend, but not all interventions are created equal. Despite the dominant trend of innovation labs in public and private sector organizations, Immigration, Refugees and Citizenship Canada has chosen to value culture change over ideas. The investment of funding by IRCC to create a dedicated unit for human-centred design and experimentation allowed for the embedding of experts in social work, anthropology, design, data science and behavioural science directly within the client experience branch, with the mandate to foster ties and build an on-going co-design methodology that works with departmental employees to help them with their challenges and have them be part of the design research. While it may be tempting to see Pier SIX as the sole catalyst for change, the reality is that it is part of the vision of IRCC to build its capacity to change its organization for the better, and it is because of that organization, and the dedicated people within it, that this change has happened and continues to happen.

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Intersemiotic Translation in Intercultural Communication Design

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Abstract: In the late nineteenth century, as new technologies, social needs and commercial opportunities emerged in industrialised societies, communication design evolved in line with them. The massive development of mass media and mass communication brought on by cultural globalisation created various levels of complexity for communication design. Understanding the different kinds of translation that take place between cultures, languages and systems will improve the comprehensiveness, quality and inclusivity of communication in multicultural contexts. This in turn demands new knowledge, competencies and skills that will allow designers to create inclusive intercultural communications to serve the current societal and cultural needs of audiences. This paper reports on a traffic awareness project initiated by the UAE Traffic Department to raise public awareness of road safety. The project was intended to explore the role of designers as cultural mediators through an iterative, research-based design process. Students were invited to create culturally relevant posters to communicate intended meanings in a multicultural community. Here, the resulting process of transmuting the visual into verbal and the verbal into visual within the communication design process is examined as intersemiotic translation (Jakobson 1959), an interactive process that creates connections between different cultures and media in visual communication. This paper highlights the role of such translation in mediating communication among individuals and communities of different cultures.

Keywords: communication design; intercultural communication; intersemiotic translation; multiculturalism; traffic awareness

1 Introduction

The United Arab Emirates has witnessed an increase in life-threatening traffic accidents in the last few years. In 2017, the road death index was 6.13 deaths per 100,000 people, higher than the 4.53 deaths per 100,000 people in 2016. The Ministry of the Interior annually sponsors Gulf Traffic Week as part of its traffic-accident-reduction programme. This event is used to engage local communities of citizens and residents throughout the seven emirates to raise awareness of traffic safety. The Sharjah Traffic Department (STD) has put a number of traffic safety initiatives into effect and has adopted a unique approach to involving the public in promoting traffic awareness. The purpose of these initiatives is to spread correct traffic culture, establish proper traffic behaviour, establish a unified community culture covering various aspects of traffic safety and serve the vision of police leaders of achieving the objectives set by the local and regional authorities.
One of the community engagement initiatives of the STD involved collaboration with educational institutions to engage students as active participants in society. Graphic design and multimedia students were invited to collaborate on integrated awareness campaigns planned by members of society who experience traffic issues on a daily basis. This promoted the campaigns’ success through realistic, culturally relevant communication. Then, the outcome of the collaboration was taken to the public through various channels.

This initiative was developed in response to current discussions in the academic and research fields of communication design in relation to designers’ social and cultural responsibility and their role in creating inclusive visual communication for multicultural audiences by effectively constructing meaning in verbal and visual systems.

This was the origin of the traffic awareness project *Your Life is a Trust*, which introduced intercultural communication to third-year university design students. This was done in a real-life integrated design project intended to raise awareness of road safety, a global issue, in a multicultural society. The project was initiated by the Sharjah Police in Sharjah, United Arab Emirates, who gave the project little specifications apart from the stipulation that it be accessible to a wide range of users and exhibit cultural sensitivity towards the societal context where its communication is mainly aimed at. The pedagogical purpose of the project was to explore the role of communication designers as cultural mediators, highlighting the importance of translation and construction of meaning in informing, warning and persuading individuals within the context of contemporary design thinking.

Students had been introduced to semiotics, communication theory and the application of these in communication design, with a specific reference to socio-culturally aware campaigns designed in response to various global issues (e.g. global warming, natural disasters or charity fundraising). Learners had already been trained earlier on typography, image-making and their uses in print and digital media. The main task was to illustrate the slogan *Your Life is a Trust, Hayatak amanah* in Arabic, into an intercultural design object that can communicate with the diverse demography of the UAE.

The participants were a group of 24 students, divided into six teams; the final products of each team were presented orally in class to their peers, the instructor and representatives of the STD. The primary products of the project were posters and short videos, in addition to various applications that could serve the purposes of the campaign, related to the vision of the different teams. This paper focuses on intersemiotic translation within poster design as a method of facilitating intercultural communication regarding a global phenomenon. The discussion of the design of the videos and other artefacts requires a perspective that is beyond the scope of this paper.

### 1.1 Students’ Demographic Details

The 24 students who participated in the project belong to 10 nationalities (Figure 1). Two of the students were Emirati and eight were UAE residents (of these, five were of Arabic nationalities and three were not Arabic). The whole class was fluent in spoken and written English, and 21 students were native Arabic speakers. All the students had been residents of the UAE for more than five years. The diversity and local knowledge of the groups inspired the context and content of the projects, which were intended to communicate on a local level.

![Figure 1. Demographic details](image)
1.2 The Process

Each design team had four students with different backgrounds, skills and knowledge. Each was required to plan, design and execute an integrated awareness campaign, following an iterative process of research, synthesis and execution. Students were briefed at the beginning of each phase, that to move to the following step, they needed to accomplish specific tasks within a certain identified timeframe. The tasks were managed and distributed among team members in accordance with each team’s own plan.

2 Communication Design, Culture and Translation

The emergence of multiculturalism and the commonality of interactions with new cultural values that have been brought to us by globalisation have two central phenomena: “the loss of traditional meanings and the creation of new symbolic expressions” (Steger, 2003, p. 75). Cultural globalisation causes cultural multiplicity in the place of a previous homogeneity among cultural values and beliefs. Some cultural flows cause changes to important aspects of society, changing “traditional manifestations of national identity in the direction of a popular culture characterised by sameness; in others, they might foster new expressions of cultural particularism” (Steger, 2003, p. 76).

The growth of cross-cultural contact and the increasing dominance of global forms of communication have led to problems of intercultural communication. A central part of cultural globalisation is the spread of foreign languages, both nationally and internationally. Steger (2003, p. 82) explains this as follows:

One direct method of measuring and evaluating cultural changes brought about by globalisation is to study the shifting global patterns of language use. The globalisation of languages can be viewed as a process by which some languages are increasingly used in international communication while others lose their prominence and even disappear for lack of speakers.

The deployment of bilingualism is a defining characteristic of contemporary society all over the globe as a means of creating communications that are accessible to a wider range of users. Meaning is produced, shared and exchanged through language. Meaning is shared through common access to a given language. Consequently, language is “central to meaning and culture and has always been regarded as the key repository of cultural values and meanings” (Hall, 1997, p. 1). Language forms a part of the practice of communication design because it is represented to users through typographic conventions that communicate to users who may or may not belong to a given culture. These communications can include verbal and visual systems of representation. Language and visual images are major forms of symbolic expression, and they have a special significance in the sphere of culture (Steger, 2003, p. 69).

Culture is a “signifying system through which... a social order is communicated, reproduced, experienced and explored” (Williams, 1980, p. 13). This means that every culture has its own systems of signs constituted from linguistic and visual signs, in which its members communicate. To understand a culture, its sign systems should be learned and understood, which is a process of translation. Torop (2002, p. 593) explained this as follows:

The translational capacity of culture is an important criterion of culture’s specificity. Culture operates largely through translational activity, since only by the inclusion of new texts into culture can the culture undergo innovation as well as perceive its specificity.

This brings to light the relationships among communication, culture and translation as they came into play in the context of the practice of communication design. This relationship is manifested in the processes of production and exchange of meaning that occur within the creation of communication design. Graphic forms (including typefaces and images) are expressions of cultural values and habits that may refer to different places and time periods. These are means of communication and of social production (Williams, 1980). Fiske (1990) concludes that the study of culture must be integrated with the study of communication, a consideration that emphasises the role of intercultural translation in contemporary communication design.

Translation is considered to be linguistic interpretation that transports meaning from one language to another. Jakobson (1959) distinguishes three means of interpreting verbal signs:

1. Intralingual translation, or the interpretation of certain verbal signs by other verbal signs of the same language;
2. Interlingual translation, or the interpretation of verbal signs by verbal signs of another language; and
3. Interaemic translation, or the interpretation of verbal signs by nonverbal signs of another sign system.
In this paper, we focus on intersemiotic translation, the most relevant category of these to the practice of communication design, as it includes transmutation of meaning between sign systems, with the verbal referring to the visual and the visual referring to the verbal. Kress and van Leeuwen (2006, p. 39) explained:

This incessant process of translation, or transcoding–transduction–between a range of semiotic modes represents, we suggest, a better, more adequate understanding of representation and communication. [...].

Intersemiotic translation involves translation with different semiotic resources, including visual images (e.g. illustration, photography and film) and typography (monolingual or bilingual); it works as a basis for intercultural communication. Furthermore, it implies multimodality as a key characteristic of contemporary communication design, as it uses “several semiotic modes in the design of a semiotic product or event” (Kress & van Leeuwen 2001, p. 20). Multimodality assumes that semiotic resources are socially constructed and convey socially and culturally specific meanings, which centre the choice of resources in communication and meaning making. In this way, the ideas of meaning, interpretation and translation are linked, making culture a mechanism of translation (Torop, 2002, p. 598).

O’Halloran, Tan and Wignell note another aspect of intersemiotic translation: “in the same text meanings encoded by one semiotic resource are often re-encoded, or resemiotised, through another semiotic resource” (2016, p. 203). This means that a photograph can be re-encoded as a narrative or that information can be reconstructed into an illustration; both of these are common occurrences in the practice of communication design.

The design process of intercultural communication used in the design of awareness campaigns encompasses various semiotic resources obtained from multiple sign systems. This imposes the necessity of levels of translation: first, there must be intersemiotic translation from design brief into visual message; second, intersemiotic translation must occur from linguistic to visual message; and third, inter-lingual translation takes place between two linguistic messages where multiple languages are used.

3 The Pedagogical Project

Designing public graphic communications for multicultural users and creating intercultural communication requires designers to operate as cultural mediators. This results in their taking on the responsibility for the context and content of an intended message and the effectiveness of the communication. Where visual messages are being created, the designer/author, determines how the message can be interpreted. “The designer, as a form-giver or channel through which the message is passed, can play a key role in actually shaping the content of the message” (Bestley & Noble 2005, p. 64). Designers are able to determine the potential meanings and interpretations at an early stage of the process because communication through design includes encoding and decoding explicit and implicit meanings within visual forms.

Visual forms (including images and typography) are culturally specific, which opens the door to multiple interpretations of any given visual object, depending on the context where the communication is occurring. This implies that designers should set out to create visual messages that can guide their viewers towards a desired interpretation. Bestley and Noble discussed this as follows: “by understanding how the message might be received by a range of different readers, the designer can try to avoid unintentional ambiguities” (2005, p. 68). The communication model of Jakobson (1960) demonstrates that the construction of meaning does not only rely on the message itself. Rather, it is derived from the context, the code and the contact (Fiske, 1990, p. 35). This understanding is at the basis of this project, where learners must translate the slogan Your Life is a Trust into culturally relevant designed messages to be interpreted and understood by a wide-ranging audience.

3.1 Research-Based Design Methodology

The traffic awareness project Your Life is a Trust was designed to introduce design students to concepts in semiotics and communication theory and to follow a systematic approach in solving design problems. Furthermore, it was intended to encourage students to explore the relationships among form, content and context as cultural translators in a real-life project. This was to emphasise “the designer’s responsibilities in a social, cultural and economic sense, the role of the designer in communicating to audiences and the construction of meaning in verbal and visual languages” (Bestley & Noble, 2005, p. 27).

The design approach was adopted from Matt Cooke’s model design methodology for use with social issues (Cooke in Bennett, 2006, p. 133), shown in Figure 2; this methodology goes through four phases: definition, divergence, transformation and convergence.
The definition phase includes the identification of the target problem(s), aims, target audience and potential visual outcomes. These were identified through discussion with the Sharjah Police Department. The design brief identified laid out the problem clearly: recent years had seen an increase in road accidents and fatalities in the UAE, and the aim was to raise awareness in communities that have diverse, multicultural population. The multicultural characteristic of the intended audience underscored the importance of intercultural communication: students needed to play the part of cultural translators.
The divergence phase includes primary, secondary and tertiary research in which learners must build a solid understanding of the context within which the project is to communicate. This phase assisted students as they determined and developed the contents of their projects. At this point, the learners must explore various aspects of traffic awareness, including the following:

1. Facts and figures concerning traffic accidents in the UAE, including causes, costs and prevention.
2. Traffic laws and pedestrian requirements.
3. The results of surveys that explore public knowledge and awareness.
4. The results of case studies of previous awareness campaigns launched on the national, regional and international levels.

The gathering of information related to traffic awareness enabled teams to identify the contents of their campaigns and helped them communicate how their intended messages could be communicated, using the findings of research. Reviewing similar projects can help learners analyse visual languages that would be suitable to the project’s context and audience.

In the transformation phase, functional visual solutions are explored through visual experiments to find those that could suit the context of the project. Here choices of images and typography, colours and campaign specifications are made. The stage of transformation starts with conceptualisation and the development of ideas, ending with design synthesis.

Finally, in convergence, the conclusion of the results articulated in the previous stages appears; in our case, this moment led directly to the production of the prototypes of the final designs. The learners gathered their feedback from their peers, instructors and the STD at this point.

### 3.2 The Outcome

As planned, six teams worked on their projects through the above-mentioned phases. After completing the requirements of the definition and divergence phases, the students began the process of translation, which took place largely in the transformation phase. The identification of the art direction of the project required extensive visual research so that the most appropriate visual forms were created to raise traffic awareness for an Arab/multicultural community. The students performed the following iterative steps to produce their final products:

1. Identification of message content, including facts, causes, consequences and prevention.
2. Identification of message type, such as informative, warning, identifiable or persuasive.
3. Identification of the visual form of the message, which may be photography, illustration, typography based or mixed forms.
4. Identification of message languages, namely, Arabic, English or bilingual.

Table 1 summarises the teams’ decisions.

<table>
<thead>
<tr>
<th>Team</th>
<th>Message Content</th>
<th>Message Type</th>
<th>Visual Form</th>
<th>Language</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team One</td>
<td>Causes</td>
<td>Warning</td>
<td>Photography</td>
<td>Bilingual</td>
</tr>
<tr>
<td>Team Two</td>
<td>Consequences</td>
<td>Warning</td>
<td>Photography</td>
<td>Bilingual</td>
</tr>
<tr>
<td>Team Three</td>
<td>Causes + Facts</td>
<td>Informative</td>
<td>Photography + Illustration</td>
<td>Bilingual</td>
</tr>
<tr>
<td>Team Four</td>
<td>Consequences</td>
<td>Warning</td>
<td>Photography</td>
<td>Bilingual</td>
</tr>
<tr>
<td>Team Five</td>
<td>Causes + Prevention</td>
<td>Persuasive</td>
<td>Typography + Photography</td>
<td>Bilingual</td>
</tr>
<tr>
<td>Team Six</td>
<td>Consequences+ Prevention</td>
<td>Persuasive</td>
<td>Photography</td>
<td>Bilingual</td>
</tr>
</tbody>
</table>

During transformation (stage three), the teams attempted to use the knowledge gained from the research and exploration done during the definition (stage one) and divergence (stage two) phases to propose effective and solid visual translations of the brief requirements.

Each of the design choices was made in the light of each team’s own understanding of the slogan Your Life is a Trust as translated into a visual message to inform, warn or persuade the audience. The learners selected different approaches to communicate the intended messages, by highlighting facts, causes, consequences and means of prevention. The selected visual forms aimed to reflect the essence of the type and contents of the messages. In some cases, the typography translated the image, in others the two visual forms complemented each other.
Figure 3. Team 1 poster

Figure 4. Team 2 poster
Figure 5. Team 3 poster

Figure 6. Team 4 poster
During the design process, translation evolved at various stages. The first translation act took place during the interpretation of the brief, where learners had to translate the brief requirements into the research act that took place, mainly, in the divergence phase. Contextual, visual and field research results were translated to visual forms including mood boards, sketches and visual explorations and experimentations. Learners resemioticize the research findings into visual forms that communicate their design ideas and solutions before manifesting them in the final design artefacts. This was a spontaneous act where students explored the appropriate visual style that signifies *Your Life is a Trust*. Although ideation, sketching and selection of the visual style are essential steps of the design process, mapping the intersemiotic translation that takes place during divergence requires a deeper investigation and discussion that is broader than the scope of this paper.

Stage three (transformation) in particular, involves multiple layers of translation, and it did so in this case as well. Intersemiotic translation was included in the following ways:
1. Intersemiotic translation of the slogan *Your Life is a Trust*, which was made into a visual content, including a type and image,
2. Intersemiotic translation of the linguistic message to a visual form and vice versa within the poster,
3. Interlingual translation of a linguistic message from Arabic and English and vice versa.

Signs (verbal and visual) convey meaning in different ways relative to the relationship between the given sign and what it refers to. This is to be understood in relation to Peirce’s categories of the sign (Fiske, 1990, p. 46): the icon, where the sign resembles the object; the index, in which the sign and its object are connected; and the symbol, where there is no connection or resemblance between the sign and the object. The design of the traffic awareness posters enabled the students to explore various ways of conveying an intended meaning to the audience with an easily interpreted visual form. On some teams, the learners considered that the use of an index is the best solution for determining the content of a poster and interpreting it correctly. Other teams preferred to use icons or symbols as a means of stimulating the audience and avoiding boredom in the design, relying on the bilingual message to complement the visual form in the communication. Table 2 summarises the type of signs used by students’ teams.

<table>
<thead>
<tr>
<th>Team</th>
<th>Sign category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team One</td>
<td>Index</td>
</tr>
<tr>
<td>Team Two</td>
<td>Index</td>
</tr>
<tr>
<td>Team Three</td>
<td>Icon</td>
</tr>
<tr>
<td>Team Four</td>
<td>Index</td>
</tr>
<tr>
<td>Team Five</td>
<td>Symbol</td>
</tr>
<tr>
<td>Team Six</td>
<td>Index</td>
</tr>
</tbody>
</table>

The bilingual textual messages were articulated to explain and emphasise the visual messages. The Arabic messages are written in classical Arabic that are literally translated into English. The issue of interlingual translation was critical as the expression of connotative and denotative meanings in Arabic is largely different from English. All teams chose clear, condensed and straightforward messages that can be easily translated into English without confusion or misinterpretation. This suits the nature of the project as an awareness campaign that aims to inform, warn and persuade people which require direct, clear and short messages. The complexity of interlingual translation between bilingual (sometimes trilingual) messages varies based on the context and content of the design.

The typographic choices were determined to be in synergy with the contents of the poster: they do not only indicate the given linguistic meaning but also carry a semiotic meaning themselves that impacts the target audience. All teams decided to use bilingual typography to support Arabic as an official language of the UAE and English as an international language, communicating meaning to multicultural readers. The used English and Arabic typefaces are sans serif, modern, simple and bold, making the written messages clearly readable. The use of a given particular typographic style within a particular context in relation to a certain visual content contributes to the construction of meaning. This means that the modern bilingual typography choices suit the created imagery to raise traffic awareness in a contemporary multicultural society.

3.3 Discussion

Intersemiotic translation took place at various stages of the design process. Students resemiotised *Your Life is a Trust* via visual and verbal signs that were organised into printed posters, which aim to communicate to a multicultural audience. Learners explored audience contribution in the creation of messages as source and as destination (Fiske, 1990). Learners had to consider the common cultural codes shared with the multicultural audience to create functional messages. The designers, as audience, know the encoded messages that are composed of a message type and image from their cultural experiences and inspirations. This was evident in the use of bilingual messages comprising Arabic as the main spoken language of the local community and its English translation as a lingua franca to ensure wider interpretation of the message. In other words, Arabic language symbolises the Arabic identity of the country and English symbolises the internationalist belief of the audience. Using images that include signs directly connected to road accidents and traffic safety such as blood, damaged cars, and injured individual as common signs of damage and life-threatening consequences enhance the signs’ international recognisability.

Although different typefaces hold various connotations derived from their visual styles and compositions, all teams chose to use modern and simple English and Arabic typefaces that are visually well-matched. This approach ensured the clarity of the message to multicultural audience, giving it an international approachability and simultaneously communicating culturally-specific meanings.
The heterogeneous nature of the intended audience’s culture required using general cultural codes to communicate the multicultural audience. The use of index visuals in four teams reflects designers’ intention to use independently defined visual signs as well as their visual and perceptual encoders. These codes constitute the shared values of the multicultural Arabian society wherein they communicate, enabling learners and audience to locate themselves within their culture. Fiske (1990, p. 82) argued that “a culture is an active, dynamic, living organism only because of the active participation of its members in its codes of communication”. This is directly linked to the adopted design methodology wherein learners had to actively participate in the process as translators and addressees. As messages’ encoders, students facilitate intercultural communication in traffic awareness posters where they communicated the cultural identity of UAE through the use of Arabic language and reached international audience by including English translation and highly persuasive visual signs.

### 3.4 Qualitative Feedback

#### 3.4.1 Students

When the project was complete, qualitative feedback was gathered from the learners through a short questionnaire. This questionnaire qualitatively assessed the achievement of the project’s learning goals and outcomes based on students’ qualitative answers. The questions were designed to evaluate the students’ in their roles as cultural translators and the relationship of those roles with their design skills and competences, the role that the research they undertook played in developing their design thinking and the results of working within a diverse design team in creating and implementing the final design direction of the project.

The findings indicate that assigning students to the role of cultural translators in a collaborative real-life project enabled them to establish a deeper understanding of the influence of culture on their design practice. The students valued the teamwork and the diversity of the members of their teams, stating that the cultural and academic differences among the members encouraged critical reflection and enhanced the work dynamics.

Regarding the research-based design methodology, the learners acknowledged the value of dividing a project into clear progressive phases with well-defined aims. The overall responses showed students’ admiration for the **divergence** phase, where they needed to perform extensive visual and literary research, using various methods. They noted that performing research broadened their perspective and helped them create functional and creative visual forms to suit the context of their projects. In all the responses, there was general agreement that visual research enhances visual analytical skills. This enabled them to predict their audiences’ interpretation of design artefacts.

Students found that the real-life nature of the project emphasised the importance of their engagement in the design process as active participants, allowing them to adopt the role of the audience as well as the designer because they too were part of the target community.

The learners noted a number of weaknesses and obstacles they faced as they worked on this project, namely:

- Although the exercise of translation stimulated their imagination, the students believed that the slogan *Your Life is a Trust* was vague, stating that it could hold a variety of meanings that do not relate to road safety.
- The information provided by the STD was limited to the slogan alone.
- The timeframe was not sufficient for conducting a focus group or research public opinion.
- Despite the benefits of working within diverse teams, on-time delivery was a challenge throughout the entire project.

#### 3.4.2 The Sharjah Traffic Department

The STD highlighted the importance of student involvement in raising public awareness of road safety. They emphasised the benefits of collaborating with academic institutions to serve the local community, including young designers in real-life projects. This expanded the outreach of the department and gave students the opportunity to gain exposure and promote themselves to the community as young designers.

The representatives of the STD expressed their admiration and positive impression of the variety of visual communications produced by the students. They acknowledged that the communication strategies used to raise public awareness of a serious issue that is usually confined to discussions of traffic law was creative. It was noted that bilingualism was considered by these designers to be a means of reaching a wider range of the multicultural community.
The STD decided to adopt some of the works to be rolled out in phases. The first one to be implemented is Group 2’s poster because it used the most culturally specific visual form, namely, a desert scene.

4 Concluding Thoughts

In this study, the design of a traffic awareness poster is a signifying practice wherein meaning was produced and consumed at various stages. The key concept involved in this paper is that of intersemiotic translation form: first, the design brief was translated into tangible artefacts and second, there was translation between different sign systems embedded in the artefacts produced. The concept of intersemiotic translations that take place during an iterative design process shall be investigated deeply, focusing on the translation of research data into design solutions. This may lead to the enhancement and development of critical practices in Communication Design.

Although bilingual communication has been widely used to serve individuals’ societal and cultural needs, there is a lack of rigorous research on interlingual translations across different languages in communication design practice. Interlingual translation holds various levels of complexity due to the differences between languages semantically and syntactically. Moreover, translation is directly linked to typography practice as a visual representation of a language, making it an indispensable topic to be further investigated within interdisciplinary research. This study recommends considering it as part of typography pedagogy due to the increased communication across cultures with these skills growing in demand.

The involvement of the students in community related projects to create culturally relevant artefacts that communicate multicultural audience brought them awareness of their critical role as cultural translators. This raised the question of their identities as individual designers and members of a multicultural Arabic society where they needed to reflect the essence of local identities while attempting to reach a broader group, a global audience. Additionally, the project enabled students to be active participants in the design process through playing the roles of both the designer and the user at the same time.

Students highlighted two challenges that they faced in this project: the first was the task of translating the slogan *Your Life is a Trust*, meant to promote traffic awareness, into a poster that could communicate meaning to a multicultural audience; the second was dealing with a real-life problem that they themselves experience on daily basis as pedestrians and drivers. The learners claimed that traffic safety is a critical, life-threatening topic to be raised and communicated visually in a creative manner to the local community.

Understanding intersemiotic and cultural translation is essential for communication design. It is recommended that semiotics, communication and modality be incorporated as key theoretical concepts in the design of a communication curriculum. This project may encourage future real-life projects, including intercultural translation processes with a variety of artefacts (e.g. illustrated books, information design and motion graphics) as fundamental exercises in studio classes where students can develop an advanced understanding of the connections and interactions among the semiotic resources used in different applications.

Adopting a research-based design methodology allowed reflection and interpretation. It enabled students to develop a better understanding of the context and goals of the project. This emphasised the intrinsic role of research in communication design practice, particularly when intercultural communications are being developed in response to the needs of intended users.

This study can be followed up by engaging the public in the process of design in a participatory action–research process. This can happen through the collection of stories, experiences and opinions from community members on the subject of traffic safety in the UAE; some of these resources can, then, be translated into new cultural artefacts. This will explore the complexity of intercultural translation where designers communicate audiences’ speculations as part of their construction of meaning, which will turn them into concurrent translators.

**Acknowledgements:** I would like to acknowledge the Graphic Design and Multimedia students who were committed to the successful completion of this project. Further, I would like to extend my appreciation to Sharjah Police Department for providing our students with the necessary information and their desire to adopt and implement the project’s outcome.
References


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Behavioural Change for Efficient Usage of Electricity at Homes

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Abstract: Electricity is not visible or tangible yet always available in our houses. The only way users can keep track of electricity consumption is to look at meters or monthly bills. Energy-monitoring systems promise to help users understand their consumption by visualizing and displaying the consumption data in a meaningful way. However, they are not successful in changing users’ behaviours and sustaining their intentions. The current paper presents a suggestion to promote behavioural change by adapting Diffusion of Innovation (DOI) Theory to stratify the target user groups and apply user-centred design approach when developing a prototype of conceptual electricity monitoring system. Initially, users’ awareness and knowledge levels were measured by a questionnaire identifying and stratifying the target groups who were interested in saving energy in their homes. For one of these groups who are ready to act on an opinion, users’ electricity usage behaviour and their intentions were captured and detailed through interviews. The resulting information was used to develop a series of criteria to design a conceptual electricity monitoring system. The study proposes a case in which DOI stratification of target users may have a potential for behavioural change.

Keywords: behavioural change; product design; diffusion of innovation; design process; electricity monitoring

1 Introduction

It is obvious that electricity is intertwined with daily-life. It keeps houses warm or cold, it helps to cook and keep food safe, and it runs almost every appliance that makes life easier. Its efficiency and reliability increase the users’ dependence upon it every day. According to the records of US Department of Energy (2009), most of the residential houses in USA, which account for 24 percent of total energy consumption, use electricity as their main energy source. The Department of Energy records also forecast that the demand as well as the cost of the electricity will increase more than any other energy sources after 2020, and will continue to rise through 2030. Therefore, American energy policy focuses on increasing efficiency, not just decreasing energy consumption (Diamond et al., 2001). European countries, on the other hand, aim to reduce energy consumption by 20% in the year 2020 (Kulkarni et al., 2014). These projections establish two main questions: how residential users should be able to learn to use electricity efficiently,
and how they should be able to control their electricity consumption. Technologies that allow users to monitor their electricity consumption attract users’ attention; however, their interest on these devices decreases over the time of usage (Anderson & White, 2009; Kulkarni et al., 2014). Also, the presentation of information is not sufficient enough for users to change their behaviour towards energy consumption in houses. They require a motivation for change (Darby, 2006; Roth & Brodrick, 2008). It appears that models assuming economical advantage and favourable attitudes toward energy conservation are not enough for users to change behaviour (Costanzo et al., 1986). Nevertheless, apart from one exceptional study (Darley, 1978) that discusses reactions of users to these systems, the awareness and willingness of users to act on efficient electricity consumption in their homes remain unclear.

Electricity is not visible or tangible and is always available in our houses. The only way users can keep track of electricity consumption is to look at their meters or their monthly bills. However, users generally might not know where the meter is, and those who check the meters cannot associate the numbers on the meter with their consumption. Moreover, the bill can be automatically paid through their bank account or their monthly rent might cover their utility expenditures (Wiggins et al., 2009). The electricity should be measured first in order for users to manage their consumption (Ambati, 2013). To do so, energy-monitoring systems appear to be promising to help users understand their consumption by visualizing and displaying the consumption data in a meaningful way. According to Anderson and White (2009), these systems provide real-time feedback in both cost and kilowatt format, showing daily, weekly, and monthly consumption and are supported by social networking. However, their study reveals that existing solutions lack actionable information, and fail to encourage behavioural change and maintain users’ interest. Furthermore, the existing solutions in the market generally provide information about the overall consumption for the house, and fail to focus on specific user types (Wiggins et al., 2009; Kapkin, 2010). The recent solutions such as Nest, Hive, Brilliant control, and iHome either focus on the specific control of a certain system, such as heating or lighting, or provides only a wireless control over the devices at home. The current paper evolved as a part of corresponding authors’ master thesis (Kapkın, 2010), and is encouraged by several conceptual studies holding scenario-based methodological approaches that suggest building prototypes and collecting user feedback (Ludvigsson, 2005; Backlund et al., 2006; Mazé & Redström, 2008). However, these studies have limitations due to the strategies when stratifying and targeting users. The current paper represents a user-centred design approach to the topic and illustrates a case study that adapts Rogers’ (1995) Diffusion of Innovation (DOI) Theory in order to stratify and identify a potential target user group of a conceptual electricity monitoring system. Initially, users’ awareness and knowledge levels were measured in order to identify the target user group interested in saving energy in their homes. Afterwards, users’ residential electricity usage behaviour and their intentions on efficient usage of electricity at their homes were captured. The resulting information led to a set of criteria that was then used to design a conceptual electricity monitoring system. The goal of this paper is to share our design process to reinforce residential users’ awareness about efficient energy usage in residential houses.

2 Diffusion of Innovation Theory

There are many tools and methods focusing on identifying target user groups for a product. To do so, this paper investigates implementation of Diffusion of Innovation (DOI) Theory in early design process. According to Rogers (1995, p. 55), innovation is “an idea, practice, or object that is perceived as new by an individual or other unit of adaption.” DOI theory suggests that users in a social system have different time sequences of adaptation to an innovation; therefore, they can be classified (into groups) according to when they first begin to interact with an innovative product or service (Rogers, 1995). The goal of the theory is to develop marketing strategies for the future new product. It is a predictive theory that supports decision makers when they introduce a new product to market (Li, 2011). Rogers (1995, p. 106) describes “the process through which a user passes from first knowledge of an innovation, to forming an attitude toward the innovation, to a decision to adapt or reject, to implementation of the new idea, and to confirmation of this decision.” The theory has been subject to many studies in different fields. Al-Jabri and Sohail (2012) looked at users’ adaption processes of mobile banking use. Alkhatheeb et al. (2009) studied physicians’ adaption of electronic detailing information systems in pharmaceutical companies. Studies have investigated educators’ adaptation to technologies in the teaching environment (Brahier, 2006; Gonzalez, 2014). The theory received attention from the field of medical technologies (Lee, 2004; Trelease, 2006; Gonzalez, 2014) to the adaption of local food by chefs and restaurants (Inwood et al., 2009), and innovation adaptation levels of design firms (Panuwatwanich et al., 2009; Panuwatwanich & Stewart, 2012). DOI has also been utilized by the studies investigating energy conservations. Darley and Beniger (1981) suggest that energy conservation behaviour is an instance of decision of the adapting of an innovation. They introduce and evaluate eight dimensions of energy conservation behaviour: cost of these systems, effect of perceived saving when using these systems, certain saving, compatibility of values between users’ expectations and what these products offer, whether a system or product requires life-pattern change, trialability of these systems, dissatisfaction of the existing situation in which users do not have control over
their consumption, and efforts and skills that require to install these systems. A study proposed that perceived compatibility and advantages that these systems offer are significant predictors of intention to adopt energy conservation behaviour (Völlink et al., 2002).

DOI theory has five major characteristics of an innovation that influence users’ diffusion process: relative advantage of innovation refers to perceived value of the innovation; compatibility of an innovation refers to value that fulfils users’ needs, values and personal experiences; complexity refers to the difficulty in understanding and using an innovation; trialability refers to the temporary interaction between user and innovation; and observability refers to the apparent benefits of the innovation to others (Rogers, 1995). Moreover, the pace of users’ adaptation depends on many macro and micro factors that can be categorized into four areas (Leung & Wei, 1999) that are adapter-related personality traits, socio-economic influences, interpersonal channels and mass media use, and perceived attributes of an innovation. Similarly, Trelease (2006) highlights the importance of communication channels by which users share messages about an innovation; time at which a user decides to adapt to a certain innovation; and social system in which the innovation is introduced and exists. The theory suggests that users’ decisions on whether to adapt or reject an innovation begins first with awareness. The characteristics of innovation drive users’ attitudes towards innovation and generate perceptions. Depending on the match between users’ perception and expectations, users decide on whether to adapt or reject an innovation. Afterwards, users utilize and confirm this decision (Lee, 2004).

The categorization of users might be driven by users’ knowledge and attitudes towards technology, products, services or social norms influencing their adaptation level of innovative products (Rogers, 1995). Innovators are not only the consumers of new ideas but also the developers. They are able to understand and apply complexity and they like to experience the new. Early Adaptors are the first adaptors. They are the ones companies like to interact with during the product development and design process. Their opinions are used to validate assumptions of the product development team. Early Majority are the users who have a general awareness but rarely have a strong interest in a new product. Rogers (1995) suggests they provide interconnectedness in the social system. Users, who are sceptical and careful about new products, comprise the late majority. They require time to adapt to a new product or innovation. Laggards are the most suspicious among all the users. They generally rely on their previous experiences and are resistant to a change. Rogers (1995) recommends removing uncertainty around the products and services helping these last two groups of people to feel safe in order for them to adapt. The DOI approach was adjusted to fit the goals of the current paper. Rather than measuring their adaptation to an innovation, it was important to identify users’ knowledge and awareness level. Therefore, the names of the categories that DOI suggests were adapted to terms that were meaningful for the study, although the logic was kept the same. Thus, the category groups were named:

1. Ready to advocate publicly (Innovators)
2. Ready to act on an opinion (Early Adaptors)
3. Ready to hold an opinion (Early Majority)
4. Ready to know (Late Majority)
5. Not ready to know (Laggards)

3 Research Procedures

The brief methodological framework of the study is presented in Figure 1. First, an in-depth literature was reviewed to define and emphasize the electricity consumption in residential houses in USA. In addition, a market review helped to identify the opportunities for the current and near-future market. An online questionnaire was conducted to measure users’ awareness and knowledge on their residential electricity consumption. The results of the questionnaire guided screening the users, and identifying the target user group. Participants that were in the target user group supported the second phase of the study where they filled another questionnaire, and contributed to a semi-structured interview. All the results were then summarized to define the design criteria for a prototype of a conceptual energy monitoring system (CEMS). After the prototype was developed, feedback from the participants in the target user group were obtained to evaluate the success of the CEMS using an online questionnaire-based prototyping tool.

3.1 Market Review

The goal of the market review is to identify the general features of existing home energy monitoring systems currently on the market. First of all, the list of the product and service suppliers was compiled. A total of 32 products were investigated based on their general features and specifications. The information for each home energy monitor was prepared from the information on vendor’s web site. Afterwards, these services and products were categorized according to their commonalities. The first group included stand-alone products that do not use the Internet. They are
generally attached to a meter and present the consumption wirelessly on their screen. They display the total electricity consumption of the house or a specific socket. They do not use any network infrastructure. The second group of stand-alone products used complex network systems and the Internet. Not only do they display the total consumption but also keep track of the history online, allowing users to take control of the electricity at home. Some examples can communicate with each socket and prepare a report that the user can access online. Although they generally use mobile devices and the computer as their interface, few companies offer an additional screen.

The last group included monitoring services that offer only Internet solutions. They offer two main services; one allows users to enter their billing information, and the other collects information from stand-alone products, providing history of usage at home and around the neighbourhood. There was a categorical opportunity to position a new product solution in the existing market. There was a lesser number of products in the market offering a modular approach to users. There were just a few products that could be positioned in between stand-alone products and Internet-based products. Such a line of products could have a great opportunity to bring modular solutions that offer stand-alone services as well as optional Internet services. Figure 2 illustrates the possible market position of a product line in terms of categorization and computerization. There was a market opportunity in modular products that use either the Internet or their own connectivity, or both.

3.2 Stratifying Potential Users via DOI Approach

An online questionnaire was designed to measure individuals’ awareness and knowledge about their electricity consumption in order to stratify and identify the target groups (see Appendices, DOI Target User Questionnaire). Initially, 217 individuals participated to the online questionnaire, mostly from North Carolina but also from Georgia, Washington, California, and New York. Only 191 participants completed all the questions (122 females, 69 males; age range from 18-55, average age ~35; 97 participants had graduate education, 55 had a bachelor’s degree and 39 had high school or equivalent level education). Descriptive statistics and frequency of occurrences were conducted for each item in the questionnaire. Approximately half of the participants (96 of the 191) held an opinion but they had not acted according to their opinions on the topic of electricity consumption (ready to hold an opinion). DOI theory
suggests that these users might need tools to act towards their opinions to save energy at home. Thirty-five participants had already taken an action to use electricity more efficiently, and they were positioned to save energy in their homes (*ready to act on an opinion*). DOI suggests that this group of people most likely allocate time and invest money on products or a service monitoring electricity usage at home. Users in this group might not need help or tools since they somehow already manage their energy consumption. Consequently, the current study focused on these two groups (the 96 that held an opinion and those 35 that are ready to act) for the further investigation (see Figure 3). These two user groups may not necessarily need guidance on the topic and it can be assumed that they most likely did not need a device to monitor their consumption since they already have their own tools and methods. Fifty-two participants had little idea about their electricity consumption and they might not really pay attention to their consumptions, and do not tend to save energy in their homes (*ready to know*). Among all, only six participants were revealed not to really be aware of their energy consumption at all (*not ready to know*). Users in these last two groups could not be considered as current potential customers until they were more motivated and until the obstacles they faced were eliminated. Once users step up to holding an opinion and seeking guidance, they may eventually become potential customers. Finally, there were only two participants who had high awareness and knowledge about the topic. These users advocated support for others, and were also not currently considered as customers.

The online questionnaire results indicate that a service or product, which supplies meaningful feedback on electricity consumption, has potential interest for the majority of the participants, particularly for the users who are ready to hold an opinion (n=96), and who act on their opinions (n=35). When these two groups were specifically explored, a higher proportion of females was observed (81 females and 50 males). The age within these two groups varied from 18 to 55 years. There were 72 participants with graduate degrees, 37 participants with Bachelor’s degrees and 22 participants with high school or equivalent education. Participants in these two groups typically reported having less than $100,000 annual income. These results corresponded to those seen in previous studies (Ehrhardt-Martinez et al., 2010) associating energy saving at home with the level of education, income and age.

3.3 Electricity Consumption Behaviours of the Target Users

After the screening process, participants who were categorized under *ready to hold an opinion* and *ready to act on an opinion* were asked to participate in the second phase of the study which comprised two substages. In the first phase, participants were asked to fill an online questionnaire (see Appendices, Questionnaire on Habits), which addressed participants’ home type, family type, reasoning behind saving energy, how they are informed about their electricity consumption, and what their preferences are in terms of feedback types and communication. Items in the questionnaire were informed by Rogers (1995) and Leung and Wei (1999). In the second phase, semi-structured interviews were held with five participants within these groups in order to collect in-depth insights (see Appendices, Interview Protocol).

3.3.1 Questionnaire on the Behaviour of Target Users

Twelve participants from both groups (users who *hold and act on an opinion*) supported this phase and shared insights. Descriptive statistics and frequency of occurrences were calculated. 8% of the participants lived in mobile houses, 58% lived in a house and 33% live in an apartment. Only 7% lived alone, while 13% of the participants shared their house with their partner or a roommate. 20% of the participants lived with three people, 27% lived with four people, and 33% lived with five people in their residence.

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*Figure 3. The results of online questionnaire that measures users’ awareness and knowledge on electricity consumption at home. The case study focused on users who are under ready to hold an opinion and ready to act on an opinion. If the Y Axis of the graphic is considered as time the results are match with Roger’s idealized curve of diffusion of innovation over time (the light grey curve).*
Only 17% of the participants reported that it was hard to learn about their electricity consumption. The rest of them reported that they could learn easily through their billing. However, 60% of them stated that monthly feedback is not an effective way to learn. 20% of them stated that their bill was paid by other parties, and they were not aware of how much they use, and the rest of the participants (20%) stated that they have automatic bill pay; therefore, they were not aware of their usage. All of the participants were informed about their electricity consumption monthly. However, only 17% of them wanted to be informed monthly. The majority of the participants, 41% percent of them, preferred to be informed weekly. 17% of them preferred either daily information or real-time feedback, while only 8% percent of the participants preferred to learn about their consumption hourly. 79% of the participants received conventional paper-bill and 21% of the participants received e-mail billing about their electricity consumption. However, 72% of the participants wanted to be informed via e-mail, and the rest of the participants wanted to receive their billing via other communication tools, such as SMS text message (8%), mail (8%) or real-time (8%). Only 8% of the users wanted to share their consumption with the public.

Based on the responses to the questionnaire, participants were more motivated by saving money (92%) than reducing their environmental impact (75%). None of them stated that competition with others on saving electricity would affect their motivation. The majority of the participants (67%) were willing to buy an electricity monitoring system to be able to control on their consumption. However, 75% of the participants wanted to be notified at a specific level of consumption. Only 8% of them wanted control over the consumption of each electrical socket, while 33% only wanted to track the general consumption. 58% of the participants wanted to keep track of some of the sockets in their home. This preference supports the idea of having a modular system in their house, which would allow users to control over general consumption as well as the consumption of specific sockets.

Half of the participants preferred a mounted stable energy monitoring system, whereas 25% of them wanted the product to be portable, and 25% preferred combination of mounted and portable systems. Participants were asked to choose from five different display types identifying the one they felt more comfortable to read (see Figure 4). 75% of the participants responded that the first display was clear to read; the third display was chosen by 25% of the participants. The second display was preferred by 17%, and the last display was preferred by only 8% of the participants. None of the participants preferred the fourth display. In terms of feedback preferences, 82% of the participants thought that visual warnings, such as flashlights and red light, attract attention and are helpful. 55% of the participants preferred auditory feedback. Some of those who preferred auditory feedback noted that sound sometimes bothers them and that is why they would turn off the system. 9% of the participants thought that tactile feedback, such as vibration, heat change, movement and surface change, could be helpful. The room utilization of the homes varied among the participants; however, most of the participants indicated that they spend most of their time in the kitchen, living room and bedroom.

3.3.2 Semi-Structured Interview with Target Users

Five participants who responded to the questionnaire agreed to participate in a semi-structured interview. Among these five participants, four of them were female and one was male. Each interview took approximately 15 minutes, and due to the locations of the participants, two of the interviews were face-to-face, two were on-phone, and one of them was online. There were five key themes specifically coded: communication preferences, room utilization, habits (strategies) to save energy at home, their motivation to save energy at home, their thoughts on an ideal energy monitoring system. Habits, behaviours, motivations and concepts that were frequently observed during the interviews are summarized in Table 1.

When considering communication mechanisms inside the house, white boards in the kitchen, posts-its and SMS seemed to be the most preferred medium among all participants. Participants mostly utilized the kitchen and living room in their houses. They considered first switching off the light bulbs, second preventing phantom load, and last adjusting the thermostat in order to save energy at home. When they were asked about placement of a conceptual electricity monitoring system, they pointed out a preference for both a table-top and mobile, or a wall-mounted system. They associated this device mostly with a wall clock or a thermostat. Their expectations from the device varied. A major expected function of the device appeared to be a reminder. It was expected that the device would
present usage, remind occupants to switch off the lights, adjust the thermostat and identify peek points for using
certain appliances. Control seemed to be the second important function that this device should have. Users perceived
this device as a central point in which they could be first notified, and then remotely control the status of lights or
sockets. Education/Instructionness seemed to be a surprising function that was revealed during the interviews.
Surprisingly, the main motivation that drives to save energy at home appears to educate and teach their children on
the importance of saving energy at home, and become an environmentally aware and conscious person, so that it
becomes a part of the family culture.

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<tr>
<th>Communication preferences</th>
<th>Room utilization</th>
<th>Habits</th>
<th>Motivation</th>
<th>ideal energy monitoring system</th>
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4 Building the Design Criteria

Results indicate that according to target users, the conceptual energy monitoring system (CEMS) should be placed
where people leave notes for the other members of the family. The system should be able to send text messages to
the users about notifications and warnings. CEMS should be placed in either the kitchen or living room. Users want to
see this device mounted on the wall, under the AC thermometer, or on the kitchen table or counter. Consequently,
CEMS should present the meaningful information in both vertical and horizontal positions. Users want to gain the
ability to control the lights, sockets, and AC. They think that CEMS may look like a wall clock or thermometer. CEMS should give an opportunity to remind the peak points where the electricity is expensive and should allow users to compare their usage with other people. Displaying numbers in kilowatt does not always make sense for the target users; therefore, CEMS should present information at least in both kilowatts and money spent, it should allow users to adjust their electricity usage. More importantly, CEMS should create scenarios in which parents train their children about how to use the electricity efficiently at home. Gamifying and engagement while offering children-safe interactions appear to be key design elements for the CEMS.

5 The Design and Evaluation of the Conceptual Energy Monitoring System

The prototype of the CEMS was designed after several iterations in order to incorporate the target users’ expectations, habits and behaviours. A main hub device, light bulb, socket, magnet modules, and room module were generated with a graphic interface (see Figure 5).

The main module can only measure the total consumption of the house when working in standalone mode without connecting to other modules. It shows weekly, daily, current and estimated monthly cost of the total electricity consumption. Main device has an online interface where real-time feedback can be watched, comparisons to neighbourhood and friends can be seen, historical usage is kept, and tips and tricks to save energy are shared. Each icon on the main device’s interface activates a specific module. Home icon helps users to switch measurements of room modules; light bulb, socket and appliance icons indicate corresponding modules. Users have ability to set and target a weekly consumption (budget). Depending on the consumption level, interface illuminates colours around the main device (green indicates efficient consumption, red indicates over consumption, yellow refers to warnings). Main device also provides awarding alerts - if the consumption did not reach the target budget by the end of the week, the device illuminates and projects images such as stars and flowers to its surroundings. This function may have the potential to engage parents and children to use the energy efficiently. They may set a target usage and follow the strategies that the device offers to save energy, and when the goal is achieved, the main device may celebrate their success.

Light module measures the consumption of a specific light bulb. The light module has a motion sensor functionality slightly different than regular sensor - if there is somebody in a room and the light is on, it does function normal. However, if there is nobody in a room and the light is still on, main device gives red warning. Users may remotely switch on/off the light via mobile device or using the main device. If there is no one in the room for a certain time period then the module turns the light off. Similar to the light module, socket module calculates the consumption on a specific socket. It also has motion sensors which function similar to the light module’s motion detection. Magnet modules measure the consumption of several different household appliances such as washing machine, dryer, kitchen fan, oven and microwave. A magnet module should be put on a corresponding appliance. When the appliance is on, it vibrates, and the magnet senses that it is on. It sends information to the main device for it to calculate the consumption. When electricity cost is peaked, magnets illuminate red warning. Users prefer either to turn on the appliance knowing that electricity is expensive or postpone using it. An optional room module communicates with other modules in the room, and shows the current consumption of the room. Room module allows users to target a weekly budget for a room. It also gives warnings and awards according to the user’s consumption rate.

Figure 5. Family of product of CEMS branded as ICO
Prototype Testing and Evaluation

A scenario-based approach was held to evaluate the CEMS prototype. A digital working prototype was created on an online prototyping platform. Thirteen participants from the target user group interacted with each and every function of the main device and its modules as if they were installed to their home. They were asked to set a weekly target consumption, turn on a light, observe the phantom load on a socket, and experience how the motion detection functions. They were able to fail or succeed over their targeted consumption and receive warnings and awards (see Figure 6).

![Figure 6. Screenshot from the online prototype. The image presents the scenario which illustrates the motion detection functionality of the light module and its interaction with the main device.](image)

After experiencing the device, they were asked to evaluate each of the functions and/or the scenarios according to their desirability (I would like to see this device in my home), usability/complexity (It is easy to use, it gives meaningful information, or it is difficult to understand), and usefulness/compatibility (It gets my attention, it impacts my behaviour, it fulfils my needs) in three questions in which 0 indicates the lowest, and 100 indicates the highest score. Also, participants were asked to provide additional comments on the value and relative advantage of the concept (Sanders, 1992; Rogers, 1995; Jordan, 2000). Descriptive statistics were calculated, and average scores were presented in Figure 7. The CEMS was found to be useful by 77%, usable by 83%, and desirable by 81% of the target users.

![Figure 7. Results of prototyping test](image)

Based on the information gained from the feedback, there were opportunities for improvement. Awarding should be emphasized as much as warnings; also, users should be able to turn off the award signs and warnings. Modules should be small, and should fit the decoration of the house; and they should be offered separately from the main package. The oven magnet module scenario was not found realistic since even though it consumes more or it is peak time, the oven will be used regardless of cost. CEMS was found promising to increase engagement between parents and children. Participants were able generate several game scenarios around CEMS (see Figure 8).
6 Conclusion

This paper presents a case study utilizing Roger’s Diffusion of Innovation (DOI) Theory when identifying target user groups during the design research phase of the development process. Results were promising providing insightful and surprising suggestions introduced by the target users. The stratification using DOI theory was found to have potential applications for promoting behavioural change, user-centred design approach and gamification. Also, such an approach provided applicational advantages such as users not being challenging to work with, since they were ready to learn about the topic, seek guidance, and share what they already knew. Although the study has promising results, there are limitations. Firstly, the prototype was fully functioning yet it was a digital prototype. Also, sustaining and maintaining users’ interest in the product and using energy efficiently at home appears to be uncertain. Cases when the users gain the habits and therefore do not need the device anymore should also be further investigated (this might occur in an instance when user’s awareness and knowledge level move from ready to act on an opinion to ready to advocate publicity). It should also be kept in mind that users who have different levels of awareness but live in the same house may need different types of feedback.

Acknowledgements: We express our gratitude to participants for their input and insights, and we thank Bryan Laffitte for his help and guidance.

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About the Authors

Engin Kapkin received his master’s and PhD degrees in Industrial Design from NC State University as a Fulbright Scholar. He worked at local craft centres, T-Design office, DLxLab Design-USA and interned at Ford-Turkey, and IDEO-CA. He currently works at Eskişehir Technical University where he pursues projects on human centred design, human factors, user experience design, and the interaction between product form and meanings it evokes.

Sharon Joines received her bachelor’s, master’s and PhD in Industrial Engineering degrees from NC State University. Sharon is a researcher, ergonomist and design educator, teaching courses in human centred design and ergonomics. Her interests reside in universal design, applied product and process research, innovation and the effect of aging on fatigue development and work. Her research focuses on quantifying the interaction between individuals, products, and their environment.
Appendices

DOI Target User Questionnaire

Questionnaire on Electricity Consumption of U.S. Residential Houses

Researcher: Engin Kapkin, Graduate student at NCSU Industrial Design Program
NC State University, College of Design Leazar Hall (214), Raleigh, NC.
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Overview
The purpose of my final project is to investigate user-friendly and on-time feedback to inform users about their electricity consumption. That is how power consumption could be represented in order to reinforce residential users' awareness about efficient energy usage in U.S. residential houses. Capturing the users' electricity usage awareness and behavior is focus of this questionnaire. This questionnaire will take approximately 2 minutes. Thank you for your participation.

Q1. What is your gender?
☐ Male ☐ Female

Q2. What is your current age?
☐ 18-24 ☐ 25-34 ☐ 35-44 ☐ 45-54 ☐ 55 - older

Q3. What is the highest degree or level of school you have completed?
☐ High School or equivalent ☐ Bachelor's Degree ☐ Graduate Degree

Q4. What is your combined annual household income?
☐ Less than $20,000 ☐ $21,000 - $50,000 ☐ $51,000 - $100,000 ☐ $101,000 and upper

Q5. Do you know where the electricity meter is in your home?
☐ Yes ☐ No

Q6. Can you remember how much money your household spent on electricity last month?
☐ Yes ☐ No

Q7. Can you remember the amount of electricity that your household used last month?
☐ Yes ☐ No

Q8. Are you interested in observing your household's electricity consumption?
☐ Yes ☐ No

Q9. Are you familiar with the terms Watt (W) and Kilowatt-hours (Kw/h)?
☐ Yes ☐ No

Q10. Do you generally unplug the power cord after you use an appliance?
☐ Yes ☐ No

Q11. Have you ever turned off the electricity in your home before going on extended vacation?
☐ Yes ☐ No

Q12. Do you have a renewable energy source in your home?
☐ Yes ☐ No

Q13. Does the energy efficiency rating of a product affect your decision to purchase?
☐ Yes ☐ No

Q14. Are you familiar with this logo?
☐ Yes ☐ No

Q15. Do you mostly use energy efficient light bulbs in your home?
☐ Yes ☐ No

Q16. Do you have an energy monitoring system in your home?
☐ Yes ☐ No

Q17. Have you ever changed your behavior to save electricity in your home?
☐ Yes ☐ No

Q18. Do you know how you can save electricity in your home systematically?
☐ Yes ☐ No

Q19. Do you believe there is an environmental impact related to individual's electricity consumption?
☐ Yes ☐ No
Q20. Are you familiar with the term "phantom power"?
☐ Yes  ☐ No

Q21. Do you know how much you pay for electricity per hour?
☐ Yes  ☐ No

Q22. Do you know what part of the day electricity is least expensive?
☐ Yes  ☐ No

Q23. Do you think that reading an electricity meter can support your reduction in consumption?
☐ Yes  ☐ No

Q24. Do you read your electricity meter?
☐ Yes  ☐ No

Q25. Do you know how to read your electricity meter?
☐ Yes  ☐ No

Q26. What kind of light bulbs do you mostly use in your house?
☐ do not know
☐ Incandescent bulbs
☐ Compact fluorescent lamps
☐ Fluorescent
☐ LED Light
☐ Other

Q27. Estimate the percent of electricity that you think is consumed by the following appliances.
Estimate the percent of electricity that you think is consumed by the following appliances.

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<thead>
<tr>
<th>Cleaning</th>
<th>%5</th>
<th>%10</th>
<th>%15</th>
<th>%20</th>
<th>%25</th>
<th>%30</th>
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<td>Water heating</td>
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</table>

Q28. Thank you for your participation. Please leave your e-mail to be informed about the results or if you want to be a part of my project. If you are not willing to be contacted, leave this blank.
Engin KAPKIN, Sharon JOINES

Questionnaire on Habits

Electricity Consumption Habits of the Target Users: Questionnaire

Researcher
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Overview
The purpose of this study is to investigate user-friendly and on-time feedback to inform users about their electricity consumption. In this sense, the question is how power consumption should be represented in order to reinforce residential users’ awareness about efficient energy usage in U.S. residential houses. Capturing the users’ electricity usage behavior and preferences are base of this interview. This questionnaire will take approximately 2 minutes. Thank you for your participation.

Q1- What kind of home do you mostly live in?
House □ Apartment □ Mobile Home □

Q2- How many people are there in your household? ____

Q3- How often are you informed about your electricity consumption?
Hourly □ Daily □ Weekly □ Monthly □

Q4- How often would you like to be informed about your electricity consumption?
Real-time □ Hourly □ Daily □ Weekly □ Monthly □

Q5- How are you informed about your electricity consumption?
I do not know □ Mail □ E-mail □ sms (Text message) □ Phone call □ Real-time feedback □ Other □

Q6- How would you like to be informed about your electricity consumption?
Mail □ E-mail □ sms (Text message) □ Phone call □ Real-time feedback □ Other □

Q7- What would motivate you to save electricity in your home?
Saving money □ Environmental Impact □ Competition with others □ Other □

Q8- Do you think it is hard to learn about your electricity consumption?
Yes □ No □

Q9- What are the obstacles for you in learning how much energy you consume in a month?
My parents pay my bills □ My partner pays utilities □ My rent includes utilities □ I share my room with other people □ My bank pays bills automatically □ Other □

Q10- Would you be willing to buy an electricity monitoring system to reduce the consumption?
Yes □ No □

Q11- Would you like a notification at a specific level of energy consumption?
Yes □ No □

Q12- Would you like to control the electricity consumption of each sockets?
Yes □ No □ Some of them □

Q13- Would you like to share how much energy you consume and how much you save with the public (Internet, social networking, etc.)?
Yes □ No □

Q14- Do you want your energy monitoring system to be portable?
Yes □ No □ In some cases □

Q15- Which type of display do you think make more sense to you? Which one you can read more clearly?

Q16- What kind of feedback would affect you electricity consumption habits? And what kinds of feedback bother you?
Visual warnings (red lights, flashing lights, etc.) ____________________________
Auditory warnings (phone rings, radio, warning sounds etc.) ____________________________
Tactile warnings (vibrations, heat change, movement, surface change etc.) ____________________________

Q17- Where do you spend most of your time in your home? ____________________________
Interview Protocol

Electricity Consumption Habits of the Target Users

Researcher
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Overview
The purpose of this study is to investigate user-friendly and on-time feedback to inform users about their electricity consumption. In this sense, the question is how power consumption should be represented in order to reinforce residential users' awareness about efficient energy usage in U.S. residential houses. Capturing the users' electricity usage behavior and preferences are base of this interview. My goal is to create better process and solution for designing meaningful feedback of electricity usage.

Interview Number ……………
Name of the Interviewee ……………
Date / Time ……………
Place ……………

Research Subject  Electricity Consumption of U.S. Residential Users
Recording  Audio Recorder, Digital Camera
Time Period  Approximately 15min.

Introduce yourself and Ask permission to remind recording.
☐ Interviewee is agree to record this interview
☐ Interviewee is NOT agree to record this interview
☐ Interviewee is agree to participate further study

This interview will try to identify your communication preferences in your home. Because the device that I will design, has to supply correct communication so that it can help to control on electricity consumption. Remind the questionnaire.

Questions
1. Do you leave messages for your family or for roommates before you leave the house? In other words, what kind of in-house communication styles you prefer to use? On table, board, refrigerator etc.
2. Where do you leave those messages?
3. How do you check the weather?
4. Have you ever tried to save energy in your home? What kinds of behavior changes observe during this period of time?
5. Do you have any future plans to save energy in your house? What do you to for it?
6. Where do you spend most of your time in your home?
7. Would you consider using electricity-monitoring systems, such as smart meters or screens to have control over your electricity consumption?
8. What kind of functions would you expect from this kind of device?
9. If you had an electricity monitoring system in your house, where would you like to place it so that you can see it?
10. Where you would like to put this device in your home? Do you want it to be installed somewhere or do you want it to be portable?
11. When you think of monitoring systems or things providing you reminders, what type of products come to your mind?
12. Do you have any questions for me?

Thank you for participating. Your assistance is highly appreciated. Invite them to my presentation. Ask if they are interested in.

Ending time of Interview
Self-Organization for Design Education: A Sustainable Flocking System

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Abstract: Scientists have discovered the efficiency and elegance of systems found in the behaviour of natural groups, one of which is self-organization and flocking. Many researchers have studied and applied self-organization in business management but it is yet to be addressed in the design education field in Egypt. Design students are reliant on the teacher’s input, which limits their independent decision-making and development. This study aims at introducing self-organization to groups of students in Egypt to enhance learning outcomes. A system was developed based on flocking to enable better team work experiences between design students. The system is based on using two positive and one negative feedback loops. An experimental method tested the proposed system on two groups of design students, backed up by semi-structured interviews and a survey to compare previous experiences with the new model. It was found that self-organization enabled students to interact with each other to create innovative designs with an improved general experience, group dynamic, and project structure. A method of rotatory leadership was also identified. By implementing self-organization and the system of flocking, teams can become more agile and therefore, succeed and sustain.

Keywords: self-organization; design education; flocking; systems thinking

1 Introduction

Design education develops according to what the world needs from today’s designers. A crucial part of today’s demand is a call for sustainable designers. Researchers have found that by following strategies in nature, design challenges can be solved sustainably and efficiently. Natural organisms use patterns for survival such as fish swimming in schools, birds flying in flocks, and ants forming highways. These behaviours are achieved through self-organization: creating a system without direct external influence. Systems lacking self-organization have order forced upon them through hierarchy (Ramos & Merelo, 2002).

One of the biggest educational problems is the dependence of students on the instructions and influence of teachers. Students in higher education find difficulty working in groups, especially in Egypt. The main issue with the design education sector in Egypt is the student’s previous backgrounds in schools where some school systems rarely prepare students for the creative, diverse and multidisciplinary field of design. By the time they enter a design college they are unable to function in a team and rely constantly on the input of the educator, especially in projects. A self-organizing system will motivate students to adapt, improve and develop themselves and their teams (Shmurygina, Bazhenova, Bazhenov & Nikolaeva, 2015). The paper aims at combining principles of self-organization with systems thinking to
develop a design education approach in Egypt. It is hypothesized that this method will enable students to work together as a group to solve problems efficiently and independently. The method can be used by design workshops and companies to rely on themselves internally without the need for external parties.

2 Sustainable Development within Design Education

Throughout the years, education methods were developed and applied according to different philosophies and market demands. The Bauhaus model was established in 1919 based on Gropius’ manifesto which proposed to teach students creativity through practical and scientific works by drawing, painting, craft, science and theory. The New Bauhaus method by Moholy-Nagy in 1937 brought additional influences to include technology. Design in education was applied first to arts then to sciences in 1958, which involved students applying theoretical information practically (Findeli, 2001).

A popular design education method currently integrated in Egypt is studio-setting, involving a teacher instructing students using practical design trials. However, this causes motivational issues and limited information about the design process. It creates learning inefficiencies because it relies on the experiences, styles and personalities of students and teachers. Therefore, messages sent by teachers are according to their biased experiences with certain design situations (Oxman, 2004). This affects students’ knowledge acquirement, independence, and unique interpretations. Discussions with teachers are unstructured according to specific, hypothetically proposed design problems causing issues with grounding students’ thoughts and ideas (Kowaltowski, Bianchi & Paiva, 2009).

Recently, design’s responsibility towards sustainability has increased due to environmental concerns, especially through education. Tools must develop to address students’ obstacles internally (mind blocks, lack of confidence) or externally (social barriers, governmental limitations, material restrictions, etc.). Sustainability is taught at the James Madison University of Engineering as the continued survival and prosperity of societies in terms of life quality according to social, environmental, economic and technical constraints (Kowaltowski, Bianchi & Paiva, 2009). Connecting between the world and our actions is key to achieving sustainability (Pappas, Pierakos & Nagel, 2013). It is, therefore, important to teach students about product contexts to consider manufacturing and materials (Klein & Phillips, 2019).

3 Nature Inspired Systems: Biomimicry Applied in Design and Education

Sustainability is achieved through integrating nature into the design process, where “design approaches that embrace the natural world are perhaps more inherently sustainable” (Klein & Phillips, 2019, p. 71). One approach is biomimicry: finding solutions and inspirations to everyday problems through knowledge in nature’s strategies and systems. It gained popularity in the 1990s when introduced by biologist and researcher, Janine Benyus. Although it is still a young science, it has significance within design education (Tavsan, Tavsan & Sonmez, 2015). Biomimicry offers solutions to specific questions by studying nature’s processes and materials providing new and innovative possibilities (Reed, Klumb, Koobatian & Viney, 2009). Therefore, natural solutions to man-made problems can evolve, leading to sustainable outcomes (Klein & Phillips, 2019).

Systems inspired by nature develop sustainable designs embedded into education. Biomimicry proposes three ideation levels: nature as form, process, or ecosystem. The deeper one dives the more sustainable the approach is. One option is to mimic natural systems to achieve similar goals. Similarly, circular economy in design education achieves sustainable development based on natural cycles decomposing dead organic materials into nutrition for upcoming generations of living organisms. Consequently, using circular economy creates a curriculum that educates about sustainable development (Andrews, 2015). To achieve, designers manage several factors simultaneously so it is necessary to study interactions between the human world and natural systems. It is not enough to know components of a system without understanding its overall purpose, as illustrated in Figure 1 by John Godfrey Saxe’s poem the Blind men and the Elephants (Sustainable Leaders Network, 2013).

Design processes are interpreted as problem-solving methods involving a need/problem and a final goal/solution with the design element acting as a link between problem and solution. However, according to Findeli (2001), an alternative interpretation is the system’s states where different states are defined to integrate designers and users. Therefore, the material outcome is not the process’ final achievement, there also exists a learning component from a project (Findeli, 2001).
4 Systems Thinking, and its Relation to Nature and Design

Systems thinking is linked to the General System Theory by Ludwig von Bertalanffy in the 1940s and became famous in 1987 when introduced by Barry Richmond. Despite its popularity, it has many diverse definitions, one of which is: a group of different parts where systems thinking is “literally a system of thinking about systems” (Arnold & Wade, 2015, p. 670). It is categorized into natural systems of biological components and designed systems of artificial mechanisms.

It can be found in nature’s survival patterns and is broken down into elements (characteristics), interconnections (linking characteristics), and function (purpose). Elements within a system are most noticeable with least importance because they do not define distinct characteristics (Sustainable Leaders Network, 2013). The interconnections between elements are more important because they change the system significantly. Finally, functions are crucial because if the system’s purpose changes it drastically differs. Therefore, systems thinking must clearly communicate its end-goals. For example, the human digestive system’s main function is to break down food into basic nutrients and transfer them into the bloodstream. Interconnections are flows of food and chemical signals. Finally, elements in the system are teeth, mouth, stomach and enzymes (Johnson, 2012).

5 Self-Organization and Flocking: The Development of Biology-Based Design Modules

Self-organization is defined as a structure’s development without an imposing external agent (Heylighen, 2001). It uses indirect interactions to communicate directly with people in a group (Ramos & Merelo, 2002). A system reproduces itself using its own internal logic due to interactions between the system’s elements, and follows several principles and strategies including positive and negative feedback loops, flocking, and stigmergy (Fuchs, 2003).

Positive and negative feedback loops are primary sources of interaction between individuals in a self-organized group. Positive feedback is enhancing; for example, a savings account with a stable interest rate where each year the interest...
and money both increase. Negative feedback is correcting; a home thermostat that readjusts according to room temperature changes (Fuchs, 2003). Stigmergy involves transferring information between individuals by manipulating the environment. For example, ants gather food individually but if one ant finds a food source it lays a trail of pheromone to draw attention. It relates to dividing labour according to the specialization of workers to function more efficiently (Ramos & Merelo, 2002).

Flocking ensures that loops work harmoniously in self-organized systems, often based on a set of rules. It illustrates a method of collecting and responding to information from one individual to another (Fuchs, 2003). Using flocking as a model gives individuals three rules: two positive feedback loops (cohesion and alignment) and one negative loop (separation).

Cohesion is a positive feedback based on creating attraction between individuals in the flock. Separation is a negative loop to limit the first loop. A group of birds, for example as shown in Figure 3, are attracted to each other yet they also repulse each other creating a distance between them, ensuring that they do not crash into each other. Finally, alignment ensures that each individual adjusts to their neighbour’s direction to move towards the same goal. Individuals vary in their responses and, therefore, the outcome of the group’s behaviour depends on the selection responses of individuals inside a flock (Fuchs, 2003).
Applying self-organized behaviour in a pattern, module or process has several benefits including cost and time efficiency, flexibility, robustness, and scalability. It requires individuals to act on local information to follow a simple set of behavioural rules. Therefore, cognitive requirements are low and changes in group sizes are flexible. It decentralizes failure points with control ranging across each individual within the system and works with small or large groups to easily add individuals following the same principles (Thomas & Harri-Augstein, 1985).

Previous Applications of Self-organization to Achieve Product Designs

Advantages found by studying self-organized groups in nature can be applied to design principles to achieve the same results. According to Prehofer and Bettsetter (2005), a set of design principles can be followed to apply self-organization to a human design. These are:

- Achieving global properties by designing local behaviour rules;
- Not striving for perfect coordination;
- Minimizing long-lived state information; and
- Creating adaptive protocols (Prehofer & Bettsetter, 2005).

Several companies have developed self-organizing design principles, such as REGEN Energy using bees’ behaviours to create swarm logic for new energy management technology. The company designed the REGEN Energy™’s wireless automated demand management response controllers which connect to electric heaters or coolers to work together, communicate, and manage cycles (REGEN Energy Inc., 2014). The Nissan EPORO Robot Car uses the concept of fish schooling to apply algorithms to their automobile concept robot car designed to travel in a group of like-vehicles to avoid obstacles without colliding with each other (Nissan Motor Corporation, 2009).

6 Experimental Methods: Self-Organization System for Design Education based on Flocking

Self-organization can benefit design teams to approach problems efficiently. By applying feedback loops into strategies, a decentralized system with better communication can be developed to reach decisions easily. To solve sustainability problems, a system’s approach is required based on achieving a common goal (Pappas, Pierrakos & Nagel, 2012). Experimental methods are used when it comes to research based on creativity giving experimentation the potential to become an educational tool (Oxman, 2004). Therefore, an experimental method was developed to implement and test a self-organization system on two groups of design students. The proposed system (Figure 4) mimics the behaviour of feedback loops found in flocking to aid designers and students to work in teams. It involves three phases:

- Cohesion: Team members would be attracted to meet each other and brainstorm.
- Separation: Team members would want to work separately at a distance to develop ideas.
- Alignment: Team members would question whether they are moving towards the same end goal so they would be attracted to meet again to find out the different ideas and discuss further.

Meetings with the teacher took place at the start of the process to announce the project brief and at the end to discuss the final outcomes.

Figure 4. Self-organization system for design students’ team collaborations based on the principles of flocking.
6.1 Testing the Developed Process on Design Students

Limitations increase creative outcomes of students based on their instinct to break barriers and create original solutions while giving them confidence in their design processes and proposals (Kowaltowski, Bianchi & Paiva, 2009). This factor was part of the experiment’s objectives to find out if these factors will occur with more or less restrictions. An experiment was conducted on product design students using qualitative research methods supported by semi-structured interviews. It aimed at testing the proposed system on students to identify the benefits and limitations of self-organization as a basis for design and education. The experiment lasted for 3 hours and consisted of six senior product design students between the ages of 23-26 years of age from the Faculty of Applied Sciences and Arts at the German University in Cairo. There were no issues regarding research with the facility mentioned.

The experiment aimed at answering the following questions:

- How would students respond to the system?
- Would they be able to manage independently without the guidance of the teacher?
- Would the teams be able to achieve tangible outcomes using this system?
- Are the three phases understandable and logical within the system?
- Would a team leader appear with the groups?
- Would they be able to reach decisions and assign tasks independently?
- What would the group dynamic be like?

Participants were divided into two groups of three students each and were given the same brief including the self-organization diagram with one main variable: freedom to divide tasks in the time phases, as shown in Table 1. Group 1 was informed that each phase would take one hour’s time and were told exactly what to do within each phase. Group 2 was informed that each phase would take one hour’s time but were left to decide what to do during each phase.

![Table 1. Constant and variable factors in the experiment.](image)

<table>
<thead>
<tr>
<th>Constant</th>
<th>Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>Group size&lt;br&gt;Type of brief&lt;br&gt;Duration&lt;br&gt;Process explanation</td>
</tr>
<tr>
<td>Group 2</td>
<td>Freedom to divide what to do in each phase</td>
</tr>
</tbody>
</table>

The teacher met the students before the first phase and after the last phase of the system, and was involved in dividing the groups and distributing the briefs as well as answering questions before starting the experiment. Students were left to discuss the design brief and follow the guidelines provided. The brief was related to sustainable development: to develop balcony design solutions for today’s modern Cairo. They were asked to conduct research, ideation, and a final mock-up of their design concept. Later they would present their concepts after the alignment phase with the teacher. Observation was used throughout the experiment. After the final phase of the experiment, a focus group discussion was conducted with the six participants.

6.2 Findings: The Process of Design Students Flocking

Through observation, it was found that students were keen on understanding the brief during the first teacher’s session. They were left to read the brief together as a group and ask questions. The cohesion phase began with students discussing and brainstorming the topic of balconies in an urban city like Cairo using mind-mapping tools, as shown in Figure 5.

They began to ideate and talk together about their ideas, as shown in Figure 6, left. During this time, tensions began to build due to differences in opinion. While the researcher was observing, a student asked if all group members should agree on the final design concept to which they were informed that they should decide this for themselves. The separation phase (Figure 6, right) was not as distinct as the first because each member acted differently; one student read an IKEA magazine and another student sat in the same place to sketch ideas. Finally, students came together during the alignment phase to create their product mock-up.
The focus-group discussion showed that both groups spent approximately the same amount of time during each phase and felt that the phases should not be divided equally in time. They spent between 45 minutes to 1 hour during the cohesion phase and the least amount of time on separation. The longest phase was during alignment where they came together to discuss ideas and create the mock-ups. Each student had a different preference of phases according to their own preferences as design students; one student preferred mind-mapping at the start and another preferred creating models by hand. Some liked all three phases but all agreed that they did not want to spend a long time in the separation phase and wanted to sit together and discuss their ideas. The 3-hour time duration worked for the topic and brief but if it was a more industrial or complicated technical project it would need more time.

One student stated that the flow of the system was beneficial because the cohesion helped to first meet with the team then separate to collect their thoughts and finally align again to discuss, decide and agree. Some suggested that separation should be at the beginning of the process instead of during the middle. All students felt that the organization and flow of the system was smooth to follow but that it could be repeated: cohesion > separation > alignment > separation > alignment, etc. Participants also felt that the approach should be circular where they would return to certain phases throughout the process. Students followed the system easily but they mentioned that it could be different if it was applied on younger, foundation stage design students as they would need more guidance from their teacher.

They felt that the brief was helpful to achieve a mock-up (Figure 7) in the end because it was a general topic that they could easily relate to. However, one of the sentences in the briefing was stated as a fact which was too limiting and should be left open. The wording of the brief helped the students with certain keywords such as “modern” which was interpreted differently from one person to another.
The role of team leader was not assigned to one student in the teams. Instead, the role was changing and rotating between them; sometimes one would time manage and motivate the rest, another would begin to assign tasks, and a third would begin decision discussions between members. Decisions were reached together in both groups where they found common grounds and compromises. One group during alignment assigned roles depending on what each prefers to do. The second group made mock-ups together during alignment. The case also differs according to group dynamics especially if the team collaboration is with a group they do not know. From their previous experiences, they found that larger groups would need to be divided according to tasks so that the project is manageable and members do not need to be 100% involved in all parts of the project. There would then be a member who connects the group together.

6.3 Benefits and Limitations of Self-organizing Systems

A survey was then distributed to the six participants to compare between previous group project experiences and the self-organization experiment experiences. Students were asked to refer to the same previous project. The data was plotted and analysed to understand the criteria that were most common between the students, shown in Figure 8.
According to the survey, the self-organization experiment showed the most preferred criteria which were in common between several students: Group dynamic, general experience satisfaction, outcome satisfaction, and project structure and process, shown in Figure 9.

![Figure 9. Criteria according to priorities.](image)

The experiment showed several benefits to using the self-organization system in the context of product design education for sustainability, shown in Table 2. It was found that outcomes were satisfactory within the time frame and that a comfortable group dynamic was achieved. It was also found that students were independently reaching decisions together through compromises and that the role of team leader was rotatory. However, there is still development required within the system’s structure to make it more circular. Limited feedback from instructors was also questionable especially if the system is applied in an actual curriculum with course grading. The experiment needs further testing on larger group sizes and a flexible approach to the time durations of each phase.

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotatory leadership</td>
<td>Process adjustments required</td>
</tr>
<tr>
<td>Time efficiency</td>
<td>Limited feedback from the teacher</td>
</tr>
<tr>
<td>Outcome satisfaction</td>
<td>Further testing needed on larger groups</td>
</tr>
<tr>
<td>Improved group dynamic</td>
<td>Durations of phases need adjustment</td>
</tr>
<tr>
<td>Independent decision making</td>
<td></td>
</tr>
<tr>
<td>Structured process for students to follow</td>
<td></td>
</tr>
</tbody>
</table>

### 7 Conclusion

The research proposed the implementation of a self-organization system to design education with a focus on an experiment conducted on two groups of product design students in the Faculty of Applied Sciences and Arts at the German University in Cairo. Students participated in a short-term design project over a duration of 3 hours while following the guidelines of self-organization: cohesion, separation, and alignment. It was found that students successfully followed the guidelines to achieve satisfactory mock-ups according to a given design brief.

The phases of the system were divided equally into one-hour durations. However, it was found that each phase was different and participants spent longer on the two positive feedbacks (cohesion and alignment) and less on the negative feedback (separation). Although separation was vital for students to ideate independently and gather their thoughts they then wanted to come together to discuss and align. Therefore, it was found that the system can be developed to become longer with extra phases. This could be depending on the size of the groups as well as different durations of design projects.

In team collaborations, a team leader would be assigned to manage and distribute tasks. However, this would normally create clashes between members when the leader takes decisions and members follow orders. The system
provided the opportunity for participants to equally participate and divide tasks and roles including the role of team leader which was rotatory. This proved the element of a decentralized approach where participants are equal members. The principle can be applied on other sectors in Egypt and design including crafts workshops, start-ups, design companies, and freelancing projects where group work settings are common.

8 Further Recommendations

It is recommended that the developed flocking system be tested on several group projects of students over longer periods of time to study if the system truly achieves successful project outcomes. A greater focus on testing learning outcomes rather that products achieved is recommended as well as developing a criterion to test and compare students’ learning outcomes and experiences.

Development in the system to add different phases and test it on different group sizes and dynamics is also recommended. This would provide a starting point for design educators to use the optimal system for each situation. The system can be developed to fit a circular approach rather than a linear one. A further study into the applicability as well as the ethical stand point of applying self-organization in education is also recommended to find out if students would be willing to learn without constant supervision and input of teachers.

Acknowledgements: I would like to acknowledge the participation of my students; Zahra Hazem, Mayar Morsy, Laila Boghdady, Nadin Eldemary, Shahd Amr, and Omar Sherif. It was a pleasure sharing this experience with you in the hope that this research will one day apply to curriculums of design education in Egypt.

References


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Integrating Repair into Product Design Education: Insights on Repair, Design and Sustainability

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Abstract: With the pressure of growing environmental problems, the world is changing and so is the paradigm of design. Accordingly, the calls for change in design education have been increasing throughout the literature day by day. As the designers of the future, students must be prepared for alternative scenarios. This paper describes an assignment which is a part of the master’s degree design course at Linköping University. In this project, repair is integrated into product design education aiming to explore insights about repair and sustainability. The requirement of the assignment for each student was to visibly repair one or more products in an aesthetically pleasing way by using different design perspectives such as artistic, industrial and critical perspectives. In the end, the students have repaired fifteen different types of products including a bicycle, leggings and a motorcycle part. Aiming to find out the insights of this process and articulate each students’ views, a focus group session was conducted. As a result of this focus group session, fifteen insights were developed such as the concepts of brokenness, designed repair and the collaboration/social aspect. All these insights emphasize the richness of the repair as a subject area and how it can be used in product design education to teach sustainability principles. Repair is an inevitable part of a product’s life and it should be understood and applied to its maximum extent if we are to transition to a circular economy. The value of this research for academics and researchers is in providing a case of incorporating repair into product design education. For design practice, its value lies in showing concrete examples as well as insights from diverse repair processes.

Keywords: repair; product design; circular economy; design education

1 Introduction

The current paradigm of product design education serves the linear system and perpetuates a throw-away mentality. The linear economy is based on continuous economic growth and does not allow alternative perspectives to survive. This hegemonic approach has brought us to a global ecological crisis, so we certainly need different ways of thinking and alternative systems such as circular economy to overcome it (Ellen MacArthur Foundation, 2012; van den Berg & Bakker, 2015; Bocken, de Pauw, Bakker & van der Grinten, 2016; Ghisellini, Cialani & Ulgiati, 2016). Having the
power to control the product lifespan, influence business and consumer behaviour, designers play a significant role in mitigating today’s environmental problems (Ramirez, 2007) and in the transition towards a circular economy (Andrews, 2015). Design students, the design discipline and accordingly the whole society can benefit from teaching that explores current problems and requires them to articulate prospective solutions.

Students, as the future designers, must be prepared for the alternative scenarios and be equipped with relevant knowledge to be able to deal with environmental issues. This need can be seen from the increasing calls for change in design education throughout the literature (Findeli, 2001; Ramirez, 2007; Norman, 2010; Scheer, Noweski & Meinel, 2012; Andrews, 2015; Wever, Charnley, Brass & Harrison, 2015). Some educational resources, courses and projects exist that aim to incorporate sustainability and circular economy into the product design education (Ramirez, 2006; Doğan, 2012; Lofthouse, 2013; Ellen MacArthur Foundation, 2015; Doğan, Turhan & Bakırloğlu, 2016; Bakırloğlu, McMahon, Eyto & Río, 2018). However, the number of these projects is not enough, and we have not come across any course that focuses on repair or visible repair.

This paper describes an assignment that aims to integrate repair into product design education and to explore insights about repair and sustainability. The assignment, called “Beautiful Repair”, is prepared as the first part of a master’s degree studio course which consists of three assignments and an exhibition. Beautiful Repair assignment explores how repair can enhance the character, value and aesthetics of a product. The other two parts study different aspects of repair. The second part focuses on the social aspect of repair for which the students organised a Repair Café at the university. The third part focuses on system thinking, designing a system of repair and exploring how repair can be a part of a system. The course is compulsory for first-year students in the product design programme. There are fifteen students with diverse backgrounds such as electrical engineering, philology, and business & management. The duration of this assignment was thirteen weeks. The requirement of the assignment for each student was to visibly repair one or more products in an aesthetically pleasing way by using different design perspectives such as artistic, industrial and critical perspectives. Students were instructed in the fundamental aspects of the circular economy, system thinking and the environmental problems. They had the freedom to choose the product they want to repair and the repair method. Throughout the process students were guided, relevant examples were shown, and their works were scrutinized. Both teachers and students critiqued each individual project during the studio classes. Finally, the students have developed fifteen visible repair projects (Figure 1). They have repaired a diverse range of physically damaged products including bicycle, leggings, and motorcycle part. Each project corresponding to each student can be seen in Table 1.

<table>
<thead>
<tr>
<th>Student</th>
<th>Project Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Clockwork</td>
</tr>
<tr>
<td>2</td>
<td>Red Bicycle</td>
</tr>
<tr>
<td>3</td>
<td>Leggings</td>
</tr>
<tr>
<td>4</td>
<td>Ceramic Concrete</td>
</tr>
<tr>
<td>5</td>
<td>3DP comb</td>
</tr>
<tr>
<td>6</td>
<td>Doll Stroller</td>
</tr>
<tr>
<td>7</td>
<td>Kintsugi Plates</td>
</tr>
<tr>
<td>8</td>
<td>Paper Lampshade</td>
</tr>
<tr>
<td>9</td>
<td>Bicycle Lamp</td>
</tr>
<tr>
<td>10</td>
<td>Cutlery</td>
</tr>
<tr>
<td>11</td>
<td>BMW Cup</td>
</tr>
<tr>
<td>12</td>
<td>Headphones</td>
</tr>
<tr>
<td>13</td>
<td>Watch Strap</td>
</tr>
<tr>
<td>14</td>
<td>Glass Lampshade</td>
</tr>
<tr>
<td>15</td>
<td>Motorcycle Part</td>
</tr>
</tbody>
</table>

2 Methodology

The purpose of this paper is to explore the insights related to product repair and lay some foundations for integrating sustainability aspects into design education. In order to explore and find out the insights of this process and articulate the individual’s views, a focus group was considered the most appropriate method for this research. This research method enables a deeper understanding of individual insights through “live encounters” with the participants (Stewart & Shamdasani, 2014, p. 12). The focus group session was conducted with the students and lasted around two hours. We did not focus on too many questions but concentrated around the theme and insights that created an interactive discussion rather than a within-group survey (Stewart & Shamdasani, 2014).
Figure 1. The students have visibly repaired a diverse range of physically damaged products including bicycle, leggings, motorcycle part, etc.
A natural and comfortable atmosphere was achieved that students were encouraged to express different points of view and did not feel pressurized (Litosseliti, 2003). Involving all the students created an extensive discussion and probing environment and particularly enhanced the potential diversity of perspectives and ideas generated. A wealth of insights was provided by the students and each insight was discussed according to its relevance to each repair project.

Content analysis was used to analyse the collected data (Weber, 1990). The respondents’ answers with similar meanings and connotations were grouped into clusters. Each cluster was coded under a relevant title. Then we defined how each cluster answers the research objective, which is to explore and define the insights related to visible product repair. With the help of this definition process, the clusters were organised into categories. Finally, fifteen insights have been created including brokenness, nature of repair, value/cost etc. (Table 2).

### Table 2. Fifteen insights related to product repair were developed.

<table>
<thead>
<tr>
<th>Repair Insights</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Nature of Repair</td>
</tr>
<tr>
<td>2 Brokenness</td>
</tr>
<tr>
<td>3 Designed Repair</td>
</tr>
<tr>
<td>4 Designer’s Role</td>
</tr>
<tr>
<td>5 Perspectives of Repair</td>
</tr>
<tr>
<td>6 Product Category</td>
</tr>
<tr>
<td>7 Repair Technique</td>
</tr>
<tr>
<td>8 Value – Cost</td>
</tr>
<tr>
<td>9 Reproducibility of Repair</td>
</tr>
<tr>
<td>10 Impact of Repair on Future Damage and Repairs</td>
</tr>
<tr>
<td>11 Less/All/More Material</td>
</tr>
<tr>
<td>12 Aesthetic Language</td>
</tr>
<tr>
<td>13 Fixing versus Something New</td>
</tr>
<tr>
<td>14 Collaboration / Social Aspect</td>
</tr>
<tr>
<td>15 Storytelling / Design Activism</td>
</tr>
</tbody>
</table>

### 3 Repair Insights

#### 3.1 Nature of Repair

This insight questions what can be called repair. How far can we go with the repair in terms of changing the object’s look or altering the way it is used? What is the difference between repair and upcycling? Repair refers to the act of bringing a damaged or faulty object back to a usable condition. This damage can be related to functional or aesthetic defects. The aim is eliminating the problems that disturb or intervene with the usual ways a product is used.

Upcycling, on the other hand, can be applied both on the material level or the object level. For the object level, it is the process of transforming discarded, faulty or out of order objects into something of higher value in their second life (Sung, 2015).

For example, Student 1’s object was an operating clockwork as it can be seen in Figure 2. The clockwork was functional, but it was missing the clock face and the handset. Instead of only creating a new clock face and the handset, the student created a whole new product and changed the way it works. In her new design, the clock face turns to show the time without the handset (Figure 2). The clock face completes one turn in 12 hours and the dots between the numbers represent each quarter of the hour. Similarly, Student 14 reconstructed the broken glass lampshade and created a new product (Figure 3). She used the broken glass pieces after sanding the edges. She designed and 3D-printed a body part and joints. Then, she used joints and red wires to attach glass pieces to the body. These two products can be considered as upcycling rather than repair because both products are reconstructed and redesigned although the function of the objects is the same after each intervention.
3.2 Brokenness

“What is broken? In which ways is it broken? What makes a product broken? And are there different kinds of brokenness? Is it incomplete or missing a part, or has it lost its value and needs a new aesthetic update?” were some of the questions that came up during the discussion related to this insight. If the product is functioning well but has some ripped parts, can we call it broken? Students had the freedom to decide “what broken is” and “what repair is” themselves so this provided a range of products which are broken in different ways. Out of the fifteen products that students repaired we can see different kinds of brokenness, including products with physical damage, incomplete products and obsolete products. Additionally, these categories can refer to aesthetic or/and functional issues.

<table>
<thead>
<tr>
<th>Category</th>
<th>Aesthetic Issues</th>
<th>Functional Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incomplete</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Physical Damage</td>
<td>3, 6, 12, 14</td>
<td>2, 3, 4, 5, 6, 7, 8, 9, 11, 13</td>
</tr>
<tr>
<td>Obsolete</td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>
Student 1’s clockwork repair was briefly explained above. It did not have any damaged parts, but it was not working because of the missing part. Accordingly, this project goes to the incomplete and functional issues categories in Table 3. On the other hand, Student 10 worked with cutlery. The cutlery goes under the obsolete and aesthetic issues categories in Table 3 since it did not have any physical damage or functional issues. Users did not want to use the cutlery because of aesthetic concerns as they were not matching.

3.3 Designed Repair

“How do you determine how to repair something? How do you get a designed repair? What are the similarities and differences between the repair process and the design process?” were some of the questions that came up during the discussion about the design process. During the repair process, one works on an already designed product with damaged parts and most of the time needs to make new design decisions. Technical and aesthetic features of the product, as well as the repairer’s skills and knowledge, need to be considered while making these design decisions. The designed repair process differs according to the materials and methods used. Some repair methods are easy to apply so that a product can be repaired more than once and enables experimenting. In the 3D comb, watch strap and headphones projects, students produced more than one repair solutions. However, there were other cases where the repair method was time-consuming and expensive. For example, Student 1 had one chance to complete the repair of the clockwork.

3.4 Designer’s Role

The designers’ role has been shaped according to the conditions set by the linear system and throughput-based economy. It is changing as the system transitions towards a circular one. This study underlines the designers’ role in the repairing process, which is bringing a product back into use beautifully, critically or functionally. Their role is transforming objects and people’s mindsets with creativity and innovation.

3.5 Perspectives of Repair

Artistic, industrial or critical are some of the different perspectives that can be used to visibly repair products. The perspective can be decided from the beginning or might be formed during the process depending on the nature of the damage, design of the product and the repair methods. For example, Student 2 repaired his bicycle with an industrial perspective then he painted the repaired part artistically also because of a functional requirement. The hinge of the folding bike was broken and got thin and weak due to rusting. With the help of the experts in the workshop, he created a new hinge by welding nuts to the remaining part of the hinge and machined a metal axle to go through these nuts (Figure 4). He drilled through the nuts to remove the threads before welding them to the bicycle. Finally, he painted the newly created hinge to prevent it from rusting again. By purposely selecting a contrasting colour, the student highlighted the repair. Here, the functional repair and the aesthetic repair are thus somewhat separated from each other.

Figure 4. Student 2 repaired the hinge of his bicycle with an industrial perspective then he painted the repaired part to prevent it from rusting.
Student 4 adopted an artistic perspective from the beginning of the project. He repaired broken ceramic cups by covering them with concrete and shaping them with cylindrical moulds (Figure 5). Then, to highlight the broken parts he used kintsugi which is a traditional Japanese repair method of mending ceramic products with gold and silver powder. He explained why he used these two different materials with the contrasting meanings with these words: “I liked the idea of using cement, a strong and sturdy material, to contrast the fragility of ceramics and create something that identified with longevity rather than fragility.”

![Figure 5. Student 4 adopted an artistic perspective from the beginning of the project. He repaired broken ceramic cups by covering them with concrete and shaping them with cylindrical moulds.](image)

### 3.6 Product Category
Students had the freedom to choose any product they wanted to repair visibly, in other words, there was no single product category focus in this study. This created a diverse product spectrum from electronic products such as headphones to textiles such as leggings and enriched the results of the study. As the visible repair was one of the requirements, all the products they chose were physically damaged.

### 3.7 Repair Technique
Repair techniques differ according to various factors such as product category, damage, product’s material, and design. Certain repair techniques can be defined referring to certain product categories and damage types, but these methods cannot be limited to a certain number because of the unique character of each damage and repair. During the focus group discussion, some repair techniques were mentioned including mechanical repair techniques, electrical repairs, electronic repairs and visible repair.

### 3.8 Value – Cost
In today’s consumerist society, repair is usually expensive and time-consuming. On the other hand, buying something new has been made cheap and easy. Under the value-cost category, the students discussed the value that repair creates and how the repair process makes us understand an object’s value. Student 7 explained how the repair process, the time and labour she spent on the project enabled her/him to realise and appreciate the value of the work spent to design and manufacture a product. Student 8’s paper lampshade is also a good example of how alternative valuation processes can be achieved and embedded into products through repair. It is a torn paper lampshade that she and her daughters repaired with handmade paper flowers. This resulted in an enjoyable bonding time between the family members and improving the emotional value of the product. During a studio critique session, she declared that: “This could be the cheapest and a valueless object for anyone else, but it is one of the most valuable objects in my house after the repair.”

### 3.9 Reproducibility of Repair
Similar damages and problems can reoccur after the repair. In that case, a repair method and material that the user can access and apply by himself/herself should be chosen to increase the use life of products. For example, Student 6 repaired a doll stroller which had signs of previous repairs such as glue residue and tied threads. It is a fragile rattan object. It was broken and has been repaired many times. As it can be seen in Figure 6, she wove the broken parts with synthetic knitting yarn. Two factors make this repair reproducible. First, the thread as a repair material is easily accessible if not available in the user’s house. Second, the method does not require many skills and is easy to apply.
The student also did not weave all the sides, left some parts empty for the user to weave himself/herself. These features of this repair invite the user to try and complete the repair.

3.10 Impact of Repair on Future Damage and Repairs
When one repairs a product, the result has an impact on the possibility of future damage and repair of the product. The repair might make the product prone to damage or might make it stronger. Similarly, the completed repair might make it easier or harder to repair the product afterward. For example, Student 5’s plastic comb reparation enables the product to be repaired repeatedly. This plastic comb had some of the teeth broken and missing. She designed a tooth and a body that a couple of teeth can be inserted through (Figure 7). This body makes the teeth stable then it is attached to the broken comb through its remaining teeth. She produced one plastic version of this design with 3D-printing and one wooden with laser cutting. The teeth are modular so when one of them breaks, the user can dismantle and change it. This feature enables the product to be repaired in the future if a similar problem happens again.

3.11 Less/All/More Material
Students repaired all the products by adding extra material or a product part. However, we discussed in the focus group session that one does not always need to add material to repair an object. Sometimes to repair a thing we need to take away material. Turning trousers with ripped knees into shorts by cutting the lower parts off can be given as a common example of this case.
3.12 Aesthetic Language
Visible repair stands out and differs from the overall look of the product in terms of aesthetics as it is made from a different material or it is in a different colour. It creates a different aesthetic language than for example the shiny and fragile surfaces of some of the currently available products. Rather than trying to hide the damage this language focuses on creativity and encourages thoughtful assessment of the damage and repair.

3.13 Fixing versus Something New
How can we compare fixing something to buying something new? What changes when we fix an object or buy a new one? Is repair a choice or is buying something new the only choice that users have? Every choice we make and every action we take has different consequences on the environment. We know and are currently experiencing the consequences of overconsumption and exploitation of people and the environment. However, we do not know how repair changes us as individuals, our society and environment.

3.14 Collaboration / Social Aspect
Repair usually enables social interaction whether you find a repairman, ask someone who has the skills to fix your object or you attend a Repair Café and meet a lot of people. In this project, the collaborative aspect of repair led to two types of gains that are learning from collaboration and bonding through repair. In the former, students collaborated with the technicians in the workshop and requested an expert opinion outside the university and learned from these collaborations. In the latter, students asked each other or their family for help and ideas. For example, Student 8’s paper lampshade repair is valuable in terms of emphasising the bonding through repair. It is a great example of bringing people together as she included her children in the repair process.

3.15 Storytelling/ Design Activism
Making repair visible is design activism in a society where replacement is the norm. Visible repair takes people’s attention, and this has both advantages and disadvantages for spreading the message. It has an advantage because by taking people’s attention, a conversation might start which is a great way to create awareness. It has a disadvantage because of the negative stigma attached to repair. Some people do not want to use visibly repaired objects because they are ashamed of repair in their value system, which is related to poverty, lack of resources, etc. This point was discussed in Student 3’s project critique sessions. She mended some leggings that have the same damage inside of the thighs. She used bright coloured thread and sashiko technique which is a traditional Japanese decorative embroidery (Figure 8). The discussion was about wearing these leggings and whether she would wear them or not. She said that she wanted to wear them, but she had some concerns and hesitation. A person might be ashamed of wearing visibly repaired clothes depending on the place of the repair, in this case the thigh area. It might require more courage to wear these leggings with visible repair on the inner thigh rather than wearing bottoms with visible repair on other parts such as knees or in front of the legs.

Figure 8. Student 3 mended the leggings that have the same damage inside of the thighs by using bright coloured thread and sashiko technique which is a traditional Japanese decorative embroidery.
4 Discussion

In this part, some suggestions for the integration repair into product design education is discussed. Repair has both advantages and disadvantages for incorporating it in product design curriculum. It is a hands-on activity and an effective way to encourage students to work with their hands and create prototypes. However, it is important that instructors place emphasis on all stages of the repair process. Students need guidance on the three phases of a designed repair process including discovery, idea generation and implementation (Terzioglu, 2017). For example, Students 11 and 12 spent most of their time on the implementation phase and neglected the first two phases. Their final repair solutions would have been more creative and aesthetically pleasing if they had spent more effort on the idea generation stage especially on sketching and visual representation.

Figure 9. After having difficulties with repairing the keyboard, Student 15 decided to repair a plastic motorcycle part.

Another aspect that should not be overlooked is the central role of studio discussions considering sustainability principles and dimensions of repair. Design solutions that are proposed by the students can be evaluated according to the different dimensions of repair during studio discussions. It is crucial for students to share their process if they are to benefit fully from the assignment and provide relevant solutions in terms of sustainability. For example, Student 15 worked on repairing a keyboard. He had some difficulties with repairing it throughout the assignment process and did not attend most of the studio discussions. Close to the end of the process, he said he failed to repair the keyboard and decided to repair another product, which was a cracked plastic motorcycle part. Repair has different risk factors compared to designing a new product. Failure is a part of the nature of the activity. Eventually, Student 15 felt that he needed to change the product, but the failed example could have been interesting to discuss. He repaired the part without getting any feedback because there was not enough time left. He welded small pieces of wire mesh in Figure 9 to the broken part after aligning the cracks. Then he filled the cracks in the front of the object with candle wax which he mixed with red food colouring (Figure 9). Candle wax and food colouring are not proper materials to fix a plastic motorcycle part. They did not provide any structural, functional or aesthetic advantage. This example shows that it might be hard for the students to comprehend the dimensions of repair such as aesthetics and functionality. It also emphasises the importance of studio discussions and following the stages of the repair process.

5 Conclusion

This paper describes a product design course prepared to integrate repair into product design education in higher education. Fifteen master’s degree first-year students visibly repaired one or more objects by using different design perspectives. At the end of the project, fifteen different insights about repair were developed and discussed in a focus group session. All these insights, including brokenness, perspectives of repair, and collaboration/social aspect, were explained with examples in this paper.

This project helped us to explore the complexity of repair as a subject area and through the insights we understood repair’s dimensions further. Repair is part of our daily life. It should be a part of the product design process, and accordingly of all products. However, there is not enough research on repair and integrating repair into product design education. This research is valuable for design practice as it provides concrete examples and insights from repair processes. It is valuable for academics as it shows an example of incorporating repair into design education. The insights developed in this research can be explored further, whereas some of them can be taken into consideration in future research about product repair.
Repair ought to be part of design education, at the very least for those design curricula that cover product design. Educators in those programs might chose to implement this exact same assignment. Based on our experiences we would propose the following pointers:

- The reflection session, in which you generate the themes overarching the individual repairs, is as important as the longer process in which the students generate their repairs. It generates a large part of the learning, if the objective is to truly reflect on the relationship between design, repair and sustainability.
- In order to generate such overarching insights, students should be given maximum freedom in choosing objects and repair techniques, as well as in defining what is broken and what constitutes repair.
- Combining this assignment with other repair related assignments, such as hosting a repair café, strengthens the learning further.

If a full repair exercise is beyond what is feasible for a program, the examples of repair in this paper, combined with the perspectives generated, should still be an effective basis for a shorter lecture or workshop exploring the notion of design and repair.

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References


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How Industrial Design Students Approach Service Design Projects

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Abstract: This paper aims to investigate the ways industrial design students approach service design projects. Taking the unique aspects of services compared to products into account, first, the notion of the studio project was discussed from a service design perspective. The elements of service design projects were articulated as the offering; the modules and interfaces; and the suppliers, customers and resources. Then, using an undergraduate service design elective course as a case, a thematic account of nine student projects was developed. Four design strategies utilized by industrial design students in their service design project development efforts were inductively identified: replacing a product with a service idea; reconceptualising an existing service in a local context; expanding the scope of a professional service through digital channels; and changing the target user group of an existing service and redesigning the customer journey. These strategies were distinguished by the locus element of the projects and the amount of iteration that took place between the three project elements. The results show that the design strategy followed, impacts the degree of novelty of the proposed service. Consequently, for successful service design projects, students and design teams need to combine different methods to visually manifest the parameters and limits of the service, decide on the locus project element that will guide the design process, and continuously explore and seize new ideas that emerge from the interactions between the different project elements.

Keywords: design strategy; industrial design; service design; studio projects; teaching and learning

1 Introduction

This paper is concerned with investigating how industrial design students approach service design projects. The global shift from a manufacturing economy to a knowledge and service economy has triggered the development of service design as a profession, in relation to the demand in private-, public-, and third-sector organizations (Sun & Runcie, 2016). In line with these developments, service design programs and courses have become more widespread in leading schools, including the Master’s in Service Design at the Royal College of Art (RCA), MDes Service Design Innovation at the University of the Arts London, Design Innovation and Service Design at Glasgow School of Art, Service Design at Savannah College of Art and Design, Service Design at Politecnico di Milano, and Service Design and Engineering at Aalto University (Sun & Runcie, 2016). Findeli (2001, p. 6) has also criticized the “overemphasis upon the material product”; “the aesthetics based almost exclusively on material shapes and qualities”; and “the sense of history conditioned by the concept of material progress” in the design discipline, highlighting the efforts to lay down
new foundations for design education. He proposed four scenarios in which the product-centred attitude could be replaced by a new one:

1. Shifting toward a systems approach and complexification that pushes material artefacts to the background in favour of the actors within the system;
2. Systematically questioning the design brief with a focus on the human context yielding the brief rather than the classical product description brief;
3. Transferring the methodologies developed for the design of material products to the world of immaterial services;
4. Engaging in a more sustainable design attitude that emphasizes the necessity for products to vanish in the near future (Findeli, 2001).

Service design emphasizes co-creation (Yu & Sangiorgi, 2018), value relations among different stakeholders (Kimbell, 2011), and representation techniques that help to visualize these value relations (Morelli, 2009). Thus, the number and variety of the components, activities, and actors involved in the design process increase. These tenets of service design potentially make the project at hand more complex compared to designing a pure product.

In the following sections, a literature review is presented that discusses the changing nature of studio projects from a service design perspective. Next, an overview of an undergraduate service design elective course is provided with an analysis of the student projects. The results illustrate the various design strategies used by the students, elaborating on the relations between different project elements during the process of designing a new service. The last section entails the conclusions.

2 Service Design and the Changing Nature of Studio Projects

With the growth of the service economy, design in this new era is going through a shift in focus from product-centred thinking to system and service-oriented thinking (Young, 2008). Hence, new opportunities are emerging as design moves from lower level product-centred design strategies to the complexities involved in designing business processes and customer touch-points on an organizational level (Cooper, Junginger & Lockwood, 2009). Additionally, in comparison with the recent past, designers’ roles have expanded from being a shaper of industrial products to acting as a mediator between the different knowledge cores in an organization (Zurlo & Cautela, 2014). These changes highlight several core factors in the designers’ activity: from global to local systems, from material production to value co-production, and interaction among different actors (Morelli, 2009). Hence, designers should not only consider the product development process itself but also the holistic service-product system context.

Service design is a young discipline that has emerged as a creative and holistic approach to service innovation (Meroni & Sangiorgi, 2011; Stickdorn & Schneider, 2010), and since the 2000s, it has established its own disciplinary foundations (Sangiorgi & Prendiville, 2015). In a recent study, Yu and Sangiorgi (2018) have shown how service design can contribute to the contextual and holistic understandings of user experiences, aligning system actors to the user experience, and building long-term capabilities to implement value co-creation. These findings complement the view that describes service design as “an exploratory process that aims to create new kinds of value relations between diverse actors within a socio-material configuration” (Kimbell, 2011; p. 41).

Bousbaci and Findeli’s (2005) conceptualisation of projects provides a useful basis to identify the elements that constitute a studio project in the service design domain. They have illustrated three project elements as the product or the outcome of the project; the process of the project; and the actors i.e. the stakeholders of the project (Bousbaci & Findeli, 2005). The unique aspects of services such as the high level of customer/user input into their production process (Sampson & Froehle, 2006), their requirement for continuous incremental improvements (Zomerdijk & Voss, 2010), and their exploratory nature (Spring & Araujo, 2013), necessitate a reconsideration of these elements in service-related terms.

3 Elements of the Service Design Project

This section explores the elements that constitute the project in the context of services and emphasizes service design aspects that are discussed in the previous literature. Building on Findeli and Bousbaci’s (2005) conceptualisation of the design project, the three elements are identified as the offering, the modules and interfaces, and the suppliers, customers and resources, as shown in Figure 1.
3.1 The Offering

With the added service, the offering as an element of the project can be referred to as a product-service combination, or in Richard Normann’s (2001) terms, a process reconfiguration, which is “designed to more effectively enable and organize co-production” (p. 114). Mason and Spring (2011) combine concepts from marketing and economic sociology and characterise the offering as comprising the value creation opportunity emerging from alternative combinations of artefacts, access to suppliers’ capabilities, and activities performed by the suppliers on the customers’ property. Thus, the main focus becomes the nature of the producer-user interaction, rather than the features of a particular product or service (Mason & Spring, 2011). Drawing upon Normann’s (2001) conceptualisation of the offering once more, students are first required to design a platform, described as an “inventory of past activities in frozen form” (p. 119). This entails determining the process, tools, and staff that would be used for all users and deciding on the boundaries of the offering. The next step comprises the specification of a “code for value-creating activities” (Normann, p. 119). At this stage, students are expected to consider the means that would allow customers/users to be able to get partly involved in designing their own solutions.

3.2 The Modules and Interfaces

According to Tuunanen, Bask and Merisalo-Rantanen (2012) and Spring and Santos (2014), a service module can be defined as a system of components or a subset of activities that offers a well-defined functionality by the service provider for the benefit of the customer via a precisely described interface. The application of modularity principles to services create important opportunities for customization and personalization (Brax, Bask, Hsuan & Voss, 2017). de Blok, Meijboom, Luijk, Schols and Schroeder (2014, p. 186) have proposed an adapted definition of interfaces: “The set of rules and guidelines governing the flexible arrangement, interconnections, and interdependence of service components and service providers.” Service interfaces are characterized by their material heterogeneity, through which intangible resources are actualized and made available to bodily perception (Secomandi & Snelders, 2011). de Blok et al. (2014) have also suggested that interfaces ensure the flow of information among service providers and the smooth flow of customers between service components. Thus, the process of a service design project mainly involves designing the modules that consist of a set of experiences and as illustrated by Spring and Santos (2014), the intermodular connections that are formalized by interfaces.

3.3 The Suppliers, Customers and Resources

From a service lens, the term actors refers to customers, organizations and non-human entities such as technology that participate in value creation (Patrício, Gustafsson & Fisk, 2018). Associating the concept of value with use and context has shifted the focus from the units of output to the interactions in the service network (Sangiorgi & Prendiville, 2015). This has given rise to the views that described service “as a perspective on the customer’s value creation” and “as a perspective on the provider’s activities” (Grönroos, 2008, p. 300). In line with these views, the suppliers either become a value facilitator by providing the resources (i.e. goods, services, information or other resources) that will support its customers’ value creation; or a co-creator of value by directly engaging in and influencing its customers’ value-generating processes (Grönroos, 2008). A service design project therefore entails the detailed description of the roles that suppliers, customers and resources play in the service ecosystem.
4 The Case of an Undergraduate Service Design Elective Course

4.1 Overview of the Course and Learning Outcomes

This study focused on an undergraduate service design elective course that was taught by the author in the Industrial Design Department of a private university. The main aim of the course is to strengthen the knowledge regarding service design approaches and methods. The duration of the course is 14 weeks. The first 4 weeks comprise the introduction to the course outline and lectures about the emergence and development of service design, service design methods and tools, and examples of service design projects at different levels and sectors. In the following 5 weeks, the students analyse the problem context, find examples of best practices, conduct desk and user research, and generate ideas. The last 5 weeks entail service concept development, visualisation, and presentation of the projects. The stages of the project according to the weekly course schedule is shown in Table 1.

<table>
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<tr>
<th>Weeks</th>
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The learning outcomes of the course are as follows:

- Being able to apply service design approach and methods in the creation of service offerings,
- Being able to interpret information that is relevant to the given service design problems,
- Being able to utilize various techniques which will enable the discovery of user needs and new business opportunities,
- Being able to conceptualise and communicate service ideas,
- Being able to collect and analyse data for studies on service design.

Van Aken (2005) has argued that process designers need to structure the design process to allow for subsequent management of this process and for coordination between the various parties involved in it. This principle is also applicable to course designs. Therefore, it is significant for instructors (in this case they are the process designers) to develop a flexible course structure that allows students (in this case they are the service designers) to work on the areas chosen by themselves and that provides them with the necessary tools to communicate the service system. Along the same lines, in this elective course, students determined the scope of the service design project themselves and targeted diverse areas including healthcare and well-being, maintenance and repair, travel and transportation. Moreover, based on the examples shown in the course lectures, they visualized their service concepts using different service design techniques such as personas, customer journey maps and storyboards.

4.2 Data Collection and Analysis

The initial sample comprised 15 students who took the service design elective course during the 2017-2018 academic year. After the completion of the projects, those of a convenience sample of nine students (N=9), who successfully fulfilled the requirements of the course, were analysed. An overview of the selected projects is presented in Table 2. To track their progress, students were asked to keep a project log book with which to document the different stages of the service design process. The log books enabled them to note down their observations, evaluations of best practices, desk research, and personal experiences, which served as qualitative elements. To guide the documentation of the projects and to gather a standardized data set, the students provided answers to the following questions: a) What are the objectives of the proposed service? b) What is the value added? c) Are there any similar examples in
different sectors? d) Who are the main competitors? Moreover, several design tasks were completed by the students through in-class assignments. These included creating a persona, mapping the main stakeholders, and filling out a business model canvas that provided additional information on the key partners, key resources, revenue streams, and cost structure, as shown in Figure 2 (Osterwalder & Pigneur, 2010).

![Business Model Canvas](image)

**Figure 2. A business model canvas example from a student project (Sayar, 2018).**

Finally, each week, the students were allotted an hour to fill out a sheet (as illustrated in Figure 3), where they first listed the activities that they had completed in relation to the project elements separately, and showed the connections of these activities with the other project elements using arrows. These sheets were then added to the log books, which were used to determine how many times the students went back and forth between elements during their service design processes.

![Example Sheet](image)

**Figure 3. An example sheet showing the iterations between the project elements (Sayar, 2018).**

The data gathered in the log books were coded and analysed using thematic analysis. The main phases of thematic analysis are familiarizing oneself with the collected data and taking notes, generating initial codes, searching for themes, reviewing themes, and providing clear definitions and names for each theme (Braun & Clarke, 2006). First, a thick description of the service design process was made, with emphasis on the interactions between the three
Deniz SAYAR

project elements in each student project. Then, design activities performed by the students regarding the offering, the modules and interfaces, and the suppliers, customers and resources were analysed and coded. This enabled the identification of the project element that predominantly led to the generation of new ideas in the design process. Analysis also focused on the amount of iteration that took place between the three elements within selected service design projects. The second part of the analysis aimed to uncover patterns; including similarities and differences between projects to articulate design strategies utilized by the industrial design students when they were asked to design a service.

Table 2. Overview of the selected student projects.

<table>
<thead>
<tr>
<th>Project</th>
<th>The Offering</th>
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<tbody>
<tr>
<td>Project 1</td>
<td>An online platform that enables people to travel with volunteer tour guides</td>
</tr>
<tr>
<td>Project 2</td>
<td>A service that enables consumers to search for local producers/farmers and gain access to fresher ingredients</td>
</tr>
<tr>
<td>Project 3</td>
<td>A service that organizes social events to bring retirees with common hobbies together</td>
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<tr>
<td>Project 4</td>
<td>A maintenance and repair station network for cyclists</td>
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<tr>
<td>Project 5</td>
<td>A medication follow-up and delivery service for the elderly</td>
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<tr>
<td>Project 6</td>
<td>A service for exchanging books</td>
</tr>
<tr>
<td>Project 7</td>
<td>A service that shows the locations of street animals with injuries and the nearby vets to facilitate their treatment</td>
</tr>
<tr>
<td>Project 8</td>
<td>An ironing service</td>
</tr>
<tr>
<td>Project 9</td>
<td>A service that aims to provide emotional support for pregnant women and improve their well-being</td>
</tr>
</tbody>
</table>

4.3 Findings

The thematic analysis of the project log books revealed four design strategies utilized by the students: replacing a product with a service idea, reconceptualising an existing service idea in a local context, expanding the scope of a professional service through digital channels, and changing the target user group of an existing service idea and redesigning the customer journey. Each strategy showed differences in terms of the locus element of the service design projects and the number of iterations between the three project elements. Figure 4 illustrates the four strategies. The coloured ellipses indicate the locus element which entails the main design decisions related to the project and integrates the other service design project elements. The double-headed arrows show the amount of iteration between elements during the design process, indicated as low (dashed lines), moderate (straight lines), or high (bold straight lines). Below, the four service design strategies are explained in detail, through examples and excerpts from the student projects.

4.3.1 Replacing a Product with a Service Idea

The first design strategy was replacing a product with a service idea. An increasing number of iterations between the offering and modules and interfaces was observed, whereas the amount iteration between modules and interfaces and customers, suppliers and resources was the lowest.

This strategy was evident in Project 6 (ironing service) and Project 8 (book exchange service). In these projects, the students imagined that a service was sold in lieu of a product. It required a reconsideration of physical product ownership, paving the way for service concepts based on sharing or designs that emphasized the purchase of an outcome performed by the service provider. Hence, the offering acted as the locus element of the project and the main source of design decisions. The students started their ideation phases from the product’s function and use (i.e. the offering) and moved on to the design of modules and interfaces, resulting in a high amount of iteration between these two project elements. For example, the designer of the book exchange service described his process as follows: “Reading is generally seen as an individual activity, I thought about how to turn it into a more collective activity. I wanted this service to bring together individuals who like the same book genres” (Student 8). The different book genres then informed the service modules and interface. For example, the two main modules were identified as fiction and non-fiction, so the first wireframe of the mobile application required the users to make a choice between the two.
Similarly, in the ironing service, the student divided the whole activity into three main modules as registering to the system and booking the collection time, collection of the clothes, and delivery of the ironed clothes. The designer of the project wrote: “Ironing is quite time-consuming, so as I’m taking over this activity as the service provider, I first need to design a mobile application that is easy to use and a nice packaging for the ironed clothes, maybe something like a gift box, to give the message: When you receive your clothes you’ll feel like you just bought them” (Student 6). Design decisions related to the offering also required the students to redefine the roles of customers, suppliers and resources in the service ecosystem, leading to a moderate amount of iteration between these project elements.

Compared to the strategies, reconceptualising an existing service idea in a local context and changing the target group of an existing service idea and redesigning the customer journey, projects designed with this strategy had a lower degree of novelty. One reason might be the fact that the students could directly rely on their own experiences regarding product usage (in this case ironing and reading), and therefore, generating an understanding of customers, suppliers and resources was not very critical at the early stages of the design process.

**Figure 4.** The relations between the three project elements in the identified service design strategies.

### 4.3.2 Reconceptualising an Existing Service Idea in a Local Context

The second strategy identified was reconceptualising an existing service idea in a local context, characterised by the high amount of iteration between customers, suppliers and resources, and the offering. However, the amount of iteration between the offering and modules and interfaces was the lowest.
This strategy was evident in Project 4 (bicycle maintenance and repair service). This project entailed designing the maintenance and repair stations specialized for the needs of cyclists. The locations of these stations were determined through a comprehensive analysis of the customer experience. Hence, the locus element of the project was customers, suppliers and resources, initiating the design requirements for the other two elements. The student conducted interviews with cyclists to gather in-depth insights about their preferred bike routes in the city where the service was intended to be used and about the challenges they faced. These insights then informed the creation of two scenarios; the first one regarding how to get from a certain point A to point B by bike and the second one regarding what to do in case of a flat tire. Storyboards were prepared for both scenarios that enabled the student to translate the collected customer data into the service offering: “The frames that I developed in my storyboards determined what I was going to offer, the boundaries of my service. There will be individual repair units with all the basic tools for 10 cyclists in each station. Cyclists will also be able to get assistance from expert service staff. I am also planning to include a small shop corner in each station, so that cyclists can buy all the accessories they need before or during their journeys” (Student 4). Thus, iteration frequency between customers, suppliers and resources and the offering was high. Design decisions based on customers, suppliers and resources also determined the design decisions regarding the modules and interfaces; such as wireframes of the mobile user interface, the roles of the expert staff in the stations, and design of the repair units. This corresponded to a moderate amount of iteration between these elements.

The degree of novelty of the proposed service was relatively high compared to the services developed using the first and third design strategies. This could explain the distribution of the amount of iteration between the project elements. According to Trischler, Pervan, Kelly and Scott (2018), capturing detailed information about service ecosystem actors’ usage and latent needs is central to new service innovation. Therefore, it was expected that projects in which customers, suppliers and resources played the key role in the design process would lead to more novel modules and interfaces and offerings.

4.3.3 Expanding the Scope of a Professional Service through Digital Channels

The third strategy, expanding the scope of a professional service through digital channels, was deployed in Project 1 (travel service) and Project 9 (emotional support for pregnant women). In these projects, the locus project element was identified as modules and interfaces. Digital channels such as websites and mobile applications made the professional services easily accessible to everyone. Furthermore, they served as platforms for sharing positive and negative experiences, enabling the active participation of actors. The content of the offering also became more dynamic, continuously evolving with the up-to-date inputs provided by the experts who delivered the service.

A notable observation in these projects was that the boundaries of the service offering was more anticipated, as the students could easily gather existing information about related professional services provided by psychologists and tour guides. Along these lines, the projects were more incremental in nature, requiring only a limited amount of iteration between customers, suppliers and resources and the offering. For example, the designer of Project 9 only conducted a desk research about the emotional challenges of pregnancy, with very limited input from experts themselves. This information was then used to design the modules and interfaces, as the service was based on a digital platform that would bring together psychologists to share their expertise. The travel service also necessitated a technical infrastructure. As the designer explained: “Some people might have a limited budget or time for traveling, especially abroad. I wanted them to select the destination they want to go and see the most popular locations of that destination with a volunteer guide through a FaceTime video call” (Student 1). In sum, students who designed these projects took advantage of ideas that aroused from modifications in the ways existing professional services were delivered, such as using the opportunities provided by video communication technologies. It was also interesting to note that design decisions about modules and interfaces mainly shaped the design process of the roles that customers, suppliers and resources would play during service delivery, resulting in a high amount of iteration between these two project elements.

4.3.4 Changing the Target User Group of an Existing Service Idea and Redesigning the Customer Journey

The last strategy was identified as changing the target user group of an existing service idea and redesigning the customer journey. Project 2 (finding local producers/farmers), Project 3 (organizing social events for retirees), Project 5 (medication follow-up and delivery service), and Project 7 (curing street animals) were inspired by the well-known examples of location-based services, courier services, and event planning services. Similar to the second design strategy -reconceptualising an existing service idea in a local context- the locus element of the project was identified as customers, suppliers and resources, with the lowest amount of iteration taking place between the offering and modules and interfaces. The degree of novelty in these projects were relatively high, supporting the view that service
How Industrial Design Students Approach Service Design Projects

concepts need to be informed by the system actors’ contextual and holistic experiences to build long-term innovation capability (Yu & Sangiorgi, 2018).

Therefore, the highest amount of iteration occurred between customers, suppliers and resources and the offering. For example, Project 2 mainly applied the principles of Foursquare, but adapted these principles according to the behaviours, needs, and contexts of a new target user group - people who would like to gain access to fresher ingredients. In this service, users selected the category of the ingredients that they wanted to buy, located the farmers who produced those ingredients, evaluated the quality of the ingredients, and followed other users. As shown in Figure 5, Project 7 was also a location-based service, through which users could announce street animals that needed treatment and take them to a nearby vet. In Project 5, pharmacies in a specific area were the main suppliers and the service focused on the delivery of prescribed medicines to patients on a regular basis. Finally, the designer of Project 3 emphasized how his detailed analysis of the activities preferred by retired people defined the experience he aimed to provide: “The qualitative and quantitative analysis of the questionnaire I applied enabled me to determine the most common hobbies of my target users, so I could plan and select the events that would really enhance their quality of life” (Student 3).

Figure 5. A service interface design from a student project (Sayar, 2018).

After setting the requirements for the offering by analysing and redefining the relations between different actors, the next phase was redesigning the customer journey. Følstad and Kvale (2018) referred to this as customer journey proposition that consists of generative activities leading toward a possible service to be. These generative activities were also linked to the design of the service’s modules and interfaces, which resulted in a moderate amount of iteration between this project element and customers, suppliers and resources.

5 Conclusion

Taking a broad perspective, university teaching itself can be perceived as a service, where value is co-created in a process through which students interact with their peers, the instructor, and the course materials (Finne, 2018). In design education, the project is the means that facilitates this co-creation process as it entails all the tangible materials, the information, and the plan of action that guide the students towards the design outcome. Given the unique aspects of services compared to products, this study revisited the notion of the studio project from a service design perspective. Drawing upon Bousbaci and Findell’s (2005) conceptualisation, the offering, modules and interfaces, and suppliers, customers and resources were identified as the design project elements that needed to be considered in the context of service-oriented thinking. During the development of a service design project, these elements become agents that shape design decisions both at an individual student level and at a collective learning level. In this way, the context within which designing takes place (i.e. the course itself) also evolves, providing more

899
possibilities for knowledge exchange and feedback as the different project elements are visualised, shared, and discussed.

The analysis of the nine selected service design projects revealed four design strategies utilized by industrial design students, each reflecting different approaches to the project elements: replacing a product with a service idea, reconceptualising an existing service idea in a local context, expanding the scope of professional services through digital channels, and changing the target group of an existing service idea and redesigning the customer journey. The results highlighted that each strategy was characterized by patterns of locus project element and amount of iteration that took place between the project elements. Based on the findings, it can be argued that the design strategy used by the students influence the novelty of the proposed service. In the second and fourth strategies, the locus element of the projects was customers, suppliers and resources and the degree of novelty achieved was higher compared to the projects that followed the first and third strategies. An essential aspect during the early stages of the design process is understanding the unique knowledge that customers possess about their preferences and translating them into new service concepts (Mahr, Lievens & Blazevic, 2014; Trischler et al., 2018). The analysis of the student projects supports this view, and suggests that when a service design project is more radical in nature, human and non-human actors in the service ecosystem become the initiator of all the main design decisions.

Furthermore, the increased complexity of the service design projects required a holistic approach to the project elements. Students developed their ideas based on alterations in an existing product or service’s use context, use scenario, ownership, and delivery channels. The design strategies followed showed that the three project elements were viewed as interconnected, and students went back and forth between them, rather than working on them one by one. This finding is in line with Santos and Spring’s (2013) argument that a structured progression of well-defined stages and activities does not fully capture the particularities of a new service development process. Consequently, in the conduct of service design projects, students and design teams need to combine different methods (i.e. personas, journey maps, storyboards) to visually manifest the parameters and limits of the service, decide on the locus project element that will guide the design process, and continuously explore and seize new ideas that emerge from the interactions between the different project elements.

References


How Industrial Design Students Approach Service Design Projects


About the Author

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Abstract: This study investigates whether problem-based learning (PBL) can further enhance interior design students’ sustainability learning. It compares the learning environment of a conventional lecture-based approach and PBL in sustainable design education. This study differs from the existing design literature on sustainable design education in that; (i) it implements PBL into interior design education to overcome the limitations of sustainability teaching in a conventional lecture-based instruction, and (ii) it proposes a new way of organising classes based on learner-centric features of PBL to increase student awareness toward sustainability. To achieve these two aspects, the two instructional modes of learning were applied during the two years of a sustainability module. In the first year, sustainability has been taught in a conventional lecture-based environment, and in the second year, in a PBL environment. It is possible to conclude that different than the other design topics, sustainability teaching and problem solving require a more learner-centric approach rather than an instructor-centric instruction to further enhance critical solving abilities of design students. Moreover, sustainability learning in the PBL setting is more effective when compared with the learning outcomes in the conventional lecture-based setting.

Keywords: problem-based learning (PBL); sustainability; learner-centric; interior design

1 Introduction

This study investigates whether problem-based learning (PBL) can further enhance interior design students’ sustainability learning. PBL, which is an increasingly popular way of presenting a problem scenario, was first introduced in medical education (Wijnia et al., 2014). In the last decade, it has been implemented in various education curricula, such as business, engineering studies, law, and nursing (Hung, Jonassen and Liu, 2008). PBL is a learner-centric instructional approach rather than instructor-centric. It is based on an active exploration process of real-world problems, which consists of the following three key phases: (1) initial discussion phase, (2) self-study phase, and (3) a reporting phase (Savery, 2006; Schmidt, 1983). However, the implementation of PBL in interior design education is not common (Galford, Hawkins & Hertweck, 2015). Since PBL requires complex thinking and cognitive activities (analysis-synthesis-evaluation), it could have potentially unique benefits for interior design context, which is also most commonly explained in the literature under analysis-synthesis-evaluation model (Lawson, 1990; Roozenburg & Eekels, 1994). Both rely on a reflective questioning process through creative experimentation (Barrows, 1986; Schön, 1987). The initial discussion, self-study and reporting phases of PBL are very similar to the studio-based learning model in interior design education that generally requires exploring precedents of architectural space and form, studying
appropriate materials and construction techniques, developing design solution alternatives and presenting them in
the form of drawings and 3D models (Afacan, 2016). As problems become more ill-defined and complex in both PBL
and interior design, formulating problem explanations and developing solution alternatives require more cognitive
effort (Rourke & Sweller, 2009). Moreover, determining the relevance of sources for such problems is a difficult task
for both novice and expert designers (Rouet et al., 1997). Hence, eliminating redundant information and engaging
with appropriate knowledge become very crucial in PBL to lead to better learning outcomes, increase creativity and
improve the quality of design solutions (Douchy et al., 2014; Wijnia et al., 2014). Thus, the present study aims to
overcome the gaps in sustainability education by effective learning models. It proposes PBL as an instructional
strategy to eliminate the high cognitive demand on sustainability learning and to integrate it as a core component of
design curricula (Afacan, 2016; Shields, Verga & Blengini, 2016).

2 Sustainability in Interior Design Curriculum

The concept of sustainability has become an overarching principle in many national and international studies since the
publication of the United Nations’ Brundtland Report (1987) and the 1992 Rio Earth Summit. Sustainable design is a
philosophy that aims to maximise the quality of the built environment while minimising or eliminating the impact on
the natural environment. A sustainable interior environment provides better sanitation (sewers and trash collection),
better indoor air quality (IAQ) (daylighting, ventilation, heating and cooling), energy-efficient water and effective
energy services, innovative and ecological materials with improved living standards (Afacan & Demirkan, 2016). The
growing concern and increasing interest in sustainable environments are changing the interior design education
agenda. Sustainability teaching is not a trend; it has become a necessity in interior design education (Zuo, Leonard &
Beach, 2010). Interior design is a major player of sustainable architectural development, and thus appropriate
sustainability design teaching must be incorporated into design education to prepare students for the real world.
According to Council for Interior Design Accreditation (CIDA) (2011), interior design students’ work must demonstrate
“comprehension of the concepts, principles and theories of sustainability as they pertain to building methods,
materials, systems and occupants” (p.13).

The literature on sustainable design education incorporates many studies ranging from sustainability teaching
methods in design studio and non-studio courses (Afacan, 2014; Fletcher & Dewberry, 2002; Gurel, 2010; Lee, 2014)
to student experiences on sustainability awareness and perception (Brundiers & Wiek, 2011; Stark, Gyu & Park, 2016).
It is not the scope of this study to list the literature contributing to sustainability integration in design curricula, rather
it tries to overcome the following three knowledge gaps in sustainability education specific to the interior design
context (Fischer & McAdams, 2015). Firstly, interior design education has lagged in integrating some aspects of
sustainability, such as solar energy use, which is not taught in detail (Zuo et al., 2010). Secondly, there is a heavy focus
on the technical-solution driven approach, which means adopting only prescribed solutions from available green
design standards (Lee, 2014), rather than letting students formulate their own answers based on a critical analysis-
synthesis-evaluation process. Thirdly, most of the studies on and concerns for sustainability in interior design explore
curriculum and student awareness issues (Fischer & McAdams, 2015), and do not address instructional models, such
as how to endow students with real-world sustainability skills, including effective reasoning process, self-directed
learning, critical awareness of physical, social and economic dimensions of sustainable design and innovative project
development. To date, little has been done to specifically integrate problem- and project-based learning into
sustainability programs. Thomas (2009) highlighted the commonalities of sustainable education and PBL. According to
Thomas (2009), there is a need for the critical thinking of PBL across all the disciplines in sustainable education. Zuo et
al. (2010) integrated performance-based design as a new teaching pedagogy for sustainability awareness at the
beginning of interior design education. They have focused only on passive solar energy use among various
sustainability principles, such as water, energy, indoor air quality, innovative process, material use. Their results
showed that performance-based design enhanced student understanding of the mutual relationship between interior
and exterior and between built and natural environment. Wiek et al. (2013) presented Arizona State University (ASU)’s
School of Sustainability as a successful first initiative to implement problem and project-based learning at
undergraduate and graduate level in sustainability teaching with all its principles. However, based on their survey
analyses and observations, there is a need for further development of instructional strategies. Stark, Gyu and Park
(2016) also reported that many interior design educators have difficulty understanding how to incorporate and teach
sustainable design in a systematised and integrated manner to achieve desired learning outcomes. Thus, sustainability
in interior design education needs to be urgently re-examined with a focus on enhanced instructional approaches and
student-centred pedagogies (Thomas, 2009).

This study differs from the existing design literature on sustainable design education in that; (i) it implements PBL into
interior design education to overcome the limitations of sustainability teaching in a conventional lecture-based
Using Problem-Based Learning in Sustainable Design Education

instruction and (ii) it proposes a new way of organising classes based on learner-centric features of PBL to increase student awareness toward sustainability.

To achieve these two aspects, the two instructional modes of learning were applied during the two years of a sustainability module. In the first year, sustainability has been taught in the conventional lecture-based environment, and in the second year in the PBL environment. Specifically, this study addresses the following three research questions:

1. Does PBL enhance interior design students’ sustainability learning? The study’s hypothesis is that there will be a statistically significant difference between the sustainability learning outcomes of the two interior design student groups with respect to their instructional modes (Hypothesis 1).
2. Are there any differences between the two instructional modes in terms of specifying design goals? The study expects that there will be statistical differences between the groups in specifying design goals during sustainable problem solving (Hypothesis 2).
3. Are there any differences between the two instructional modes in terms of the required mental effort? The third hypothesis is that students’ mental effort ratings of sustainable problem-solving process in a conventional lecture-based environment will be higher than to the scores in a PBL environment (Hypothesis 3).

3 Study

3.1 Participants and Procedure

200 third year interior architecture students participated in the study (54 male, 146 female). Two different semester offerings of the same course, IAED 342- Sustainable Design for Interiors, at Bilkent University, Turkey, were used to compare the two instructional approaches. The same faculty member, the author, taught the courses first in the Spring semester of 2014-2015 academic year using conventional lecture-based approach (100 students; 22 male and 78 female), then in the following year, the Spring semester of 2015-2016 academic year using PBL approach (100 students; 15 male and 85 female). Both semesters were composed of 14 weeks of teaching.

The conventional lecture-based approach consisted of two-hour lecture sessions twice a week, during which seven sustainability topics (sustainable strategies, water systems, waste water and its reuse, toilet design, energy conservation, heating and cooling) were introduced every two weeks. The assessment of learning outcomes was done through the following methods; (i) seven homework assignments, one for each topic; (ii) one midterm for evaluating content learning and (iii) one final project for assessing critical thinking and problem-solving abilities. Each method was assessed based on four criteria: application of appropriate sustainability knowledge; consideration of proper spatial arrangements and layouts; usage of sustainable products, furniture and materials, and integration of innovative strategies. A score of 1 point was given for each satisfied criterion, and a score of 0 was assigned if the solution did not satisfy the criterion. Students, who received a total mean score between 2 and 4 points, were considered to have satisfactorily completed the requirements of each assessment type. Thus, the study defined these students as successful in terms of weekly learning grade and the other students, who received below the score of 2, were considered as unsuccessful.

The PBL also consisted of two-hour lecture sessions twice a week, but incorporated five key features of PBL (Newman, 2005):

1. The instructor as a facilitator to deliver the learning content;
2. The ill-structured problem solving in the form of a designed script;
3. Integration and contextualisation of learning by the ill-structured problem solving;
4. Collaborative learning
5. Learning assessment in relation to the objectives of learning.

In the introductory lecture of the first week, the instructor introduced a set of learning objectives regarding each topic. At the beginning of each week, an ill-structured real problem along with a set of resources was presented in the online course management system at Bilkent University. At the first hour of the two-hour lecture session, the students were divided into predetermined groups of 5 to 6 students, who worked on the problem for the entire lecture hours. The instructor guided them by asking questions and discussing their answers, similar to a brainstorming process. In the second hour, each group presented how they approached the problem and what they critically proposed as a solution alternative. An exemplary problem from the hot water week was as follows: “A residential building with 10 flats has
recently been renovated, and all the water distribution systems (cold and hot) have been renewed. The hot water system, which was previously local, is now central. Describe in detail the possible sustainable hot water solution alternatives in terms of different heat source types and different climate conditions”.

3.2 Instruments
To observe the impact of PBL, data was collected by comparing student learning outcomes and their specified goals during problem solving of the final project. Learning outcomes in each semester was defined in terms of student overall course grade obtained as the mean value of the seven homework scores in the conventional lecture-based instruction and seven weekly learning scores in PBL, the midterm grade, final project grade. Students who received a C (Grade>2, 00/4, 00) or a higher grade were considered to have satisfactorily completed the course. Thus, the study defined these students as successful and the other students, who received below C (Grade<2, 00), as unsuccessful. These mean values from each instructional mode were compared in the Result section to test Hypothesis 1.

The same final project was given in both semesters to test Hypothesis 2. The final project was designing a sustainable energy-efficient table unit. In both conventional-based lecture approach and PBL environment, only a single sentence was given to the students at the beginning: “You are asked to design a sustainable table unit and state your reason for your design goal by selecting only one of the given relevant explanations” (Table 1). In all two instructional modes, the same specified design goals were asked. In both modes of instruction, the same instructor and two guest jury members did the evaluation of projects. A successful project was defined according to the mathematical average of the three-jury members’ grades.

<table>
<thead>
<tr>
<th>Categories</th>
<th>Explanations</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Form</td>
<td>Shape, and other external visual appearance of the source example.</td>
</tr>
<tr>
<td>□ Symbolism</td>
<td>Other objects, contexts or designs that the participant associated with.</td>
</tr>
<tr>
<td>□ Structure</td>
<td>The relationship among the elements of source example.</td>
</tr>
<tr>
<td>□ Function</td>
<td>The way the source example will benefit or serve its users.</td>
</tr>
<tr>
<td>□ Aesthetic</td>
<td>Sense of form, art, or visual pleasing sensation that source invokes.</td>
</tr>
<tr>
<td>□ Experience</td>
<td>Similar project has been done or observed by the participant.</td>
</tr>
<tr>
<td>□ Green character</td>
<td>The relationship to energy efficiency, recycling, reusing material and colour.</td>
</tr>
<tr>
<td>□ Adaptability</td>
<td>Being long lasting to accommodate changes in later use.</td>
</tr>
<tr>
<td>□ Ecology</td>
<td>Natural, organic and local resources.</td>
</tr>
<tr>
<td>□ Usability</td>
<td>Inclusivity for all people regardless age, ability and size.</td>
</tr>
<tr>
<td>□ Design and construction process</td>
<td>Innovative and sustainable methods, such as recycling and technological advances.</td>
</tr>
<tr>
<td>□ Novelty</td>
<td>Associated with new, creative and original.</td>
</tr>
</tbody>
</table>

Mental effort during the course was also assessed based on a student self-evaluation questionnaire to test Hypothesis 3. The questionnaire was inspired by Paas’s (1992) study on the cognitive load theory to problem solving skills. The cognitive load theory was proposed by Paas and Van Merrienboer in 1993 to compare the effects of different instructional approaches on learning. Cognitive load theory is mainly concerned with the learning of complex cognitive tasks, where the number of information elements that need to be processed simultaneously before meaningful learning can commence often overwhelms learners and their interactions (Kostons, Gog & Paas, 2012; Paas, Renkl & Sweller, 2004). At the end of each semester, the students were asked to evaluate their invested personnel effort to the course (homework assignments/weekly sustainable problem-solving sessions, midterm and final project) on a 9-point scale, ranging from 1 (very, very low mental effort) to 9 (very, very high effort). So, a high mental effort meant a negative outcome.

4 Results
To test the hypotheses, the grades and questionnaire data from two semesters of 200 participants (100 students from each semester) were obtained. Descriptive analyses and analyses of variance (ANOVA) tests were conducted. The ANOVA is for explicitly testing equality of means of values between two or more groups. Differences between student groups were considered significant at a level of 95% (p=0.05). For statistical analysis, IBM SPSS Statistics version 21 was used.
4.1 Learning Outcome

ANOVA test (One-Way ANOVA) was performed to see if there were any differences between two student groups in terms of the course grade, weekly learning grade and final project grade (Hypothesis 1). Post-hoc comparison test using the Tukey procedure was carried out to determine exactly where the differences between the groups existed. According to Hsu (1996), Tukey is the best for all possible pairwise comparisons with exact P-values, such as Bonferroni, Duncan and Scheffe, when sample sizes are big and the numbers within the groups are equal. Table 2 illustrated descriptive statistics for course grade. In the study, successful students based on the explanations in the previous section, were coded as 1 and unsuccessful students as 2. According to the means and standard deviations, the number of successful students was increased in the PBL environment. The results of ANOVA (Tables 3 and 4) indicated that there is statistically significant differences in overall course grades for the two student groups (F (2,297) = 13.975, p=.000 < .05). Subsequent post hoc Tukey indicated that students who were taught in PBL were more successful than students in the conventional-based learning (PBL vs. conventional-based: Mdiff = -.19000, p = .007, one-tailed).

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error</th>
<th>95% Confidence Interval for Mean</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lower Bound</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conventional_based</td>
<td>100</td>
<td>1.4800</td>
<td>.50212</td>
<td>.05021</td>
<td>1.3804</td>
<td>1.5796</td>
<td>1.00</td>
</tr>
<tr>
<td>PBL</td>
<td>100</td>
<td>1.1500</td>
<td>.35887</td>
<td>.03589</td>
<td>1.0788</td>
<td>1.2212</td>
<td>1.00</td>
</tr>
<tr>
<td>Total</td>
<td>300</td>
<td>1.3150</td>
<td>.43049</td>
<td>.04305</td>
<td>1.2296</td>
<td>1.4004</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Table 3. ANOVA result for course grade.

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>5.487</td>
<td>2</td>
<td>2.743</td>
<td>13.975</td>
<td>.000</td>
</tr>
<tr>
<td>Within Groups</td>
<td>58.300</td>
<td>297</td>
<td>.196</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>63.787</td>
<td>299</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4. Tukey HSD test for course grade.

<table>
<thead>
<tr>
<th>(I) InstructionMode</th>
<th>(J) InstructionMode</th>
<th>Mean Difference</th>
<th>Std. Error</th>
<th>Sig.</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional_based</td>
<td>PBL</td>
<td>.19000*</td>
<td>.06266</td>
<td>.007</td>
<td>.0424 . .3376</td>
</tr>
</tbody>
</table>

* The mean difference is significant at the 0.05 level.

The same multiple comparison analyses were conducted to analyse the differences between student groups in relation to their mean grades of weekly learning for each semester. The means and standard deviations indicated that the number of successful students was increased in the second semester (M_conventional-based = 1.5900, SD = .49431; M_PBL = 1.0500, SD = .21904). The results of ANOVA revealed significant group differences in weekly learning grades as well (F (2,297) = 48.131, p=.000 < .05). According to the comparative analysis using the Tukey HSD test, the mean learning grades of students in conventional lecture-based learning differed significantly compared to the grades in PBL at 0.05 significance level (conventional lecture-based learning vs. PBL: Mdiff = .54000, p = .000, one-tailed). Similar to the course grade results, students who were taught in PBL mode were more successful in terms of weekly learning than students in the conventional lecture-based learning. Moreover, in terms of both course grade and weekly learning grade, success in the PBL environment has been significantly increased.

The results of ANOVA indicated that there exist statistically significant differences in final project grades for the two student groups (F (2,297) = 18. 927, p=.000 < .05). Subsequent post hoc Tukey indicated that students who taught in PBL mode were more successful than students in the conventional lecture-based learning (PBL vs. conventional-based learning: Mdiff = -35000, p = .000, one-tailed). As indicated, the difference in mean scores is relatively high. So, Hypothesis 1 was confirmed by the results. As expected, there is a statistically significant difference between the sustainability learning outcomes of interior design student with respect to their instructional modes.
4.2 Specified Design Goals

ANOVA test (One-Way ANOVA) was performed to see if there were any differences between the two student groups in terms of specifying design goals during sustainable problem-solving process. The results of ANOVA revealed significant group differences in specified design goals (F (2,297) = 15.728, p=.000 < .05). Most of the students in the conventional lecture-based instruction mode stated sustainability definitions as the basis for their solution alternatives- green character stated by 37 participants out of 100; adaptability by 27 participants out of 100 and ecology by 20 participants out of 100. The rest of the students explained their specified goals under structural (6 out of 100), aesthetical (5 out of 100) and functional considerations (5 out of 100). None of the students in the conventional lecture-based instruction mode chose symbolism, experience or design and construction process as their specified goals. However, in the PBL environment, rather than the more direct sustainability concepts, experience become the most important explanation as their design goals. Experience was stated by 25 students out of 100; green character by 22 participants out of 100; adaptability by 18 participants out of 100; ecology by 17 participants out of 100 and design and construction process by 18 students. Similar to the conventional lecture-based instruction mode, none of the students stated symbolism as their specified goal. This suggested that the use of PBL during sustainability learning process had an impact on the student specified design goals as well. Figure 1 illustrates one of the successful design solution examples in PBL based on form as the specified design goal.

<table>
<thead>
<tr>
<th>Source Selection</th>
<th>Specified Design Goal</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form</td>
<td></td>
<td><img src="image" alt="Form Example" /></td>
</tr>
</tbody>
</table>

Figure 1. One of the successful design solution examples in PBL based on form as specified design goal.

4.3 Mental Effort

The third hypothesis was that mental effort ratings of students in the conventional lecture-based environment would be higher compared to the scores in the PBL environment. The adapted cognitive load mental effort survey evaluated invested personnel effort of students on the following four items: (i) understanding the resources of homework/the source domains of weekly problems; (ii) solving homework/sustainable problems of each week; (iii) understanding final project; (iv) solving final project. Reliability results of the survey in each semester were respectively $\alpha$ (conventional lecture-based learning) = .808 and $\alpha$ (PBL) = .816. There was a statistically significant mental effort difference between student groups in terms of understanding the resources of homework/the source domains of weekly problems (two-tailed, p = .000). There was also a significant mental effort difference between student groups in terms solving homework in the conventional lecture-based instruction mode (two-tailed, p = .000). According to the pairwise comparisons, mental effort differed significantly in the conventional lecture-based learning environment (M_rank_conventional-based = 243.07; M_rank_PBL = 141.90). Figure 2 illustrates the instructional differences on mental effort rankings for solving weekly homework/sustainability problems.
Using Problem-Based Learning in Sustainable Design Education

Figure 2. Differences on mental effort rankings for solving weekly homework/sustainability problems.

Thirdly, there was a significant mental effort difference between the student groups in terms of understanding final project (two-tailed, $p = .000$). According to the pairwise comparisons, the difference in mean ranks was also relatively high ($M_{rank\_conventional-based} = 238.89; M_{rank\_PBL} = 146.74$). Finally, mental effort required for solving final project differed also significantly between the student groups (two-tailed, $p = .000$). Again, pairwise comparisons found a significant mean rank difference ($M_{rank\_conventional-based} = 225.68; M_{rank\_PBL} = 159.27$). So, Hypothesis 3 was confirmed by the results. As expected, mental effort ratings of students on solving final project in the conventional lecture-based environment were statistically different compared to the ratings in the PBL environment. Figure 3 illustrates these instructional differences on the mental effort rankings.

Figure 3. Differences on mental effort rankings for solving final project.

4.4 Student Attitudes

Most of the students (80) had a positive attitude towards PBL and found PBL as an effective way of sustainability learning in terms of (i) multi-dimensional analysis (ii) self-study and (iii) creativity. 55 of 100 students stated that by integrating information from multiple literature resources with the aim of finding an answer to the learning of sustainability issues, they could approach sustainability from different perspectives and analyse it in a multi-dimensional way, which they couldn’t achieve on their own. 20 students found brainstorming sessions very helpful: through these sessions they could share different ideas, collaborate, discuss and make use of each other’s
experiences. Since creative design is a matter of working out all solution variants, according to 25 students, PBL developed their creativity skills by giving them autonomy to actively construct their own solutions:

You can learn more efficiently by self-directed learning rather than being directed by the instructor (Student, #75).

You can enjoy project more if you have the freedom to choose my own literature resources (Student, #22).

We study sustainability because the tasks are interesting and motivating for future (Student, #88).

Brainstorming helped us to learn something different and develop creative designs (Student, #45).

PBL provides variety of solutions and self-motivation (Student, #3).

We put less mental effort in the PBL environment, because we don’t feel to be forced by others (Student, #19).

However, 12 students had very negative responses to PBL as they reported having frustrations and uncertainties during the brainstorming sessions, source selection and integration of that literature in self-study. Some students could have difficulty with the activities undertaken during self-study and creative process, and might learn better when given a defined task, like homework assignments in the conventional lecture-based instruction mode:

Self-study places high demand on working memory (Student, #15).

Brainstorming session and integrating the ideas obtained from that session could be frustrating (Student, #73).

5 Discussion

The findings indicated that the three stages of PBL process, which are initial discussion, self-study and reporting (Schmidt, 1983), could enrich learning outcomes of sustainable design education. Compared to the conventional lecture-based learning, in PBL both the number of successful course grades and final projects have increased through the collaborative process of discovery; learning before and during the brainstorming session in class; visualising and conceptualising solutions by analysing the relevant real-world case examples and presenting a solution alternative. Concerning the mental effort ratings in PBL, this study suggests that PBL required less mental effort in all assessment types than the conventional lecture-based instruction. This nature of PBL could lead to better understanding and consolidation of acquired sustainability knowledge. Thus, it is possible to discuss the results in terms of two points of view: the learning process and critical reflection. There is a significant correlation between the amount of effort spent on sustainability learning and success of the learning outcomes. Higher grades in all assessment types (homework/weekly learning and final project) were obtained with lower cognitive load investment of self-study during sustainability learning and problem solving. Critical reflection may not be the case in all instances, but in this study, the importance of student’s active role and self-study to understand and solve is emphasized in the construction of their own knowledge. Furthermore, in terms of the specified design goals, students in the conventional lecture-based instruction were more concerned with direct sustainability concepts, such as green character or ecology, to find a solution alternative. However, in PBL, because of the improved critical thinking sessions throughout the semester, students had the opportunity to consider their experiences and the construction process to solve the problems.

6 Conclusion

The study explores a PBL environment to further enhance interior design students’ sustainability learning. When results from the two semesters and two different modes of instruction are considered together, it is possible to conclude that sustainability teaching and problem solving requires a more learner-centric rather than instructor-centric instruction strategy to increase knowledge acquisition and critical solving abilities. Even though sustainability learning in the PBL setting is more effective compared to learning in the conventional lecture-based setting, but it could be further developed based on the following strategies: (i) letting students find their own source domains and solution alternatives and (ii) integrating information across multiple design resources during the self-study phase. Thus, the results of this study is significant in terms of highlighting the importance of eliminating the search of irrelevant design resources, and so, overcoming the challenges of sustainable problem solving as a cognitively demanding task.

It should be noted that the two instruction modes are specific to the current sample and may also be impacted by the course syllabus and type of the final project. The success and mental effort findings could be different under different design experiment conditions. Usage of online learning environments and/or blended learning rather than face-to-
face could also influence student-instructor interaction and the process of PBL. Moreover, the expertise level of students has also impact on the use of PBL.

References


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Asking the Industry Partners: Reflecting on the Value of Internships for Circular Design

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Abstract: As part of Circular Design: Learning for Innovative Design for Sustainability (L4IDS) Erasmus+ Knowledge Alliance project, a series of internships were conducted in collaboration with local industry partners and interns from four different European countries. The aim of these internships is to develop an adaptable training programme focusing on design for sustainability and circular economy with standardised educational tools and techniques, which can be replicated by other European HEIs. The internship projects were focused on local industry partners’ real-life challenges at the time, and industry partners, interns and researcher/educators facilitating the collaboration throughout the programme. While the immediate feedback upon the completion of the internships was generally positive, as authors we were interested in long-term effects of this experience on industry partners’ professional practices. This paper introduces the internship programme and industry partners’ involvement throughout it and presents the results of interviews with key contacts from each industry partner conducted a year after the internship ended to uncover what/if any changes occurred in practice. The paper presents some considerations on developing the structure of an internship programme on sustainability, ways of collaboration among industry partners, novice designers and universities, observed and potential effects on business practices, and limitations in implementation.

Keywords: design education; industry collaboration; knowledge exchange; design for sustainability; capacity building

1 Introduction

In the final report of the United Nations Decade of Education for Sustainable Development (2014), the role of higher education institutions was discussed widely through capacity building for staff (O’Rafferty, Curtis & O’Connor, 2014; Lozano, 2006), changes in learning outcomes (Shephard, 2008) and facilitating change in future practices (Zilahy & Huisingh, 2009). The report also highlights the rising demand from students for sustainability issues to be integrated into curricula (UN, 2014). For design education and research in higher education institutions, there are different levels at which universities can build the relationship between design practice and sustainability, including but not limited to:
mainstreaming sustainability inherently throughout the design education (O’Rafferty et al., 2014; de Eyto et al., 2008),
• introducing modules focused on sustainability incorporating design practice (Boks & Diehl, 2006),
• intersecting design research activities on sustainability with undergraduate education (Doğan, Turhan & Bakırlıoğlu, 2016),
• acting as intermediaries in industry through utilising the expertise of academics on design for sustainability (Küçüksayraç, Wever & Brezet, 2017).

In order to facilitate the deep learning of sustainability principles and its design-related competencies, a more holistic approach integrating these principles and competencies throughout the curriculum over an extended period of time can be adopted. This integration requires the development and adoption of a more hybrid approach, one that weaves sustainability concerns throughout the design education. This ensures that the concerns are addressed effectively in future design practices and not regarded as an additional design consideration (O’Rafferty et al., 2014; Boks & Diehl, 2006). Collaboration and knowledge exchange among different institutions to build educational capacity (O’Rafferty et al, 2014; McMahon et al., 2012) and between universities and industry to transform business practices (Küçüksayraç et al., 2017) are crucial for continued adoption of such a hybrid approach. There are many barriers that can be grouped under overcrowded curricula and limited expertise or awareness of staff (Sterling & Witham, 2008; Boks & Diehl, 2006; de Eyto, 2010) against such a shift in education. Fortunately, the UN Decade of Education for Sustainable Development (2014) presents promising outcomes of collaborative efforts among higher education institutions and stakeholders.

Following this line of thought, this paper introduces an internship programme that builds such collaboration among institutions and businesses, thus enabling novice designers to experience this complex relationship first-hand in the development of sustainable design solutions that can transform business practices.

Circular Design (L4IDS) Erasmus+ Knowledge Alliance comprises four European institutions with design departments [University of Limerick (UL) in Ireland, Universitat Politècnica de Catalunya (UPC) in Spain, NHL Stenden University (NHL) in the Netherlands, Linköping University (LIU) in Sweden] along with four design-led SMEs (Small to Medium Enterprises) and four National Design Agencies. The project aim is to develop a training and exchange programme for Circular Design with an adaptable schedule conforming to the structures of the HEIs. This internship programme promotes a culturally-diverse, interdisciplinary working environment for students from varying backgrounds (i.e. Product Design, Business and Materials Science). There are three main goals for this internship:

1. to develop an adaptable training programme with standardised educational tools and techniques, which can be integrated into many existing design departments around Europe. This, in turn, can build interdisciplinary capacity within those departments to train future designers with a comprehensive understanding of sustainability, as well as ways of undertaking innovative design practice to tackle its issues.
2. to create training opportunities for novice designers and other disciplinary students on working in multicultural training environments and tackling the issues of different local contexts and local industry, through setting up student exchange programmes and bringing industrial partners into the training programme.
3. to facilitate knowledge exchange among industry partners and higher education institutions about Circular Economy, and to explore its practical implications for participating partners. Through becoming partners in the internship programme, industry partners can explore sustainable alternatives to their existing business models and ways to achieve such transition.

On September 1st, 2017 the first Circular Design internship started in UL with the attendance of 10 interns (i.e. three interns from UL, three from NHL, two from UPC and two from LIU). With this internship, a long-term collaborative action research process also started to further develop and optimise this internship programme that can be adopted by other European HEI Design Schools. This paper briefly introduces this long-term collaborative action research process and the internship structure. However, it focuses on the third goal of the internships and presents the industry partners’ reflection on the experience a year after the internship ended, to explore its effects on their businesses and consequent attitudes towards sustainable practice.

2 Developing a Circular Design Internship Programme

Action research is a commonly used methodology in educational contexts for the continuous development of curricula and educational content, as the distinction between them (i.e. development and education) is removed, and they are brought together as research (McKernan, 2008). The educators’ role changes significantly as well; they become researchers that perform continuous self-evaluation and work on the problems they identified (McKernan, 2008). The
Asking the Industry Partners: Reflecting on the Value of Internships for Circular Design

development and the goals of this internship programme are beyond the capabilities of a single researcher. The attempt to create a programme repeatable within different curricula and content, no less an exchange programme to bring together interns of different understandings on issues of sustainability and the development of the programme requires a collaborative framework.

This internship programme is being developed by four HEIs in four different EU countries, who share similarities on their approach to design education (i.e. practice-based learning in a studio environment) and present differences in the structuring of curriculum and content (e.g. duration of bachelor education, courses, training, access to workshops, etc.). This complicates the development of a standardised internship programme with respect to the students’ differing backgrounds and the inclusion of the programme in existing curricula. On the other hand, the focus of the internship (i.e. sustainability and circular design) clarifies the common educational goals that help structure the internship programme. Hence, four higher education institutions agreed upon adopting an AR methodology through iterating the internship programme by reflecting on and building upon the previous implementation of it and providing reflections and guidance for the subsequent internships (Figure 1).

The first internship programme ran from September 1st to November 30th, 2017. Upon its completion, the researchers reflected on the internship and its outcomes, and this reflection along with all the internship material developed was sent to the next institution (i.e. UPC in Spain). The educators/researchers in the second institution reviewed the materials, reflected on the first internship and further developed the internship structure and content. At the time of writing this manuscript, the third internship in NHL, the Netherlands is being finalised, and the final internship will start in LiU, Sweden. The purpose of the iterative 4-phase process is to develop a comprehensive internship programme to train the next generation of designers for a sustainable future, which can be conducted in different design schools all around Europe and in collaboration with local industry partners.

For this framework, the knowledge transfer among lecturers/researchers needed to be well-structured to ensure the continuation of the action research thus reaching meaningful outcomes. The internship programme was developed according to key learning outcomes that were devised at the beginning of the first internship:

- Creating an environment for interns to self-learn and experience the necessary tools and techniques for Circular Design.
- Facilitating learning for innovative, sustainable design for both the interns and the industry partners throughout the design process.
- Present the potential of innovative design tools and techniques for sustainability and the circular economy as applied to real-life innovation processes.

While the project focuses on the development of the internship programme through its iterations in four European countries, this paper focuses on the industry partners’ reflections on the experience after a duration when any possible, long-term change is observable (i.e. around a year). As shown in Figure 1, nearly a year has passed since the completion of the first Circular Design internship in Ireland and the authors wanted to shed light on the possible long-term effects of the internship on the industry partner’s practices. Has the internship program affected the industry partners’ practices in delivering products and services, or were the outcomes of the internship put aside? Was such collaboration between university and industry partners beneficial to initiate professional development, or even transition toward alternative businesses? If they were to participate in such a programme again, what would they do differently, and why? Similarly, were they satisfied with the content, structure and implementation of the internship?
programme, or would they seek improvements? Such feedback from the industry partners of the first internship can be reflected on the final Circular Design internship in Sweden and help improve it.

2.1 Industry Partners of the First Internship in Ireland

In the scope of the first internship in Ireland, researchers decided to find three industry partners with diverse needs, who are capable of realising projects of different scales. This diversified the type of projects undertaken, to observe the outcomes for these projects of different scales and to understand the potential of the internship to train individuals for diversely-scaled design projects. As a result, a craft-producer company (Mamukko), a furniture design consultancy (One Off) and a regional government institution (Southern Region Waste Management Office) agreed to become industry partners for the internship programme, and three different design briefs were developed, which are summarised as follows:

- **Material Explorations with Mamukko, Kinsale**: Exploring the potential of a reclaimed material – used fishing nets – and developing innovative solutions on reusing it along with leathercraft. The team consisted of four interns from UL, UPC, NHL and LiU.
- **Retrofitting with One Off, Dublin**: Designing bespoke, high-end office furniture with a take-back system and reusable products/parts/materials. The team consisted of three interns from UL, UPC and NHL.
- **Preventing Food Waste with Southern Region Waste Management Office (SRWMO), Limerick**: Reimagining the food waste management in/around Limerick and developing solutions for prevention and reuse of food waste. The team consisted of three interns from UL, NHL and LiU.

These projects present three distinctly different scales in terms of circular design. The *material explorations* project focuses on the reuse/recycling of a problematic material that is discarded in oceans, contaminating the sea and endangering marine life. The purpose of the project was to explore ways of introducing this material into SME production processes thus giving it a second life. The *retrofitting* project focuses on the problem of underused, high-end furniture with valuable materials being discarded before their potential lifespan ends and aims to explore ways of reusing the furniture or the materials used in the furniture with the limited organizational capabilities of a design consultancy. The *preventing food waste* project identifies the issue of excessive amounts of food waste produced by citizens and the cultural implications of this issue. The project aims to intervene in existing models of discarding food waste and its waste stream to explore ways of preventing food waste in the first place. Detailed information about the project briefs and scheduling can be found in Bakırlıoğlu et al. (2018).

Although the challenges of each project were quite diverse, they were regarded in the scope of the Circular Economy. These projects were well-positioned to observe the implications of Circular Design at different scales and how this internship programme can train the next generation of designers to respond to the diverse challenges imposed by a Circular Economy approach. It should also be noted that the industry partners for these projects were aware of the global and local issues related to sustainability, however, they needed assistance to respond to these challenges in the context of their businesses. The outcomes of this internship did not have to be applicable right away, rather these industry partners were interested in the Circular Design process and the opportunities it presented for their businesses. The enthusiasm of the industry partners was important to support the design process, and concurrently, the interns.

2.2 Internship Schedule and the Involvement of Industry Partners

To enable clarity for the interns and industry partners, and to let the interns experience an innovative design process from the beginning until the end, the internship programme was structured in four phases (i.e. Research, Ideation, Detailing and Prototyping). In the research phase, the interns gained the experience of collecting different kinds of input from various stakeholders and developed a focused design brief through understanding the context around their projects. In the ideation phase, they developed various design solution ideas to explore potential solutions and evaluated those ideas according to their design briefs. In the detailing phase, the interns developed their idea further to address all aspects of their design brief and finalised the design solution. In the prototyping phase, they built prototypes of their solutions and developed communication material to convey their solutions addressing the sustainability issues defined in their briefs to industry partners. Throughout the internship, different learning tools were used:

- Four masterclasses on different topics were given. These classes focused on developing sustainability-related, as well as general design-related, competencies by experts in different areas.
- Half-day workshops were held by researcher/educators to help interns move forward when they had issues, or simply did not have enough expertise and knowledge.
Asking the Industry Partners: Reflecting on the Value of Internships for Circular Design

A comprehensive list of available online educational resources was shared with the interns. The resources were categorized according to their strengths in different design process stages.

In addition to these tools, there were mandatory industry partner meetings scheduled in the brief (Table 1). The purpose of these mandatory meetings was to ensure client exposure and buy-in throughout the design process. Prior to the internship, researcher/educators held meetings with industry partners separately to develop the initial design briefs. Throughout the internship, industry partners were invited to UL for kick-off and presentations of outcomes. In addition, the interns were asked to meet with their industry partners for developing detailed design briefs and gathering feedback during design detailing stage.

While the above-mentioned meetings were scheduled and mandatory, the interns were encouraged to arrange regular additional meetings with their industry partners to gather feedback and move ideas forward. The right side of Table 1 presents ‘flexible’ meetings the teams arranged with their industry partners on their own accord. As can be seen, the appointments varied in nature for each industry partner, according to their availability, the progress of the internship projects and opportunities arisen throughout the internship (i.e. conference).

Table 1. Industry partner exposure in relation to the internship structure

<table>
<thead>
<tr>
<th>Internship Stage</th>
<th>Mandatory Industry Partner Meetings</th>
<th>Flexible Industry Partner Meetings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Research/educators for initial brief development</td>
<td>Mamukko, Kinsale</td>
</tr>
<tr>
<td>Preparation</td>
<td>Interns for workplace visits</td>
<td>SRWMO, Limerick</td>
</tr>
<tr>
<td>Research</td>
<td>Interns for workplace visits</td>
<td>- Research/educators and interns for kick-off and introductions</td>
</tr>
<tr>
<td>Ideation</td>
<td>Interns for preparing design ideas</td>
<td>- Interns for providing feedback on design ideas</td>
</tr>
<tr>
<td>Detailing</td>
<td>- Interns for design detailing feedback</td>
<td>- Interns about additional resources</td>
</tr>
<tr>
<td>Prototyping</td>
<td>- Research/educators and interns for final presentations</td>
<td>- Interns about attendance to a Start-up competition</td>
</tr>
<tr>
<td></td>
<td>- Interns bi-weekly virtual meetings</td>
<td>- Conference attendance with interns</td>
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<td></td>
<td>- Interns for copyright issues around the project</td>
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</tbody>
</table>

2.3 Interviews with Industry Partners

Nearly a year after the internship was completed, interviews with the three key contacts from each industry partner were conducted. The partners were sent the project reports ahead of the interview and encouraged to recap on both process and outcomes. The interviews were semi-structured and followed a previously prepared protocol around four main headings. Firstly, they were asked to recall their internship experience, looking back on their decision to participate in the internship, the process, changes in the direction of the project throughout the internship and the outcomes. Then, additional questions were asked to reflect further on their experience, including interesting aspects of the process, new knowledge acquired, working with novice designers and the role of UL throughout the process. Thirdly, they were asked if and how the internship affected their practices over the past year, in terms of the impact of the outcomes on their perception of sustainability, the way they conduct their businesses and unexpected results or unfulfilled expectations. Finally, their future plans were discussed about any potential shift toward sustainable businesses, as well as their collaboration with design departments and/or universities. The interviews took between 45 minutes to one hour and were audio recorded. Both researchers independently coded these recordings, using open codes and then compared their analysis to reach consensus. The coding revealed codes on assumed roles of industry professionals.
3 Discussion- Internship Programme, Outcomes and Industry Partners

3.1 Collaborating with Universities Through an Internship Programme

This internship, in addition to being a unique experience for students with regard to its international nature and its direct focus on real-life innovations for sustainability and circular economy, also created a space for collaboration between industry partners and universities. The project briefs were centred on real-life challenges facing the industry partners, motivating them to actively participate in the process and to identify and exploit opportunities for sustainability. However, their levels of engagement varied, as well as their expertise on the project topic and perspectives on sustainability, affecting the roles they assumed in relation to the interns.

As illustrated on the right side of Table 1, the frequency of flexible meetings between interns and industry partners varied. For the Materials Exploration brief, the interns and industry partner worked closely, setting at least bi-weekly meetings (in addition to mandatory meetings) to discuss the project, give updates on each other’s activities, exchange ideas, and so on. For the Retrofitting brief, there were not any additional meetings scheduled except for a further feedback session right after the presentation of the ideation results. For the Preventing Food Waste brief, the nature of additional meetings was different compared to others and more steered towards expanding interns’ knowledge on food waste (i.e. conference) and exploiting alternative implementation routes (i.e. additional resources, attendance at a design competition).

The interviews revealed that the differences in engagement were also related to what industry partners expected to learn from the internship. For example, although Mamukko had the expertise in leathercraft and related design and production capacities, the challenge they were exploring with the interns (i.e. fishing nets, plastics reuse and recycling) required additional capacity building which they were hoping to get through collaborating with UL. Hence, they assumed the role of collaborating partners with the interns, as well as researcher/educators, and became more actively involved compared to other industry partners. On the other hand, SRWMO had a lot of expertise on food waste and projects around it and was aware of many real-life challenges on behaviour change. Working with novice designers, the representative in SRWMO assumed a mentor role, trying to inform interns and expand their knowledge around the food waste issues. One Off’s role, however, shifted throughout the process. They began as a collaborator working closely with the intern team to develop a new business model for their design consultancy firm. But, this role changed to that of a client, where One Off was providing feedback in the confines of their own focus on designing products and the interns were reconciling their work based on said feedback at specific stages. This shift in their role throughout the process confused the intern team, and whilst the partners were satisfied with the eventual outcomes, the process was not as smooth as the other two projects. The way these roles were adopted by industry partners indicates the importance of developing design briefs in facilitating knowledge exchange through such internship programmes.

3.2 Internship Outcomes and Long-term Impacts

At the end of the internship, the intern groups presented their design solutions to industry partners. They also prepared detailed reports outlining their design processes, user research and material testing conducted, production processes, prototypes, the ways they can be implemented in real life, and so on. These design solutions are summarised below.

- For Mamukko, the interns tested used fishing nets and explored ways of cleaning and recycling them within the capacities of the SME (i.e. their workshop), as well as opportunities of growing their business with sustainable products and services. The growth plan they presented included step-by-step business implications along with suggested product designs at each step and potential local collaborators (i.e. other businesses, institutions and NGOs).
- For One Off, the interns revealed the realities of implementing a take-back system within the limitations of a design agency. In addition to designing a product-service system for leasing high-end furniture and recovery, they also focused on how this system can be incrementally integrated into their existing business. This revealed challenges with regard to interaction with associated manufacturers and clients, as well as logistics, which they addressed throughout the implementation plan and an app to assist One Off’s fast-paced design processes.
- For SRWMO, the interns focused on resolving food waste issues in a more confined area (i.e. campuses) and designed a food sharing platform for students and staff, with the collaboration of on-campus businesses and the
management of UL. Although the user research and piloting were conducted in UL, they designed a toolkit for
their solution so that it can be adopted by other universities in Ireland and around Europe.

What these outcomes indicate is that the solutions developed differed in scales from those outlined in the initial
project briefs. For Mamukko, the design solution included the introduction of an ordinarily complex procedure (i.e.
recycling) into the small-scale craft process — as a response to the initial design brief — but it also included solutions for
the business to incrementally grow and become a significant actor in recycling fishing nets. On the other hand, the
design solution for SRWMO was towards behaviour change in a more focused area (i.e. campuses) than initially
intended by the industry partner (e.g. general public). However, these changes were decided upon with the industry
partners throughout the process.

During the interviews, a clear positive emerged— all industry partners were partially utilising the outcomes of the
internship after a year. Mamukko explained their intentions of growing their business with the help of the material
experimentation completed by the interns, and they have been in touch with potential stakeholders including the
ones they learned about from the interns. SRWMO talked about a fundamental shift in the way they were targeting
their audiences, from addressing the general public and generally families to more niche groups e.g. students and
campuses. They are currently developing a food sharing platform directly targeting these niche groups to be released
nation-wide.

Contrarily, One Off emphasised that there are many aspects of the design outcome that requires “waiting for the right
time and project” so that they could begin implementing the long-term integration plan the interns developed for the
take-back system. In addition, they were overly stressing their existing limited human resources and capital, to
simultaneously continue their business and prepare for this implementation, to which they are looking for alternative
opportunities. They also mentioned that this challenge of transitioning towards sustainable business models is similar
for many SMEs, as they require to work within their business model without disturbing their revenue stream while
also implementing changes incrementally.

3.3 Limitations of Collaborating through an Internship Programme

Finally, the partners were asked what changes they would suggest for the remaining Circular Design internships and
for any further partnerships between them and the University of Limerick. All partners agreed on one point with
regards to the project logistics— they would have liked more time for the project, as they felt three months was too
short. The scale of the briefs and the time required for the intern groups to become familiar with the area meant that
the work only began to flow after several weeks. At this stage, the project was almost halfway through and the reality
of completing a well-detailed design solution was not feasible.

Whilst the project would ideally be longer, allowing for deeper research and more evolved concepts to emerge, this
unfortunately isn’t always possible. In addition to EU project restrictions on internship durations, academic calendars
often misalign with industry timelines which can negatively affect the internship experience for all partners. Similarly,
with all the interns returning to their home institutions to complete their studies meant the project couldn’t extend
past the deadline even if there was scope in the concept for further development or even implementation.

Also, all of the partners expressed a desire to have continued communication with the intern groups in order to
progress some or all of the concepts or simply give feedback on how related projects were progressing and how these
were influenced by the internship outcomes. In some cases, this communication has continued but establishing a
more long-term communication channel between all partners could be included in the future internships.

The partners also discussed that an ‘immersion phase’ at the start of the project would have helped speed up the
familiarisation and research stage. Both One Off and Mamukko suggested that this could comprise a block of time
(e.g. one week) placed in the company offices. This would ensure the interns really understood the business practices
of the partners. While SRWMO suggested visits to similar initiatives and businesses to assess and review successes and
failures. This immersion would also help to overcome the lack of real-world experience of the interns, which was
expected by the industry partners but none the less commented on by all of them during the interviews. They
perceived this as both a positive and negative; negative in how the interns were making simple mistakes that a more
experienced group perhaps wouldn’t and that they lacked in-depth understanding of the mechanics of business. But
positive in that they brought fresh perspectives to the problems the industry partners had been experiencing. The
suggestion of a planned immersion period was brought forward to the subsequent internships to avoid similar issues
arising again.
One final interesting topic raised by SRWMO was what type of industry partner would have the ability and the incentive to implement sustainable innovation in their practices. It was suggested that perhaps the private sector would be better positioned to implement real and tangible changes but that the public sector would need to support such changes through policy development, incentives and expert support. The Circular Design Internship has explored one such public sector initiative that engaged and supported private industry as they transition towards sustainable practice.

4 Conclusion

There is no denying the need for industry at all levels to move towards more sustainable innovation cycles and realise the SDGs (in particular SDG 12: Responsible Consumption & Production). However, what is needed are a variety of practical routes and vehicles for achieving this. One such approach is for higher education institutions to collaborate with industry, where the HEI shares their theoretical sustainability expertise and human capital (interns) and for industry partners to offer the business insights and pathway to production/implementation. It is clear from the first cycle of the Circular Design internship, that it is an effective means of creating collaborations that inculcate sustainability knowledge and build capacity towards sustainable innovation in SMEs across all partners. There are limitations, however, and the efficacy is in recognising these limitations and building on the positive aspects of this type of project.

This type of collaboration ensures novice designers are more knowledgeable about implementing sustainability and this will feed directly into their professional practice. This can be one of the only ways in which small companies can collaborate with larger academic institutions. Even though the projects were educationally based there were clear impacts on industry as the partners have all continued on with elements of the project and integrated the learning into their business practices. This can be attributed to the collaborative approach to creating the briefs, structuring the project and the implementation process.

The drive towards sustainability is a long road but initiatives such as this one can help towards realising the positive impact of design for sustainable innovation.

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Asking the Industry Partners: Reflecting on the Value of Internships for Circular Design


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Abstract: A series of design studio projects on sustainability and design was initiated in 2017 at Istanbul Bilgi University, Department of Industrial Design. The series aims to lead the students to think, discuss, and get aware of their responsibilities on their decisions, about the environment, living things and resources in design projects. For this purpose, a design studio course encompassing the processes and methods of sustainable design was structured. The topic was the context of a locality in Turkey, outside the campus and within daily life, so the students would directly relate with these responsibilities. Similarly, the structure and project briefs of the studio were determined through a direct interaction with the locals and the local knowledge of the region. Aiming that, and in line with certain methodologies of sustainable design, three visits were made to the site during the semester; the first by the coordinators before the semester started, the second and the third with the students and coordinators, for research and project development phases. The research phase was based on the core topics related to sustainability and the region: built environment, culture, food, energy, waste, and water. During the project development the students focused on one of these topics and built vision scenarios for future on the grounds of the past and present of the village, and proposed system and product designs to facilitate reaching their vision. They shaped their design ideas on the grounds of the local context and shared their projects with stakeholders and the inhabitants.

Keywords: sustainability; industrial design education; systems thinking; design camp; local and rural

1 Introduction

Design is defined as an area tackling with “wicked problems”, which are “social system problems”, in which many stakeholders with “conflicting values” are involved within a “thoroughly confusing” context (Rittel & Webber, 1973; Schön, 1987; Buchanan, 1992; Irwin, 2015). Defined as such, the practice of design is supposed to consider the intricate web of relationships and influences within which it operates. The designer’s role is to be aware of the consequences of each decision and action throughout the design process and design accordingly. Such awareness necessitates a wider look at the design problem at hand, in terms of who and what will be affected, when and where
the impact will expand. A broader and closer approach to places, times and actors is essential. Design, proposed to naturally involve such an approach, is being defined and practiced in such a wider sense more and more, today (Irwin, 2015; Ceschin & Gaziulusoy, 2016).

1.1 Sustainability and Sustainable Design

Defined as tackling with wicked problems, design practice is associated with the current issues of sustainability, which are also wicked in nature (Tonkinwise, 2014; Irwin, 2015). Sustainability involves environmental, social, economic issues, all of which are within the realm of design projects (Tischner, 2006; Irwin, 2015). Design activity proposes situations in which resources are altered, combined, used in ways that effect related stakeholders within wide areas and long durations. Thus, the designer takes on the responsibility of making decisions for the living and non-living things in the world. This basic definition of design activity holds a holistic approach, similar to that of systemic thinking, to which design is increasingly associated, especially within the area of sustainability (Tischner, 2006; Irwin, 2015; Battistoni & Barbero, 2017). The close connection inherent between design and sustainability has been studied by design community, where design is applied as a tool to challenge problems wicked in nature (Papanek, 1984; Irwin, 2015; Ceschin & Gaziulusoy, 2016).

People within the area of product design are bound to be able to answer the questions of what product is designed, how and why (Tischner, 2006). A designer should evaluate the context and necessity of a design project in relation to the above-mentioned responsibilities (Papanek, 1984). The context and the necessity of a product is determined through studying the space the project will cover within the actual life, a must in tackling with wicked problems. The designer, who skips these evaluation processes and who does not question the place and the reason of design projects in real life, would probably “best not design” (Papanek, 1984). Still, professional design practice or the educational programs in design, does not cover issues of sustainability, sufficiently (Tischner, 2006). Even though design activity is to deal with the complexities of wicked problems, it seems to miss its capacity and approach design problems from a narrow perspective.

1.2 Product Design Education and Sustainability

Studio-Sustain series adopts the idea that design education and practice are determined by the people, situations, necessities, needs of real life (Tischner, 2006). Instead of assigning students with a predefined brief, the course initiates by presenting them a context which they will be a part of, experience, analyse, and then form a project idea. Thus, students bring out the need and causality of their design projects out of the given specific context. While questioning what and why they design, students also take the responsibility of their decisions on what to be sustained, why and how. Design education programs on sustainability also include humanitarian content into their curriculum for “a new generation of compassionate designers with global awareness, local engagement and personal integrity” (Tischner, 2006). In addition, they adapt the approach of “holistic education” which suggests “seeing things as a system (or wholes within wholes)”, also stated in the sixth property of wicked problems: “Every wicked problem is a symptom of another, higher level, problem” (Rittel & Webber, 1973; Forbes, 1994; Battistoni & Barbero, 2017).

2 Studio-Sustain Urla-Barbaros

In Summer 2017, the coordinators of Studio-Sustain decided initiating a studio course series on sustainability and design. It was important that the first of this series would be about a site outside the city. Essentially, students and coordinators would get out of the campus and the city they live in, and study the specific context of another region. The first property of wicked problems suggests, “wicked problems have no definitive formulation, but every formulation of a wicked problem corresponds to the formulation of a solution” (Rittel & Webber, 1973). Consequently, students would be given the context which they can study, and then, frame the problem from their point of view. By working directly on-site students could experience “co-design processes starting with the consumer/customer needs and aiming at maximum social, environmental as well as economic sustainability” (Tischner, 2006).

The field-study was planned as a design-camp where students and coordinators would get in a collective living-working setting among themselves and with local people. The camp format was both a concept of focusing and working on a subject collectively, and a physical activity. Students would get out of their comfort zone and encounter, study, understand the reality of another region in an intense, concentrated way. Camping enables living and experiencing the site temporarily, getting out of the usual routine, creating a hub that attracts local people and institutions on sustainability and locality. As an alternative to design-studio in the campus, the design-camp is proposed to be a multiple learning, sharing, experiencing environment (Kıyak İngin, 2004).
Upon evaluating the alternatives for the site to be studied in this first implementation outside campus and Istanbul, Barbaros village was selected. The close connection with the Building Biology and Ecology Institute (1), located in the village and active on sustainable design, was significant in the decision. As the Institute informed, the locals in the region were active on sustainability issues and were open to working with a group of students and coordinators visiting the region. Barbaros village is located in West Urla Region, within Urla municipal area, west of Izmir. Urla, whose history goes back to 2000 BC, hosts coasts, villages, valuable agricultural lands, natural landscapes as well as historical, cultural, architectural values (IZKA, 2014).

In Turkey, by 2012, villages turned into neighbourhoods by law 6360 (2), which caused a fundamental change in administrative and structural status of these areas. This issue was essential while working on-site and was discussed with local people and institutions. Within the studio context, the region is intentionally called village instead of neighbourhood in order to emphasise the importance of sustaining the potentials, abilities of villages as villages. During the studio three site-visits were made, all for a duration of four-five days. The first one was the pre-visit by the coordinators, while the second and third ones were the two design-camps of students and coordinators.

In the very beginning, sustainability was addressed in a general sense. The topics of sustainability suggested by Day and Mindbjer (2007), “buildings, food, goods, waste, economy, traffic, water, rainwater, flooding, sewage, air, energy, trees, wildlife, micro-climate”, were re-categorised according to the region and established the basis for the first phase of the studio. The issues to be followed in the first research phase were: agriculture, built environment, climate, economy, energy, local and regional production, natural resources, transportation, village culture, waste, water, wildlife.

2.1 Pre-Visit to the Site and Semester Planning

Before semester started, the coordinators made a four-day visit to the site in order to explore, understand the region, to meet local people, institutions and to plan, organise the semester and the design-camp. They stayed in the village, had meetings with stakeholders, made a preliminary study on the above-mentioned topics in the region (Figure 2).
2.2 Interactions: Sustainability and Sustainable Design

Studio-Sustain Urla-Barbaros started in Autumn 2017, with 18 students of third and fourth grades, two coordinators and an assistant. As one of the main intentions of the series, the semester started by hosting and visiting people and institutions working on sustainability and sustainable design, creating a dynamic relationship between the studio-class and outside the campus.

In the beginning of the semester, the focus was sustainability, sustainable design and pre-research on the site. Related people and groups were invited to the studio, while visits were made to related collectives to see and practice some examples. Architect Süreyya Topaloğlu who studied the region for her masters, shared information on the site. Artikışler who study the waste cycle in cities, Dürtük who question the ways of food production and consumption, Ege Okal and Senem Tüfekcioğlu who practice and study Permaculture were some of the visiting experts. During a one-day visit to the Permakamp in Beykoz, Güneş Savaş told about the camp, students analysed, practised permaculture. Ayça İnce from the urban farm and restaurant Ek-Biç-Ye-İç presented their sustainable food business within the city (Figure 3).

Permaculture is one of the key themes of Studio-Sustain. It was an “inspiration” for Transition Design, which proposes that “the transition to sustainable futures is a design process that requires a vision, the integration of knowledge, and the need to think and act at different levels of scale, and that is also highly contextual” (Irwin, 2005). Methods, processes of transition design were adapted by Studio-Sustain and was introduced with a kick-off workshop.

2.3 A Workshop: Sustainable Design and Systems Thinking

Studio-Sustain was based on the methods within the studies and practices in the area of sustainability and design. In order to introduce the basic definitions and methods Dr. İdil Gaziulusoy, the head of Nodus: Sustainable Design Research Group at Aalto University, was invited for a seminar and a one-week workshop (Figure 4).
Design for Sustainability has evolved from a technical approach based on product design into a broader study of systems and products within these systems (Adams et al., 2016; Ceschin & Gaziulusoy, 2016; Irwin, 2015).

“The current understanding suggests that sustainability is a system property and not a property of individual elements of systems. Therefore, achieving sustainability requires a process-based, multi-scale and systemic approach to planning for sustainability guided by a target/vision instead of traditional goal-based optimisation approaches” (Ceschin & Gaziulusoy, 2016).

This gradual change also includes differences in the issues of sustainability from more environmental topics to more social ones (Ceschin & Gaziulusoy, 2016). Also suggested in the studies, is the varying scales of contexts. There are micro contexts, "places", which, together, form macro contexts, "spaces" (Manzini, 2015). Interventions made on micro contexts eventually make a change in macro scales and the designer needs to consider both scales, simultaneously. Studying micro contexts includes developing design ideas and projects through field study, working on-site and with locals. In such a transition design process, "speculative, long-term visions of sustainable lifestyles fundamentally challenge existing paradigms and serve to inspire and inform the design of short- and mid-term solutions” (Irwin, 2015).

During the workshop the campus was taken as the demo-site, where students could work directly on-site and implement the methods of research and visioning. By studying the familiar setting of campus, students would experience the attitude, approach of sustainability on the basis of a daily micro area, and then transfer this experience, approach, methods to the village. One of those methods were the Iceberg Model in which a present issue, or "event", is analysed through the ongoing patterns, structures, mental models shared by people. Another method was the Seeds of Change, which involves ‘looking for clues to solutions for sustainable futures in the context of the present and developing the ability to anticipate over long horizons of time’ (Irwin, 2015).

Students were divided into six research groups. The above-mentioned topics of sustainability were adapted to the campus. The research groups analysed the campus on the basis of these topics, namely, built environment, campus lifestyle, energy, food, waste, water. On the grounds of their analyses, the groups proposed vision scenarios for 25 years into the future of the campus, which they visualised in collages. The campus inhabitants, locals, were called to participate in developing vision scenarios together. Finally, each group presented their research and visions, and processes for system designs were discussed (Figure 5).

2.4 First Design-Camp
The first design-camp took place for five days at the end of October, with all students and coordinators.

2.4.1 Research and Visioning
The first design-camp was planned in detail by the coordinators where students and coordinators stayed in the village, becoming part of the daily life. They gathered information, material on the region, had meetings, made interviews
Simge GÖKSOY, Ash KIYAK İNGİN

with related people and institutions. Among them were Building Biology and Ecology Institute, BUKöyDer (West Urla Villages Association) (3), the mukhtar, the Municipality, the village bakkal, the village kahve, the village lokanta, a villager who collects seeds and plants them in her garden, an architect who designed and built his own house in the village with local materials, all significant figures in the area (Figure 6).

Students, working as the same six research groups, implemented field-study on the basis of the topics of sustainability, as determined in the beginning of the semester. The topics were distributed as: built environment and natural resources; agriculture and wildlife; village culture and local production; natural resources, energy, water, climate; regional production and economy; waste and transportation.

The group working on natural resources documented, categorised the distinct types of local plants through drawings, photographs, videos, collecting actual plants. The group working on waste analysed, categorised the garbage and other waste of the village, in drawings, photographs. Some looked into the seed archive in the area, also visiting villagers in their homes to learn how they plant, cultivate in their gardens (Figure 7).

The neighbouring villages and Urla, as the administrative centre, were also included within research. The first two days, groups collected data and started building visions on their specific topics. On the third day, they presented their findings and vision proposals to the related people of the village and received direct feedback from the stakeholders. After the presentation, which was an occasion of mutual, collective thinking-learning, students carried on researching
on the grounds of the feedback. The last two days, groups evaluated their proposals, ideas, made more interviews, talks with the locals, collected material, data (Figure 8).

Additionally, students and coordinators visited Urla Municipality, presented Studio-Sustain Urla-Barbaros to the Head of Municipality. They were able to learn about the vision, perspective, agenda of the municipality on related issues and to get feedback from the authorities, directly.

2.4.1 Research and Visioning
Returning back to campus, students concentrated on organising, interpreting the material. They used mind-maps, various mapping techniques to situate, organise, visualise their research and ideas (Figure 9).

Students developed their visions on-site, on the basis of direct interactions in interviews, talks and time spent with the inhabitants, their observations, existing projects, plans, activities of the local municipality, groups, institutes, associations, and the vision of the village: “Reviving the traditions, putting forth our production potentials without harming the serenity of our village, ensuring our sustainable progress without compromising the blessings rural life offers us!” (4). They proposed future visions and visualised them in collages, some of which were “a valued, embraced, united Barbaros”, “a herby, herb informed, colourful Barbaros”, “a self-sufficient village”, “village: 1 waste:0” (Figure 10).
2.5 System and Product Design Proposals

After research and visioning, students started to work on their system and product design proposals, determining the context of their design projects on the basis of the field-study. The focus was not what students and coordinators brought to the site but what the site shown, taught them. Six research groups dissolved and students started to work on their design ideas individually or in groups of two. They proposed system designs for the next two-year time and product designs that would function in and facilitate these systems, both planned to be the means to reach the future vision they suggested. They presented their proposals, received feedback in a midterm jury before the second site-visit (Figure 11).

2.6 Second Design-Camp

The second design-camp took place at the end November, staying in the village for five days.

2.6.1 Developing Systems and Products

During the second design-camp, students were to directly test and try out their system and product proposals. They experienced relevant activities, production processes, got feedback and advice from the locals and stakeholders, made further research specific to their areas. Before the visit, the coordinators guided the students to plan their second-camp and, on-site, facilitated students and locals to collaborate for testing ideas and proposals.
One student, who proposed the use of permaculture methods in villagers’ gardens, tested his ideas using waste material of the village to create permaculture units in one of the gardens in the village. Another group tried out natural dyeing methods collaborating with the textile workshop in the village. Some were guests of the villagers being part of the daily production in the hosts’ house and their field, while some others learned the making of the local hat of the village (Figure 12).

The first day, students worked intensely, trying out, experiencing specific practices and processes related to their proposals. On the second day, they presented their system and product proposals to the villagers and related people in the region. On the basis of the feedback, opinions, critiques they received, they planned the next three days, and carried on testing and trying out their proposals accordingly. Meanwhile the coordinators visited the Municipality, presented students’ proposals to the Head of the Municipality and received her feedback (Figure 13).

2.6.2 Back from the Site: Finalising System and Product Designs

Returning back to class, students went on developing their system and product designs on the basis of their experience and further research in the village. They worked on detailed system scenarios and product designs that are central within these systems.

Their system scenarios included "establishing a tradition of production with collaboration of local women producers by creating a village brand", "vacations where volunteers socialise with villagers and among themselves, experience village life helping out the villagers during harvest", "creating communal areas throughout the village to trigger relationships among locals, and using units to direct the inhabitants to these areas", "building a village calendar,
archive, in time through local products of the village and at the end experiencing these products altogether” (Figure 14).

2.7 Final Designs
Students developed their system and product designs simultaneously, elaborating systems in storyboards, scenarios while improving their products through drawings, mock-ups, two processes that helped refine each other. They presented their final designs in a final jury (Figure 15).

2.8 Back to the Village: Exhibition On-Site
At the end of the semester, studio outputs were shared with the village, electronically. The plan was to revisit the site when the village organised its traditional, local festival for the third time. The coordinators visited the site in September 2018, during the festival with print-outs of student projects and photos of the studio process. They set up the exhibition and made a presentation of the studio, and received very positive feedback from visitors and the locals. After the festival the exhibition stayed on-site. Some of the stakeholders organised a meeting to discuss the process and output of the studio (Figure 16).
3 Conclusion

The first of the series of Studio-Sustain can be evaluated in terms of design education, the site and sustainability.

3.1 Design Education: Students

Making research on topics of sustainability and using methods of sustainable design on-site, students developed future visions for the region. They proposed system and product designs to be facilitators in reaching these visions and finalised their projects through testing, experimenting on-site.

“How we approached vision-system-product altogether and how we built vision and system in order to reach the product, were fundamental” (6).

“Notions of sustainability and system design taught in the studio were different than my previous courses. I learnt the basics on sustainability in the presentations and visits during the semester, and consequently, grew an interest in natural dyeing and papermaking” (6).

“Studio-Sustain was quite nurturing, informative. It was unique, interesting that we would travel to another location and work on-site. We were not used to work, live or design in a sustainable way. Throughout the semester I learnt system design, considering the ones effected within this system, using resources wisely and realised that design is a whole, not just the product” (6).

One of the themes was that students would question what they designed and why, and their responsibilities to the context, the site and their design projects.

“I started to think of sustainability and design within a different context. I realised that social innovation necessitates considering the traditions of collective production, collaboration, participation altogether” (6).

“Apart from design educational processes, it also contributed to our social skills. Besides, it was very improving to start considering the materials, how each step I took would have an impact in terms of sustainability” (6).

“I experienced design in relation to different scales, environments, people than usual. What I gained was not just design-related. I learned about Permaculture which influenced me not only in the studio but in my life in general. I acquired new ideas on agriculture, sustainability, climate and villages in the country” (6).

Field studies were planned as design camps where the studio people worked outside campus and the city, on-site and altogether. These design-camps on-site were positive experiences for students, coordinators and the locals. An intense working set-up was formed within the short duration of five days, where issues of rural, local, sustainability were discussed, evaluated, collectively. Students formed their project briefs on the basis of their work on-site, consequently adopting the site and their design ideas better, which effected their learning and design processes.
“In the village we observed the context and discovered how we could create resources for sustainability. The most important point was collaboration. If we aimed for a truly sustainable system and product, our relations with the locals needed to be strong and they were to be involved within the system-product” (6).

“I conducted field study in real terms for the first time. The villagers’ being very open-minded, collaborative and ready to help encouraged us. When we presented our work in the village, participation by locals was very high” (6).

“The villagers were really positive, open to our suggestions, and in only two visits, they really affected us. Our close relations with them were reflected in our warm, honest design approach, enabling us to design products and systems addressing real, thought-through problems” (6).

A design process including intense field-study in a distant location, wide scales of time and place is challenging even for professionals let alone for students. Even though this educational process is weighty for students and coordinators within a three-month semester, the iterative approach of going back and forth between micro-macro, local-regional, future-now is necessary within sustainable design.

“Time-management could be improved. A one-semester period is not enough for such a dense content of design studio. If there were three site-visits, we could finalise our designs on-site, even produce our products there and observe them being used in the village” (6).

“Barbaros village was difficult to get to from Istanbul. Next courses of Studio-Sustain could be planned considering the logistics” (6).

Students who could tackle with varying scales were the ones who changed their perception of the design problem and dealt with these scales, simultaneously. Students who worked on systems while making one-to-one trials on products progressed on both levels much faster. Working directly with stakeholders throughout the process facilitated students to compose more realistic projects, both as systems and products.

The design-camps on site were positive experiences for students, coordinators, locals. An intense work set-up was formed within five days, where issues on rural, local, sustainable were discussed and evaluated, collectively. Regularly, such field-studies in distant sites are organised as workshops or summer-schools of short periods. Integrating such a practice into a semester-long course, parallel to other ongoing courses and routines, makes Studio-Sustain a more challenging educational process, but also rare and unique.

“The studio had a nature of sharing, which strengthened the communication among students, and between students and coordinators. What caused this atmosphere was very simple: eating and enjoying together. This studio, which gives you the chance to get away from your own routine and to get in and experience others, touches not only your design approach, but also your life decisions” (6).

“Thanks to this studio, we encountered many things that we do not see or think in the city, and found out how we can be part of sustaining the resources that the nature offers us and that we consume day by day, through design. We discovered the diversity of resources for production and living, and vitality of supporting sustainability of local spots” (6).

3.2 The Site: Barbaros Village

Studying the village and the rural, which are significantly different from the city in scale and structure, necessitated adopting a distinct design language and system approach. We all distanced ourselves a little from what we previously knew on design and adjusted to this new situation. Considering the boundaries of the role and position of the university on-site, the coordinators gave utmost importance to study the region in a participatory and pluralistic way. During the studio process relations with the site were dynamic and positive. Locals in the village and area actively participated in the process and the studies implemented. Related people and institutions gathered together in students’ presentations creating a setting of exchanging of ideas, thinking, discussing together. The findings of research process were shared with people in the meetings, and later in exhibition and presentation.

“What made the essential difference in Studio-Sustain, compared to other studies we organised in collaboration with other university groups, was that it was a semester-long project where students visited the village and lived with the villagers for four-five days. Such an intense study enabled the students to learn about the village culture and habits in-depth, and consequently, to achieve more sustainable and applicable design ideas. ... We
experienced that the approach of the tutors mattered more than the corporate approach of universities. Naturally, their horizontal communication and curiosity contributed very much in the students’ attitudes and the villagers’ adopting the study. They made everyone feel that they were on-site to improve education with the knowledge of the villagers and not to educate the village” (7).

“Students observed, analysed the village through curious and conscious eyes, under close supervision by their tutors. They were friendly and respectful with the villagers. ... University meeting the village to conduct a collective work was extremely helpful for identifying, sustaining, developing, efficiently using cultural resources and wealth. The village grew more aware of these resources. Students and coordinators staying in the village and interacting with the villagers during long durations got the locals closer to the group and university. ... The university group were in harmony with the village and locals. The villagers responded to the positive attitude of the group and helped them. Even friendships were born. ... We were reminded, informed about our cultural wealth. Our awareness of our natural resources developed. Discussing the values that identify the village strengthen our feeling of belonging” (7).

“As someone who was born and raised in the village, I think they had quite a warm, sensitive influence. ... I saw the exhibition and was moved. Photographs of studio people and villagers collaborating were perfect. The exhibition was well-received by locals and visitors” (7).

3.3 Sustainability: Sustainable Design
Studio-Sustain Urla-Barbaros got involved in the ongoing local studies, practices on sustainability and design. Connections with people and groups working on sustainability and sustainable design, in Turkey and abroad, were established while future collaborations are discussed and implemented. Studio-Sustain series continues taking a different local context as its subject matter each Autumn semester. Each location has its specific topic, character, properties, content that lead the studio course to take a different approach within sustainability. While tackling with issues of sustainability in varying ways depending on the specific context, the methods followed throughout design process within the course remain similar, although constantly reviewed, updated.

Notes
(1) http://www.yapibiyolojisi.org/
(2) https://www.tbmm.gov.tr/kanunlar/k6360.html
(3) http://www.bukoyder.com/
(6) Comments by students, anonymous.
(7) Comments by locals, anonymous.

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References


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PART 2
PhD Pit-Stop Short Papers
PhD Pit-Stop: An Inquiry into Architectural Space in Computational Design Practice

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Keywords: architectural space; computational design; representation; computability and non-computability

1 Introduction

Computational design, one of the prominent agenda items of current architectural practice, has led to drastic changes in the way we think about the concept of space, which is one of the main elements of architectural discipline. Computational design has proved to be effective in the field of architectural production, yet its repercussions in the way we think about and imagine space need to be fully examined. This research inquires into what kinds of changes are experienced in the way we conceptualize space in the light of computational design approaches, and discuss what is preserved, adapted or neglected from our modern understanding of space while conceiving, understanding and interpreting space while designers use computational strategies. Computational terms, being imported from mathematics and computer science and from production process into to the architectural vocabulary dominates over space, which seems to have lost its prior position not only in designers’ language but also in designers’ thinking. It is proposed that computational tools have a drastic impact on designers’ way of thinking while imagining space and the parameters that they consider. The assumption here is that space as a multi-layered and multi-meaningful concept has both computable and non-computable aspects and that it is worth exploring how computational practice treats both aspects. While computation may provide an appropriate medium for thinking about and representing the quantifiable aspects of space, the ineffable and ambiguous aspects of space highlight the limits of what is computable. The research tries to identify the current trends in computational architectural design through interviewing pioneering practitioners in the related area. The doctoral research is planned in three stages: preparation of interview questions, collection of data, interpretation and explanation of collected data. This research is shaped around three main questions.

• How is architectural space imagined in computational design practice?
• How is architectural space considered as a multi-layered, loosely defined and ineffable concept in computational design approaches in which procedures are precise, descriptive and prescriptive?
• What are the spatial concerns of computational design practice?
2 Research Design and Activities

2.1 Research Design

Interview questions which were prepared after the literature research were re-evaluated according to the opinions taken from the academicians who were prominent authorities in the computational design. Then, face to face semi-structured interviews were conducted with the participants. At this stage both the interview questions and the interview method were modified. The interviews were conducted both on-line and face-to-face. In addition to three pilot interviews, 20 participants contributed to the study. Five of the 20 interviews were conducted face-to-face and 15 participants expressed their opinions in writing on the internet.

2.2 Interview Questions

Interview consists of introduction text and the interview questions are grouped under three headings (Table 1).

| Question 1.1 | What are the reasons why you use computational tools in your design process? Is it more efficient, does it facilitate the generative process, does it help in visualizing and spatial thinking, does it enhance creativity etc... |
| Question 1.2 | In your personal design process, how do you benefit from or use these conventional spatial representations and the newly emerging computational tools? Do you sketch something first, or do you do modelling / coding / scripting first or do you use all of these simultaneously? If you prefer certain tools explain how they are used during your design process and if you prefer more than one tool how and why you go back and forth between different tools? |
| Question 2.1 | Could you describe the importance of computational tools for you while imagining architectural space with regards to your design philosophy, formal repertoire, building technology etc.? Do computational tools help you conceive an image that you cannot think, draw, produce without them or do computational tools help you enrich your imagination process? |
| Question 2.2 | When do your spatial ideas and images emerge in your design process? Could you describe the process, relations, and negotiations between the computational tools and your understanding of space? How do the computational design tools foster spatial thinking? Could you illustrate it through examples of your own work? |
| Question 2.3 | What is the importance of the quality of space in your design approach and how do computational design tools ensure the quality of space? |
| Question 2.4 | Could you describe spatial concerns that are personally significant to you and could you describe how your personal spatial concerns and anticipations are fed into the computational process? Please illustrate through examples of your own work? |

Table 1. Introductory and the list of interview questions.
2.2.1 Tools and Design Process
Tools connect designers to their designs through the design process (McCleary, 1988, p. 4). Representation tools such as sketching and physical models have been used during the design process since at least Renaissance. With the prevalent use of computational tools, we see the use of new representation tools such as scripting, algorithms, and parametric formulations becoming more and more pervasive since the 1960s. Here, what is discussed is how the transformation of representation tools affects designers and their design process. Designers were asked about the computational design tools they prefer to use, how they use these tools, and methods of personalizing computational design tools.

2.2.2 Tools and Spatial Thinking
Every tool, every representational system we create simultaneously opens and closes different ways of thinking, which in turn define who we are. As often attributed to McLuhan, “We shape our tools and then our tools shape us” (Culkin, 1967, p. 70). Following McLuhan’s idea, our imaginations of space are at least partially shaped by the tools we use. It is queried how computational tools effect designers’ design philosophy, formal repertoires, and construction preferences while imagining architectural space. Computational tools’ influences on fostering designers’ spatial thinking and their characteristic spatial concerns were asked. Potentials and effects of computational tools about ensuring the quality of architectural space were questioned.

2.2.3 Understanding of Architectural Space in Computational Design Approaches
The importance of the concept of architectural space in computational design approaches, its value and its symbolic meaning in different approaches are discussed here. Participants are asked to express new point of views, transformations and changes that they experienced through their own works with the integration of computational design tools.

2.3 Participants
Invited participants to the interviews consisted of independent designers who have worked in a small- or large-scale projects in computational design practice so who have gained experience as freelance architects or architects experienced in different offices, or academicians from different institutes. Participants who contributed in writing were sent a form consisting of seven open-ended questions under three headings and an explanatory briefing. Participants can fill this form via online app or send it back via e-mail after filled it. In face-to-face interviews, the same form is sent to the participants before interview and they are allowed to reflect on questions.

3 Analysis Phase
Labelling, classifying, interpreting, analysis of connections and segregations of raw data consist of participants’ comments is organised as a matrix table (Figure 1). The top line of the table is the questions directed to the participants, the names of the participants are listed in the left column and the comments of the participants are put in the line-column intersections. This table helps to see all comments together to facilitate through the analysing process. In the horizontal readings of the rows in the table, the characteristic approaches, insights and personal stances of the participants are analysed. In vertical readings made in columns, different answers given to the same question can be analysed. Main tendencies, similarities and divergences can be read about the concepts and approaches mentioned in the questions. In the diagonal readings similar and/or opposite comments and concepts that different participants mentioned in different questions are analysed. In the process of analysis of the raw data horizontal, vertical and diagonal readings will be interpreted together.

The process of participation and analysis phase of the research is ongoing. Early outcomes of the data obtained are reported below.
Participants’ contributions to the questions about their computational design process and the reasons of preferring computational tools while designing are interpreted here.

### 3.1 Designer, Design and Post-Design Relations

There are different reasons of using computational tools. These causes are divided into two phases design and post-design. The other highlighted theme is the designer’s awareness and responsibility (Figure 2).

**Figure 1. Raw data as a matrix table.**

**Figure 2. Relationships between computational design process and the used tools.**

Design phase reasons of using computational tools are concentrated around three issues. The first one is complexity concept which is matched with geometry, form, design problem, data and information. Designers use computational tools to deal with complexity in the design phase. They define that computational tools allow them to handle complex problems, geometries and forms. Next issue is about conceiving phase of design process. Participants have remarkably declared that computational design tools provide greater freedom especially on geometry and form. In addition, computational design tools satisfied the designers’ exploratory nature of design process. They claim that computational tools help to explore potentials and catalyse imagination. The third of the design phase reasons is that computational tools are dynamic, generative and interactive systems. Exploring search space with automated procedures through modifiable responses attract designers’ attention.

Post-design phase reasons are discussed under two topics. One of the forthcoming concepts that designers commented about is certainty. It is seen that when the early design decisions are matured and abstract ideas become ready to take shape, freedom expectation of designers transform into certainty expectancy. Mutually supportive triple
structure of control, accuracy and precision is welcomed while considering geometry, data and information. The other post-design phase reason is that computational tools are highly expressed with fabrication advantages. Especially when the complex geometries are considered computational tools are accepted as standard of architectural industry. Designers prefer using computational tools because of pairing well with CAM technologies.

Designer cognition is another field that participants commented about. In addition to previous reasons most of the designers united in two opinions which are basically focused on the designer’s self-control and the meaning of tool. The first view that participants mentioned is the importance of designer’s awareness, responsibility and conscious while using tools particularly computational. Some of the designers complains that insensible use of computational tools reveals blindfolded designs. The other point that some respondents united around is that no tool is superior to another in increasing creativity and spatial thinking. However, any tools enhance thinking and creativity, this situation does not reveal inferiority or poorness but brings differentiation and enrichment.

3.2 Designers’ Tool Preference Affecting Factors
Predictable unexpectedness is a concept that designers welcome through the design process. Many of the designers are designing with the aim of satisfying the feeling of unexpectedness. Most designers think that computational tools expand the search space through an unexplored area before where they see wide range of potentials. Creativity in a way matched with looking for and waiting for an unanticipated/unexpected moment. However, many of the participants declared that computational tools do not directly enhance their creativity like any other tools do not. Controllability is another important concept emerged. Many of the participants relates that designers’ taking full control of the computational tools is connected with authenticity and awareness. Otherwise, unaware and copy-paste use of software applications, scripts, modelling environments, etc. might cause inconsistency and contradiction between different phases of thinking, designing and producing is inevitable (Figure 3).

Figure 3. Designers’ tool preference affecting factors.

4 Expected Outcomes
The research continues within the framework of increasing the number of participants and the analysis studies go on this direction. It is expected that the transformations and different patterns in the perception of space in the minds of designers will be discovered with the new and different meanings that are loaded on the concept of space in computational design approaches. The values, norms, concepts, variables, properties and qualifications that make up the space in computational design practice can be learned and the areas beyond the computable despite the computational design tools is thought to be opened to discussion.
References


About the Researcher

Kadir ÖZTÜRK received his BArch from İzmir Institute of Technology in 2008 and completed his MArch at İstanbul Bilgi University in 2010. His main inquiry is to explore the imagination of architectural space in the computational design practice. He is continuing his doctoral studies in İzmir Institute of Technology under the supervision of Prof. Dr. Fehmi Doğan.
PhD Pit-Stop: A Creative and Innovative Design Approach to a Traditional Cuisine - A Comparative Analysis of Turkish Cuisine (Developing A Conceptual Model of Culinary Design Thinking)

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Keywords: culinary; design thinking; creativity; chef

1 Introduction

The 19th century is a critical period for both the field of gastronomy and the profession of the chef. After the French Revolution, chefs who were the workers of the private patrons became both unemployed and free and opened their restaurants to serve the elite public who were the politicians, businessmen, journalists, writers, and artists in the city (Ferguson, 1998). The chefs transferred their art and craft in the elaborated banquets of court and palace into to the public. Thus, those people who earned their lives by cooking began to serve food in their own shops, which is called restaurant today. Since then, the history of gastronomy has witnessed different movements thanks to the preeminent chefs. Generally, culinary movements have developed upon the former’s simplification, modernization, modification, and alteration in terms of dishes, ingredients used, preparation and cooking techniques, serving style, consumption pattern, business model, and position of chefs.

Gastronomy has become a creative industry (Chossat, 2008) and haute cuisine, which is a field consists of fine dining restaurants, has been the supportive element of this evolution. Contrary to popular belief, haute cuisine improves and promotes countries’ ingredients, cooking techniques, and traditional dishes through creative and innovative approaches.

The developments in the culinary world have accelerated even more. Chefs are not only the cooking person, but also, they are professionals who pursue, plan and manage the restaurant business from beginning to end. The commitment and perfection of the chefs to the profession has led dining out beyond the satiation. Thus, being a chef has become an occupation that makes valuable contributions to the national economy.

Today there is a gentle competition, cooperation and sharing in the culinary world. Chefs represent their cuisines internationally through creative contributions. Turkish cuisine, which is considered to be the one of largest cuisines along with French and Chinese cuisines, has fallen behind the developments.
The research covers the creative processes of chefs through design discipline and creativity which is the subject of the discipline of psychology. Specifically, this study is conducted using a mixed methods research design to (a) gain an in-depth understanding of chefs’ creative processes when they generate a recipe or a menu, (b) distinguish the stages they execute, and the connection that this creative process has with design thinking methodology, (c) understand chefs’ perceptions towards creative culinary product and (d) understand culinary academics’ and chefs’ perceptions towards environmental factors that influence culinary creativity. The thesis aims to develop a conceptual model of design thinking by applying theories from the discipline and design and creativity to be used by culinary professionals that are chefs, chef candidates, restaurateurs, or even food critics, cookbook writers; in other words, anyone who has a direct relationship with food.

2 Research Design and Activities

A mixed methods research design was chosen to take the advantage of qualitative and quantitative approaches to improve explanation of the findings. The research was a comparative, multiple study with an exploratory mixed methods design (Creswell & Clark, 2017). Constructivist approach was used, and social science theory was applied. Because of mixed methods research structure, three main questions were asked.

- Quantitative research question (RQ1): What are the attitudes of culinary professionals in Turkey towards external factors that influence culinary creativity of Turkish Cuisine?
- Qualitative research question (RQ2): What are the phases and considerations of chefs in the development of new dish? Does the conceptual model of culinary design thinking represent chefs’ dish development process?
- Mixed methods research question (RQ3): How can development of and openness to culinary creativity of a traditional cuisine be improved through culinary design thinking in the domain of gastronomy?

To answer RQ1 the study aimed to discover the roles of environmental factors in the development of culinary creativity by comparing chefs and academicians’ perspectives from different professions of gastronomy in Turkey. After conducting semi-structured interviews with arbiters of Turkish cuisine who also appear at the international gastronomic scene a questionnaire with a 5-point Likert scale (from strongly disagree to strongly agree) and 29 items was prepared to investigate the effects of environments on culinary creativity. To collect the data, the questionnaire was sent online to the chefs of Turkish cuisine and academicians involved in gastronomy and culinary arts education in Turkey.

RQ2, which was also the second phase of the thesis research, was mainly divided into two sections. Firstly, using a qualitative research method, including in-depth interviews with prominent Turkish chefs to understand their approaches to the development of a dish or a menu regarding the proposed model of culinary design thinking. Secondly, quantitative data were collected by questionnaires in order to confirm the feasibility of the proposed model. By employing a qualitative approach, nine chefs were interviewed. Twenty-five semi-structured questions were framed under three main stages of design thinking: data gathering, idea generation, and implementation. Interview transcripts were analysed as well as other relevant documents (secondary data; cookbooks, newspaper articles), and used grounded theory technique to interpret their development process. Based on the results of the qualitative study, a questionnaire containing 51 statements was created which included 19 inspirations, 13 idea generation, six implementations, and in addition to the main concept 13 dish attributes statements were constructed.

3 Expected Outcomes

The multidimensional and comprehensive research will shed light on the domain of gastronomy, chefs’ creative processes, and culinary arts education. The proposed conceptual model of culinary design thinking can be used by both artisan restaurants in a neighbourhood and fine dining restaurants, because chefs are the centres of the model.

Perspectives of professionals in the domain of gastronomy in Turkey towards culinary creativity were positive, which was an essential stage for the application of the second phase of the research. The second phase of the research showed that chefs responded to both semi-structured questions and questionnaire statements in line with design thinking. This will provide an opportunity for chefs to utilize the tools and methods designers apply in their creative processes.
References


About the Researcher

Sedef Yücel is a PhD student at the Izmir University of Economics, design studies program. Her doctoral research focuses on the creative process of professional chefs who generate a new menu or a new dish by applying and adapting the framework of design thinking. She takes a multidisciplinary approach that encompasses the fields of gastronomy, design, and the psychology of creativity.
Keywords: carpenter; digitization; handcraft; Industry 4.0; identification

1 Introduction

The job of a carpenter is going to change radically. As we can see in all kind of services, new technology promoted by Industry 4.0 leads to substantial changes. Being aware of this fact, it is only a matter of time until craftsmen have to reorient their profession. A lot of research is being done on predictions of how jobs might be substituted by new technology (Frey & Osborne, 2017). When creating a more positive vision of our future, we could ask what new qualities, opportunities and professions, caused by digital transformation might emerge. This PhD is going to conduct in-depth investigations on the work of a carpenter. As expected, outcomes, key skills of their profession will be shown. These core-qualities are not substitutable by new technologies. Therefore, Industry 4.0 solutions can even promote the requirement of an expert and will make his/her profession even more valuable.

1.1 Technological Revolution or Evolution

As shown by Christoph Schindler (2009) the profession of a carpenter is on a continuous progression. Their working environment did change significantly with each technological step our society participated. A substantial change in this process was the industrial revolution at the beginning of the 19th century. In this context, Industry 4.0 is often mentioned as the next striking step. This raises the question of “how new technology affects the job of a carpenter.”

Until now, the process of manipulating a piece of wood has been directly related to the tool and the person who is using the tool. This interaction between operator and work piece had a quite simple and easy to understand feedback-loop. The person who is working on an object is in direct relationship with the material. The carpenter substantially influences the shape of the final product with his/her hands. This moment will lead to a personal interaction/identification that can promote a deeper incentive.

1.2 Where to Find Insider Knowledge

As a natural resource, wood comes with a high variation in strength, durability, quality, etc., and by that demands a careful handling. The job of a carpenter can rely on a long history that has evolved for many generations. As experts on all kind of different wooden constructions, these craftsmen could develop a broad range of knowledge. Their
professions is well-known for specific skills, dedicated to the characteristics of a natural construction material, wood (Schindler, 2009).

1.3 New Technology Becomes Affordable
For a few years, the construction industry has been able to provide CNC-joinery-machines that are at an affordable cost, even for small carpentry shops. These computer-operated machines to provide a substantial rise in speed and efficiency for the construction process. On a regular basis, the programming of the robot will be done in the office of the workshop. Processed data will then be sent via ethernet connection directly to the CNC-joinery-machine. From there, the actual manipulation of the wooden material takes place. The process of manipulation is then going to be monitored by a human, most of the time a carpenter (Figure 1). His/her function in this system is more or less limited to a passive surveillance position. Compared to the traditional, manual procedure, the machine does most of the workload (Schäfer, n.d.). At moment, these robots act on a local basis with a seemingly simple communication from the workshop to the office. They may only act as work enhancement in terms of automation compared to industry 3.0 (Lars et al., 2015). Already equipped with crucial technology it is only a question of further connected IT-infrastructure to develop a smart factory according to aspects of Industry 4.0 (Pereira & Romero, 2017).

1.4 CNC-Robot vs the Craftsmen; Does He?
According to Sennett (2009), the work of craftsmen has a deeper motivation than just providing a product that was ordered by a client. In the mind-set of Sennett, handcraft implies a personal commitment of people doing their job well for its own sake. Therefore the question arises of what the core elements of a profession might be. Referring to Sennett, these values shall be preserved to enable this moment of deeper identification and by that keep the work of a craftsmen doing worthwhile (Figure 2).

Figure 1. ‘Hundegger SpeedCut SC3’ by Eura Ply Gendringen; video provided by Ron Berendsen media (Berendsen, R., Retrieved May 10, 2019 from: https://www.youtube.com/watch?v=SOZ5wX6ROU8)

Figure 2. ‘We are working together... aren’t we?’ Question, raised by a carpenter; (W. Schwarzmann, 2019).
When comparing the process of wood-manipulation between a carpenter and a CNC-joinery-machine, it is obvious that core activities can be handed over to the machine. A daily task known as timber framing can be easily done by these robots. The same job that may need two to three skilled workers for days is now being done by a worker and one CNC-joinery machine in a few hours. When educating craftsmen, big parts of their knowledge are developed by participating in these time intensive tasks. Therefore knowledge is handed over to the next generation on a small scale, in portions, absorbed day by day, while spending a great amount of time working with the material wood.

It is important to encounter new technology with an open mind while still being aware of what place it might occupy (Herres, 2016). Originating from this challenge between new possibilities compared to proven traditional methodologies, the according questions shall be addressed in the research project:

- How does the process of Industry 4.0 change the job of a carpenter?
- What are new connections between the traditional work of a carpenter and Industry 4.0?
- Which kinds of tasks provided by a carpenter are still indispensable in the 21st century?
- How does the ongoing automation of labour, currently done by a carpenter, change his/her identification with the process (e.g. the final product)?
- What knowledge do we have to provide to young people, (with focus on the job of a carpenter) to equip them with substantial tools to face challenges of the future?
- How can small carpentry firms (2-5 employees) benefit by technologies provided by Industry 4.0?

2 Research Design and Activities

The main focus is going to be laid on small wood workshops (less than 50 employees). Especially in the region of Bregenzerwald in Vorarlberg, many small carpenter workshops can be found that often provide a long-established family history. This aspect of preserving knowledge in the family and by that promoting personal values shall enrich the discussion with an emotional incentive. As found out in the first preliminary talks, the contact persons felt highly excited when being asked about their personal opinion of tradition in handcraft. When talking about new technology (e.g. Industry 4.0, digitization, etc.) there seems to be a conflict of interest for these people on how to integrate new technology while being loyal to their heritage and tradition.

The collected data will mostly be divided into companies that use and others that do not use CNC-joinery machines. Additional data will be collected by participatory observations in the workshops. Everyday tasks of a carpenter will be observed and recorded in a work-logbook. This method shall illustrate the highly diverse tasks these people have to manage on a daily basis. Provided with the data of these work-logbooks expert interviews will be performed. Questions are going to be prepared that will have a link to everyday work situations. This semi-open questionnaire will then build up on work that was performed by the interviewee, enriched with their personal perception.

Possible questions that will be asked include:

- What kinds of tasks do you enjoy in your working environment?
- Are there tasks that you can (not) identify with? make you proud of doing?
- Imagine a building site you already finished and you really enjoyed. What were your main activities performed? Why did you enjoy working on this project? What was a task specific for your profession?
- What kind of knowledge do you think is crucial when starting as a carpenter in the 21st century?

3 Expected Outcomes

An expected outcome will be the illustration of tasks performed by a carpenter. With these log-books and the data of the interviews, core activities of a carpenter can be shown. These data will lead to a job specific profile that allows to make a comparison of what tasks a CNC-joinery-machine might claim. It shall be possible to determine which tasks are time and labour intensive. A main focus will be laid on the overlapping picture of objective observations and subjective, personal perception.

Furthermore, with this set of collected data we will be able to draw the broad spectrum of abilities a carpenter might need in his/her profession. By that it is possible to point out that the job of a carpenter contains way more aspects than Industry 4.0 solutions might be able to fulfil. Even though these machines make the job of a carpenter much more efficient, they might not threaten the overall profession of manufacturers. Craftsmen have to preserve the ability to do things that cannot be performed by a CNC-robot. These are general abilities that make each and every
profession safe to automation like: not doing things that lead into a daily routine, developing empathy for your surrounding and promoting the ability for generating creative new combinations (Friesike, 2018). These points are all core competencies of a vital craftsman, and by that, match the aspects provided by Sennett (2008).

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Selected Bibliography

About the Researcher
Wolfgang Schwarzm ann is employed as researcher and enrolled as PhD student at the University of Liechtenstein. After he finished his architecture studies in Austria he worked as a carpenter-trainee at a workshop and by that developed a deep understanding of this specific field. Further on he worked in the architecture office of Prof. Hermann Kaufmann, a well-known Austrian wood construction architect.
PhD Pit-Stop: Products as Mediating Entities in a Connected World

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Keywords: post-phenomenology; philosophy of technology; technological mediation; digitalization; human-world relations

1 Introduction
Industrial design is one of the disciplines that shape our material world around us. According to Dutch philosopher Paul-Peter Verbeek (2005, p. 2), besides areas like philosophy, even areas like industrial design has neglected the material entity of objects around us. Even for industrial design, objects around us were just signs or containers of meanings for a long time. A post-phenomenological approach to technology would change such a view (Hauser et al., 2018) and would put objects into the role of mediators between humans and the world. According to Gamm (as cited in Nordmann, 2015) technology can be seen as a medium, an example of this would be the function of an object and all the possibilities that go beyond.

This study is expected to deal with the human-world relationship through a post-phenomenological approach. It will also argue that digitalization has changed our relationship with the objects around us. The work will document, in a few exemplary cases, the changes that objects have undergone through technological developments.

1.1 Definition of Medium
Defining the notion of medium is an important aspect of the theoretical framework through which objects can be classified as a medium between humans and the world. There are very different views on defining medium (Mock, 2006) and whether the objects can be classified as medium. Hoffmann argues that the word medium has so many definitions that everything can be seen as a medium (as cited in Hubig, 2006).

Historically, one of the first definitions of medium is in the dictionary of Herder which defines it as “middle” or “being in the middle” (Münker & Rösler, 2008). Nowadays the word medium is mostly used as “information carrier” (Mock, 2006). Another historical usage of the word is in the Brockhaus Dictionary from the year 1911, which defines medium as “someone who communicates the messages from spirits” (Münker & Rösler, 2008). A more sophisticated definition of medium would be the definition of Christopher Hubig (2006) as Möglichkeitsträum which can be translated as “area or space for different possibilities”, or the definition of Gerhard Gamm as Transformationsraum translated as “area or space for transformation”. For Hubig (2006) many things such as air or automobiles can be seen as a medium as they open new possibilities which were not available before. Every medium has the ability to widen humans’ perception (Engell, 2003). This idea can also be supported by Marshall McLuhan’s notion of the medium as “extension of men.”
1.2 Human-World Relation in Post-Phenomenology
Since the empirical turn philosophy of technology deals with specific technologies rather than a reductionist approach
to technology as a singular phenomenon (Franssen et al., 2016). One of the key figures in post-phenomenological
understanding of technology is Don Ihde (Wendt, 2015), who developed several formulations concerning how humans
four types of relations —hermeneutic, embodiment, alterity and background relations— with technology that also
affect how we perceive the world (Torres, 2010). In each of these relations, there is a slightly different mediation-
ability of each technology. Dutch philosopher Peter-Paul Verbeek (2005) introduces a new term “technical mediation”
to this field. In his theory, Verbeek emphasizes the material existence of the objects or technologies as a property that
affects people’s relationship with the world (Verbeek & Kockelkoren, 1998). Verbeek (2012) argues that objects or
technologies not only place themselves between the world and humans, but they also build up the relationship
between them. Wendt (2015, p. 85, p. 86) lists other important aspects of a post-phenomenological approach to
human-world relations as follows: “individual meaning versus essence, industrial tech versus everyday tech,
technophobia to critical acceptance, meditation, and new interaction styles”.

1.3 Digitalization and the New Human-World Relationship
Floridi (2015) categorizes technology into three: technology of first order, second and third order. The technology of
first order are technologies that are directly related to humans like a cup that constitutes the relation between
humans and fluids. A second order technology would be a hammer that connects us with another technology, in this
case, a nail. The third order technologies are the ones that connect technologies with other technologies, an example
would be a thermostat that adjusts the heat of a radiator. In this case, there is no obvious connection to a human
actor in such a relation.

Artificial intelligence, virtual reality or machine learning are terms that propose a new relation between humans and
the world. Each new technology would propose new possibilities of experience that can be seen as a medium in
Christopher Hubig’s (2006) term. Those technologies change the interaction people have with the objects. For
example, a digital pen gives the user a wider area of possibilities than an ordinary pen. Through technology, a single
pen can be seen as a medium that can be transformed into other pens, brushes, etc. On the other hand, an analog pen
can also be seen in this way that it transforms itself into other kinds of functions, for example, it can be used as a
bookmark or as hair scratcher, etc. It can be argued that digitalization widens the space or place of possibilities of an
object and it makes the medium-ness of an object more obvious but all the products and objects we had before
digitalization had also the quality of a medium.

2 Research Process
The research will place itself in the area of philosophy of technology and design research. A literature review on those
subjects would be an essential point to start. In order to bring findings from the review process into the subject area
that the thesis is dealing with a historical analysis of several product evolutions would be necessary. How products
have been developed through different orders of technology in Floridi’s (2015) terms would be important. As the
theoretical framework began to build another important aspect of the research would be building material
experiments. Those objects designed according to a theoretical framework would have an experimantal role as the
application of theory and may reveal different aspects of medium-thinking in relation to digitalization.

2.1 Literature Review
The literature review covers two main subjects: philosophy of technology and design research. But areas such as
media theories, object-oriented ontology, science and technology studies, and cybernetics are also included. A post-
phenomenological approach to technology would be the main source of literature for the first part. Beginning with
Husserl and Heidegger a short review of phenomenology in terms of technology would be important. From that point
on post-phenomenological thinking of Don Ihde, Paul-Peter Verbeek, Andrew Feenberg and Alfred Nordman would be
included. From the design research perspective, it is important to include writings on the methodology of design
research by Gui Bonsiepe, Wolfgang Jonas and Claudia Mareis. Writings on thingness and materiality from a design
perspective is also an essential part of this area, those include works by Prasar Borodkar, Alison Clarke and Jan Boelen.
Media theories especially media-materialism is another area which has its place in the literature review.

2.2 Historical Case Studies
In order to illustrate the findings from the theoretical background, it is necessary to apply those ideas into objects and
technologies. Analyzing a product’s evolution throughout its historical existence and through different phases of
technological development will show how different concepts of medium-ness would apply to products. The case studies could focus on certain products such as a pen or on specific tasks such as writing. For the first example, the analysis will be more materially focused, for the second example the analysis will be more about actions and behaviors arising from the thingness of the object/technology.

2.3 Material Experiments
There are several academic institutions doing research and developing ideas around post-phenomenology and design such as Peter-Paul Verbeek at University of Twente and Ron Wakkary at Simon Fraser University. Recent Ph.D. studies done within those institutions also give an example of how post-phenomenology and design research can be combined in a successful way. Holly Robins (2018) develops a way to make invisible algorithms more visible and convincing for the user within her research activity. Sabrine Hauser (2018) designed a non-functional interaction that explores object-human and non-human interactions. From a design perspective, in both cases it is important to see application of ideas and theories in order to re-frame or re-think them. Observations and follow-up interviews based on those experiments could reveal the differences between the intention of the designer and the experience of the user or the audience.

3 Expected Outcomes
A theoretical framework with a review of existing literature about how products act as a medium between humans and the world is the main outcome of the study. The study aims at finding answers and developing discussion points to the following questions:

- How do we perceive the world through human-made objects?
- How is the human-world relation affected by technological developments such as digitalization?
- What are the differences between mundane objects and objects that are highly connected with each other in reference to human-world relations?

Another outcome of this research would be the experiment of creating objects designed with a post-phenomenological approach. Those objects will also act as feedback or comment on theoretical findings and will reveal new insights about the research questions. Those objects could also be used to verify whether the assumptions for the research questions were confirmed.

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References

About the Researcher

Fazıl Akin has a BID and an MSc in Industrial Design from Middle East Technical University, an MA in Product Design and Management from Lucerne University of Applied Sciences and Arts, and a CAS in Interaction Design from University of Applied Sciences and Arts of Southern Switzerland. Currently he is a PhD student at Hessen State University of Art and Design.
PhD Pit-Stop: A New Approach in Design Learning - Childhood Pretense

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1 Introduction

Creative thinking is a natural component of the design process to generate novel ideas for solving real world problems. Real world problems are rarely neatly presented and as Sawyer (2012) argues, most creativity occurs when people are working on these ill-defined design problems. There may be different solutions to design problems and designers always try to broaden the point of view to find possible solutions in creative design processes. Therefore, enhancing creativity is a significant issue in design research (Lawson, 2005; Cross, 2006).

According to the situated account of design problem depiction, designers examine and interpret the design situation for a new way of seeing. They construct the design situation by setting the dimensions of the problem space, see it from multiple perspectives and create the moves to find solutions (Schön, 1983; Schön & Wiggins, 1992). The see-move-see sequence of designing process is also described as “the art of seeing the design situation in multiple ways or seeing as” by Lawson and Dorst (2009, p. 26). Focusing on seeing as action, brings the question of whether this can be interrelated with seeing as if ability, referred to as pretense in the cognitive psychology literature, that is also outlined as “childhood pretense is an exemplar of human creativity” by Carruthers (2002).

Generally, when the term pretense is used, children’s pretend play is the first that comes to mind. Fein (1987) described pretend play as a symbolic act in which “one thing is playfully treated as if it were something else” (p. 282). Pretense, pretend play or acting as if is associated with the notion of affordance (Szkolksy, 2006; Rucińska, 2015). Children are aware of the affordances of different objects and explore the various action possibilities of objects for their different kinds of play events (Szkolksy, 2006). The common definition for affordances is, they are possibilities for actions (Gibson, 1979; Norman, 2013; Rucińska, 2015). In pretense, an agent uses objects differently than what it usually affords in everyday life. Rucińska (2015) indicates that pretend play of children enables seeing beyond the known uses of objects in different contexts. This approach brings flexible ways to create circumstances that suit our present and future needs.

The affordance-based explanation of pretense has similarities with the design process. In the design process, it is essential to see different affordances of objects considering the interaction between an object and its user enables the action. The possible uses of an object depend on its affordance referring to a relationship between the properties
of an object and the capabilities of the agent. Discovering new action possibilities of objects related with users in different contexts could bring creative solutions in the design process.

The aim of this research is to understand and describe the similarities between childhood pretense and creative design process. The scope of the research is cognitive processes of pretend play as a way of seeing-affordances-in and its relationship with design process. In the framework of creative design process, the observed relation between the object; its possible affordances and the ability of seeing affordances in, and the context; seeing the situation as if something else, is the main subject of this study. The research questions are:

- What are the similarities between childhood pretense and the design process?
- How do designers pretend like children in the sense of seeing-affordances-in?
- Could we compare the designers’ pretense process with imitating the children’s seeing-affordances-in approach in terms of creativity? Does this comparison make any difference in terms of creativity in results?
- How can the seeing-affordances-in process of pretense like children be simulated experimentally with design students?

The Integration of Affordance-Based Pretense in Design Process

In this study, it is hypothesized that children’s pretense or acting as if has significant similarities with designers’ initial designing process. The similarities between children’s pretend play process and designers’ pretense in conceptual design phase, as this study hypothesized, are shown in Figure 1 and Figure 2. Figure 1 schematizes children’s pretense process. To call someone in play scenario, first the child searches around for the affordances of phone in other objects. Then if the affordance matches with an object (e.g., banana) then he/she uses this object as if it is a phone in her play. Figure 2 schematizes the hypothesized pretense process in initial form search process in designing activity. As shown in Figure 2, at the initial form giving process, the designers search for the affordances of the intended use and intended product as well as intended user behaviour. This search process can be seen as childhood pretend play. Designers, like children, try to discover new action possibilities in different contexts of use. Both children and designers try to switch between ideas. Because they look for affordances and they are both pretenders.
Figure 2. Describing affordance-based pretense in early stages or conceptual phases of design process

2 Research Design and Activities

After generating the conceptual framework of childhood pretense and design process relationship with literature research, the next aim is to observe this relation experimentally. Because the main point is to understand if designers could pretend like children and how childlike pretense affects the results in terms of creativity.

After the literature research for exploring the research questions Finke’s (1990) Creative Mental Synthesis Task is selected as a method for the experiment. In this task the subjects are required to combine and draw three separate object parts into one structure. For the experiment there are two separate groups of subjects. One group of subjects combines the parts and creates a form according to an object category which is given beforehand. The other group of subjects combines the parts and creates preinventive structures without knowing the object category. Then the object category name is given to the second group and they are asked to interpret the preinventive structures in meaningful ways belonging to this category. Then the final object forms of both groups are rated for their originality and practicality by independent jury members. These measures are combined to produce a creativity score of object forms. In this experiment the core idea is visual discoveries of emergent structures in imagery. This process of discovery can be considered as seeing-affordances-in. The preinventive phase is expected to enable participants to follow affordances of object forms. The preinventive structures have creative potentials for interpretation in different contexts. This process can be understood as discovering action possibilities of preinventive forms like in childhood pretend play. The interpretation of preinventive forms could be a new way of seeing the possibilities. Similarly, in play context children can discover the affordances of different object forms in a flexible way. The experimental studies and data collection are still ongoing for the research.

3 Expected Outcomes

Transforming the way of thinking, re-imagining the problems and creating alternative solutions is a complicated but necessary process in design. Thinking about the possible world scenarios and imaginary situations are necessary to bring novel solutions to ill-defined problems, therefore, designers need to think about what if scenarios for future designs creatively. Therefore, pretense could be an effective practice to inhibit canonical or pre-defined way of use and may lead to the discovery of new ideas in the design process. In this particular context, this study provides the first explorative research creating a conceptual framework on the integration of design creativity and pretense, pointing to an important interdisciplinary topic for enhancing creativity, which many creativity related fields and education can benefit from.
**Acknowledgements:** I would like to extend my sincerest thanks and appreciation to my supervisor Asst. Prof. Dr. Deniz Leblebici Başar for her invaluable comments and insights. Also, I am sincerely grateful to Assoc. Prof. Dr. Sema Karakelle for her invaluable feedback and for offering extensive insight into this interdisciplinary research. I would also like to thank the instructors and students who have contributed to my PhD research from Istanbul Technical University Faculty of Architecture and Istanbul University Faculty of Letters.

**References**


**About the Researcher**

**Derya Gürcan** is a PhD student and Research Assistant in the Industrial Product Design Department at Istanbul Technical University, Turkey. Her search interests include design cognition and creative process. In her research she is drawing connections between childhood pretense and the design process.
PhD Pit-Stop: Exploration of Interactive Data Visualization from the Design Perspective

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Keywords: interactive visualization; information visualization; design guidelines; data visualization

1 Introduction

Today, there is an abundance of data. One of the main problems of big data generation is how to make sense out of it. Big data is a large volume of data (both structured and unstructured) that can be analysed computationally to reveal patterns, trends and associations. A solution is to create visualizations. According to Schneiderman (cited in Fester, 2013, p. ix), information visualization enables users and/or researchers to comprehend social, political, historical and economic processes through revealed networks and patterns. Below are the fundamental concepts in the data visualization area.

1.1 Information Visualization
Representing unprocessed information and/or data via graphical elements that are inclusive of spatial factors such as position, size, colour and shape to present connections and patterns that can be derived from the data (Fester, 2013, p. 5). This includes infographics, simple statistical graphs, maps, and topological representations. John Snow’s “Cholera Map” 1854 (Tufte, 1997, p. 27-31), Charles Joseph Minard’s “Map of Napoleon’s March” 1869 (Tufte, 2001, pp. 40-41), and Harry Beck’s “London Underground Map” 1933 (Mayor of London, n.d.) are among the earliest examples of information visualization.

1.2 Interactive Visualization
“Interactive visualization is the process of letting primary sources of information communicate directly with a viewer to support inquiry in a visual, compelling, and interactive manner” (Fester, 2013, p. 1). Enabling actions such as selecting/deselecting, and zooming in and out within visualizations allow users to explore the data.

1.3 Significance of Information Visualization
Information and/or data visualization help the users to see the patterns and associations within structure of data created. Data visualizations makes data understandable, and the analyses fast and less costly. Scientists, medical experts, social analysists, business investors, journalists and researchers from many other fields can benefit from visualized data. Below are two examples:
Sun and Huang (2019) developed an interactive visual approach for clinical experts who make decisions on fall-risk assessments of the elderly (p. 33). They showed a large amount of data on a single screen and a design that allowed interaction to explore the data (p. 34). Their research results indicated that interactive visualization process was more accurate compared to traditional methods and it was quicker for the experts/doctors to make decisions (p. 43).

Sensei: Sensing Educational Interaction (2017). Researchers from MIT worked on a system that aimed to help teachers evaluate the needs of children within early-childhood education. They installed non-interfering sensors on shoes of the students, toys, materials and educational stations. They created a visual dashboard for the teachers to see where and for how long the students spent their time, which educational materials were their favourites, and which remained untouched. This system allowed the teachers to assess their educational plan. They installed this technology in three Montessori schools and it was found helpful by the teachers.

1.4 Visualization Productions

1.4.1 Automated Productions – The Software

There are various software being developed to create visualizations. A taxonomy of visualization methods is listed at Duke University Library webpage. Each software is designed to create a type of visualization (e.g. timeline, tree, node-link, etc.).

1.4.2 Hand-Drawn Visualizations

Visual elements that lack function are considered excessive and even harmful (Kim et al., 2017, p. 491) as they become distractions for the viewers. Above mentioned visuals were called chart junk by Tufte (1983; cited in Kim et. al). On the other hand, well-reasoned illustrations are helpful in increasing engagement and memorability (p. 491). A joint research team from Harvard University, Cornell University and Adobe Research found that existing tools are not flexible enough to create custom-made visuals and designers preferred traditional tools such as Adobe Illustrator (Kim et. al, 2017). However, with Adobe Illustrator, the designers have difficulty in creating accurate visualizations. Kim and colleagues developed a drawing tool in Adobe Illustrator which enabled custom-made visuals with accuracy. When the data set is updated, visuals are updated automatically.

1.4.3 Mixed Methods

Byrne et al. (2019) propose a new model for visualizations in which figurative elements are used together with representations of abstract data and they called it hybrid visualizations (p. 45). This increases engagement (aesthetical input), memorability and attracts user’s attention.

1.5 Designing Visualizations: Guidelines and Heuristics

A highly cited guideline, “visual information-seeking mantra”, is created by Shneiderman. It is “overview first, zoom and filter, then details on demand” (Ware, 2004, p. 317; Fester, 2013, p. 34). Another guideline, ASSERT model, defines the steps of the design process proposed by Fester (2013): [A]sk a question, [S]earch for information, [S]tructure the data, [E]nvision the answer, [R]epresent the visualization, [T]ell a story (p.39). The aim is to create an insight to designing interactions without being bound to technical tools which would expire in short periods of time.

1.6 Testing Visualization Models

Kazmierczak (cited in Almquist & Lupton, 2010, p. 3) claims that design does not exist without the users; others argue that user studies reduce the human subject down to reflexes that can be foreseen and transformed into persuasion of using and/or buying the design. Ellis and Dix (2006) analysed 170 articles and concluded that only a few of the researchers conducted well-established user studies.

2 Research Design and Activities

2.1 Aim

The aim of this study is to improve design guidelines for interactive visualizations of big data from the graphic design perspective.

2.2 Research Questions

Part 1: Creating the guideline
Part II: Testing the guideline

- How do visual designers work with the new guidelines?
- How do visual designers work in the absence of guidelines?
- Do guidelines have an effect on the effectiveness of information visualizations?
- Do guidelines have an effect on the efficiency of designers when they do information visualization tasks?

2.3 Methodology

2.3.1 Methodology 1
Alternative guidelines will be created and tested with design students, then improved through iterations. The guidelines will be prepared by using an open source data on a selected subject. Experimentation method will be employed with an experimental group and a control group consisting of design students. After conducting experiments with design students, additional surveys will be applied to each group to see if the guidelines are working or not. The collected results can be analysed to determine the effectiveness of each guideline.

2.3.2 Methodology 2
Another way to conduct experiments with the guidelines is to test the outcomes of the design processes on users. This could be carried out with online surveys and/or selected groups of people in a more controlled environment (lab). The users would be asked questions that would require them to analyse and interpret prepared visualizations. The outcomes of the surveys can be compared with previous results of other researchers in the field.

2.3.3 Methodology 3
This method includes joining a project and forming and testing guidelines within the scope of a project where data generating software is under development. This is could mean a collaboration with a research group based in another university or maybe to find a start-up that needs or aims for information visualizations.

3 Expected Outcomes

Researchers in the area have been working on models for creating effective and powerful visualizations. There are various guidelines for information visualizations, but very few have been specific to the needs of visual designers working in this field. There is still room for research on understanding how the design processes and tools can be improved for creating visualizations. Specialized design guidelines are needed in the visualization field. By providing these guidelines, this research will provide significant knowledge for the field of information visualization.

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**Selected Bibliography**


**About the Researcher**

Duygu Beykal İz received her BA from Sabancı University, in Visual Arts and Visual Communication Design in 2007. In 2009, she completed her MSA degree (Master of Studio Art) at Sydney College of the Arts, The University of Sydney. Since 2010, she has been teaching courses on graphic design, photography and art as an instructor. Her research interests include graphic design and interactive design solutions.
Keywords: material education; design education; materials experience; design pedagogy; material designers

1 Introduction

The exploration of materials begins with the use of tools by human beings. Started from the original exploration on stoneware, earthenware and metal, the history of human beings has experienced a long period of craftsmanship, two industrial revolutions, the explosion of science and technologies, and finally evolved into the mode of production and manufacturing what we see today. Design became a discipline with the growth of industrialization: in that period of "chaos", large-scale manufacturing had gradually replaced traditional small handicraft workshops on a global scale, which have brought about tremendous changes in the form of products as well as people's thoughts on aesthetic. Today's designers are facing up to more challenges: the emerging of new materials, the development of new manufacturing approaches, the diversification of users, unpredictable market demands. etc. And the teaching and learning of design become very diverse, and young designers are required to have interdisciplinary thinking and collaborative competence. Contemporary design education has become like this is the result of the development of the outside world, also thanks to the exploration by generations of designers and design educators. From the Arts and Crafts movement in the 19th century, to the advanced exploration in Bauhaus era on design education, and then to the heritance and diversification of design styles and movements after the second world war until today, we step into a new era surrounded by science, technologies and information. In this context, designers are no longer just satisfied with the form and function of the product, but focus on designing experience.

Although material is always as a very important aspect in design education, it plays multiple roles in different historical stages. In the early times, materials are the basic element of craft apprenticeship, apprentices had to manipulate the mud, the wood, the glass, or others to gain their skills on processing the materials. With the development of design education in the modern era, material became a tool for design teaching and learning. Points, lines, surfaces, with diverse materials, students were thinking and exploring with their design forms expression. With the development of outside industrial world, design education has emerged with more detailed classifications. Educating students of material attributes became convention of design education, which aims to cultivate students' ability on understanding technical properties of materials and make proper material selection for their design.

However, as the world becomes more diverse nowadays, the role of materials in design education becomes more complex. As an important medium for students to explore their own design thinking, materials are used to design diverse meanings and experiences. The learning of materials has evolved into more open and diversified exploration and innovation, and the aim of the material curriculum has become rich. Some material courses start from the...
perspective of market and resources, to inquire the feasibilities of the circular economy through the lens of materials; Some courses teach and conduct the material practice based on the advance of new fabrication technologies; some material courses encourage students to explore their own ingredients with do-it-yourself process, to achieve the expressions of feelings, emotions or meanings; some courses lead students to speculate and explore the plausible future through the development of materials and modern technology. More and more design courses with material as an entry point, and the issues they inquiry are also becoming more widespread. All of these came up the question of this research: How material education in design will be in this fast-changing world? Besides teaching and learning technical attributes of materials, what is the experiential aspects we attached to the material education nowadays? Which competencies and abilities should be integrated into today’s school of design in order to shape the professionals and researchers’ capability in dialoguing with materials and their technological dimension?

The three scopes of design, education and material, intersect to provide an overarching theoretical framework for this research, which occurred in the intersection of all three (Figure 1). The principles and development of design education as the background, the pedagogical framework and learning innovation network in education scope serve as the guideline for the research on materials course. Material selection and design materials experience are key parts of this research.

Here is some brief explanation of the key terms:

**Material selection:** Designers need to select proper materials for their design concepts. The selection of materials in design relies on both materials’ technical and their experiential attributes (Manzini, 1986; Ashby & Johnson, 2013).

**Materials experience:** The experience that people have with and through the materials as *materials experience* (Karana et al., 2014), there are four levels of materials experience are being defined: sensorial, interpretative, affective, and performative (Giaccardi et al., 2015).
**Design pedagogy:** Started from Bauhaus, educational approach in design discipline is a dynamic, evolving process with constant improvement to the teaching curriculum (Cross, 1983). The process of learning design is actually a process of understanding and improving one's own abilities, and schools and teachers teaching by providing an environment and guidance for such process (Dewey, 1997).

**Constructive alignment:** Constructive alignment is a principle for devising teaching and learning activities and assessment tasks, that directly address the intended learning outcomes (ILOs) (Biggs & Tang, 2007). Based on this principle there is pedagogical alignment, it figured out four elements contribute to learning: course contents, learning outcomes, teaching strategies and assessment techniques.

**Pedagogical framework:** A pedagogical framework is a useful strategy to inspire, design and manage the learning experiences. It can support teachers deliver the quality teaching and improve students learning. The Kolb's cycle, problem-based learning, inquiry-based learning, social learning, rhizomatic/connectivist approach, and discovery learning are all pedagogical frameworks.

**Learning Innovation network:** This term is the cross fertilization between pedagogy and design for experiences. It shows the features and actions in a knowledge transformation process, and channels through which the communication among the subjects flows. It shows the learning environment and learning experience intuitively (Figure 2).

![Learning Innovation Network](image)

**Figure 2. Learning Innovation Network by Politecnico di Milano-METID**

### 2 Research Design and Activities

In summary this research is structured according to these four phases:

[1] **State of the Art:** Understand approaches of pedagogy and theories of teaching and learning in general, and figure out what is already happened in the world of design, and what particularity has been done or being done in the design space. In this way, it's possible to have an overview of teaching and learning theories and get a historical vision of how the materials were being taught by mapping the references.

[2] **Field research:** Interview and collection of information from selected design schools, in order to make a framework of current material didactics, analyse them to understand what could or should be improved or optimized. The data of the courses will be collected through 3 types: documents, observations, and interviews (Creswell & Creswell, 2017). Documents is the stage of desk research, to collect the material courses in different design schools. Up to now, this collection already has more than 60 courses. These courses are being catalogued into different typologies, and some
of them are being chosen for field research. With the study of courses’ description, aims and all the other information online, the Material Learning Innovation Network (MLIN) generated. With the four big features of material education in design: competences, tools, spaces and services, it contains all of the actions and communication channels during the material teaching and learning process. MLIN map is not only an initial result of the current situation of material education in design, but also paves the way for the field research on real material course.

[3] Consolidation of the analysis with the formulation of the hypothesis: Identifying the competencies and abilities which need to be developed, supplemented or modified; highlight the advantages and restrict of material courses, including the activities, tools, communication channels, etc.; and proposing projects for the improvement of future services and spaces with guidelines and programmes of workshops and/or masters.

[4] Verification of the hypothesis: Implementation of workshops and/or master for testing what has been proposed and verification of the guidelines formulated.

3 Expected Outcomes

By depicting the panorama of a material world in design, this research aims to reveal the development law of design material education, and gain foresight on material education frameworks. As an important aspect of design, material always represents to our world which is real, tangible, and full of experiences. Thanks to technological advancements, also thanks to the continuous original applications by designers and the reinterpretation by design researchers that reveals new ideas, suggestions and unconventional paths, this world of materials for design will keep on changing and evolving.

The outcome of this research can be guidelines for the design and/or implementation of workshops/masters, or frameworks for design and creating services and spaces which are suitable for teaching students to understand materials, use materials, and explore materials, to better cope with this fast-changing world.

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About the Researcher

Ziyu Zhou Ph.D. candidate in Politecnico di Milano, Department of Design. She has the background both in industrial design in Bachelor and product service system design in Master. Her research focus is material education in design. She started her research in the field of materials and design in 2017 and she is a member of Materials Experience Lab (http://materialsxperielab.com/ziyu-zhou).
PhD Pit-Stop: An In-Depth Inquiry of Student Happiness in Spatial Design Education

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Keywords: student happiness; student perspective; spatial design education; ethnography; culture; architectural design theory; design education; ethnography

1 Introduction: Happiness and Education

“Joy [happiness] comes first” (Holden, 2009, p. 51). Happiness is the start, everything else in life adds up to it. As the importance of happiness is justified in the contemporary world, new notions such as Gross National Happiness and Happy Planet Index are entering to the terminologies (Marks, 2010; Khesar ‘King of Bhutan’, 2013). Likewise, researchers in the fields of philosophy, theology, psychology, sociology, education, health act in collaboration in scope of happiness studies.

Happiness is a fundamental part of our existence... ‘pursuit of happiness’... [is] an essential human right” (David, Boniwell & Ayers, 2013, p. 39).

Education is an ongoing pursuit towards knowing/knowledge. It is a road that individuals take towards bettering themselves, widening their perspectives, developing as critical thinkers and problem solvers. In today’s world, it is clear that higher education is considered by some as a duty to be finished and certain period to be endured before starting their life. Unhappiness observed in the educational platform can be resulting from nature of creative process, design education and dynamics of contemporary world.

Creative process is known to have a challenging nature. It is suggested that to create is in direct relation to suffering (Gilbert, 2009). Accordingly, spatial design education challenges students on a daily basis with its demanding nature; sleepless nights, stress, etc. Design students work more additional hours in comparison to learners in differing subjects (Howarth, 2017). Additionally, it is clear that being a design student is often linked with struggle (I am an Architecture Student, i have no life, n.d.; Parnell, Sara, Doidge & Parsons, 2007); and juries are seen as frightening confrontations.

The defence of ideas, drawings, and models in an open format before staff and peers is intended to be a foreground for healthy creative debate, but many students view it as hostile confrontation – an ego trip for staff and humiliation for them (Parnell et al., 2007).
Furthermore, dynamics of contemporary world such as competitiveness, immense change, constant demand result in exhausted, worn out individuals. Education like everything in this world is closely related with above mentioned dynamics. How can happiness be reached? Finland, the pioneer country in education uses the philosophy of humbleness. Education model used does not value quantity but quality, believes less results in more (Day, 2015).

Education is an important pillar of the society. By that reason it carries vast importance to improve the system so that it gives possibility to all actors involved to be happy.

The issue of happiness in the school context is important for the success of the educational system... In the future, could it be imaginable that the majority of students would admit to liking school? (Uusitalo-Malmivaara, 2012, p. 616).

2 Prisms to Look Through

In this research, multi-dimensional notion of happiness will be discussed through four prisms (viewpoints/perspectives): philosophy prism, spiritual divine prism, psychology prism and social prism. Philosophy prism will define a start point to the research. This prism will discuss notion in four stages; ancient philosophy, medieval philosophy, modern philosophy and contemporary philosophy. As the periods progress it is evident that happiness notion changes from being lucky and in control of god/spirit/demon towards an outcome of a well-lived life to a basic human right (McMahon, 2013).

Spiritual divine prism defines notion in accordance to beliefs. Monotheistic religions have differing standpoints. Christian understanding suggests that happiness will not be obtained in this life; it will take place in Garden of Eden (past), return of the Christ and in heaven (future) (McMahon, 2010). Islam believes in leaving the control to the creator, “being content with our lot in life”. As they love and trust the creator, they are content with the decisions made for them and they are happy (Ahmad, 2012).

Yet, in Judaism it is a religious calling to be happy. Their belief can be argued to be much less fatalistic in comparison to above mentioned beliefs and it suggests to pursue happiness on earth (The Jewish Vision of Happiness, n.d.).

In enlightenment, it is started to be suggested that happiness is here on earth (Zevnik, 2014); “Hell is no more; tis Heaven now on earth...” (McMahon, 2006; cited in Zevnik, 2014, p. 130).

In the Christian [divine] perspective, true bliss was only accessible in the afterlife. The Enlightenment perspective, on the contrary, refuses the possibilities of life beyond this world and sees the potential for true happiness as something only pertaining to life on Earth (Zevnik, 2014, p. 130).

Psychology prism will aim to create a standpoint of positive psychologists on the happiness notion. Concepts such as true happiness, happiness types, mindset, positive emotions, subjective well-being, positive psychology, subjective measurement of happiness, paradigms of happiness will be discussed (Holden, 2009). Focus will be on the self and happiness of the individual.

Social prism will focus on collective aspects of happiness and universal pursuit/goal of happiness. In this prism, collective happiness will be discussed through anthropology of small groups (culture of university – culture of faculty – culture of studio). Focus will be on the tribe and happiness of the mass. This prism that incorporates anthropology, sociology and ethnography represents the centre of the study.

3 Aim and Scope of the Research

In today’s world everything is aimed to be considered in detail, yet it is evident that student happiness is not thought as much as other criteria in educational platform. Awareness has increased towards necessity and importance of student happiness in education however the notion is habitually taken as granted. This study will aim to describe and interpret common patterns of spatial design students’ understanding and culture of happiness in accordance to four prisms, namely, philosophy prism, spiritual divine prism, psychology prism and social prism. By this method, multifaceted issue of happiness and intersection points of these prisms in relation to spatial design learning is aimed to be further discovered. Information gathered will aid defining a bigger picture of the issue and origins of deformation will be aimed to be discovered.
4 Main Research Question

Main research question of the study is expressed as follows: How can the notion of happiness be described and interpreted in spatial design education according to philosophy, spirituality, psychology and social prisms?

5 Research Design and Activities

Research method selected for this study will be critical ethnography since this research and method both have in their core “describing and interpreting a culture-sharing group” (Creswell, 2007, p. 78). In ethnography method researcher describes and interprets collective patterns of behaviours, values, beliefs of the culture-sharing group (Harris, 1968; cited in Creswell, 2007).

Typically, this group... one that has been together for an extended period of time, so that their shared language, patterns of behaviour, and attitudes have merged into a discernible pattern” (Creswell, 2007, p. 71).

Critical ethnography gives importance to the problematic aspects of the culture studied. Cultural themes/issues will be extracted to be studied from the group (Creswell, 2007, p. 71).

Place of research will be Eastern Mediterranean University, Department of Interior Architecture. EMU is selected by the reason of researcher being the local participant of the tribe.

As a process, ethnography involves extended observations of the group, most often through participant observation, in which the researcher is immersed in the day-to-day lives of the people and observes and interviews the group participants (Creswell, 2007, p. 68).

Study will have three main parts; literature review, observations – informal discussions – workshops, in-depth interviews. First part, prisms/viewpoints, will be literature study and aim will be to discover intersection points towards origins of deformation and cultural themes to be studied. Second part will have a co-creative nature to further develop and generate ideas with learners as co-researchers of the study. Third part will be conducting in-depth interviews with selected students. Analysis and evaluation method of the study will be by emphasizing the following three aspects “interpretation, lessons learned, questions raised” (Wolcott, 1994; cited in Creswell, 2007, p. 80).

6 Expected Outcomes

Diving into the complex notion of happiness from multiple standpoints, expected outcomes are to understand and define the term, discover synonyms from differing disciplines and finding nodes/ intersections from different layers. Furthermore, study may create a structure defining happiness and origins of deformation may be revealed. Recent approaches to education place happiness notion in their core and consider it to being very important in raising successful individuals. Study will be significant for the spatial design education and fellow researchers since it questions the possibility and attempts to increase happiness and moreover evokes an awareness to the necessity of the notion in education.

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PhD Pit-Stop: Self-Regulated Learning in Industrial Design Studio

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Keywords: design education; self-regulated learning; industrial design studio; educational design research

1 Introduction

Design as a multidimensional activity to solve an ill-define problem (Simon, 1973; Eastman, 1969), starts with a brief in which the conditions, needs and restrictions about the project is written. At the end, this written text transforms to a tangible output. This transformation is a process which happens in the designer’s mind; reading the brief, generating ideas, researching, internalizing the information, externalizing the ideas and reflecting on them (Schön, 1992), creating solutions, deciding, etc. Design itself involves various skills and deep-thinking processes, however, learning designing and designing itself are different issues. Learning can be a complex and confusing process for some students.

Design studio, mostly called studio, are different from other classes in the university campus by means of both physical conditions and educational approaches. Design students do not listen to or watch any speech or presentation conventionally, they must come to studio with their works and have conversation with their instructor to take feedback on their project. It can be seen or defined as a free environment, but it has many uncontrollable factors. Instructors employ a range of strategies that are often based on how their instructors had taught them and they reflect these experiences by talking. Because of project-based education, students are responsible for their own design processes in the studio and they must understand and interpret the comments and develop a strategy on it. This ambiguous environment is so learner-centred that, it may cause some difficulties and failures in achieving learning outcomes and making students achieve their full potential. There are many studies about the problems in studio education, however only a few of them focus specifically on teaching, learning and instructional design.

These circumstances lead us to a design student-based learning condition, and one important factor that influences design learning is ensued as the process of Self-Regulated Learning (SRL), which refers to a student’s self-generated thoughts, strategies, and goal-directed behaviours. As stated before, the design studio environment evolves depending on students’ self-developments in their design activities and decisions. Furthermore, there is a need for a study, particularly from a self-regulatory viewpoint by means of learning theories, in design studios.

Motivated by observations of the author herself and literature research on design and design education, the primary goal of this study is to provide new information that fills a gap in the existing body of knowledge in industrial design education to qualify the learning process in design. To manage this, a set of research questions related to
performance on design studio projects, design student’s learning and self-regulated learning are used to guide this study.

At this point, this doctorate study addresses five research questions as follows:

1. What is the level of reported use of SRL among industrial design learners before participating in SRL based learning environment in design studio?
2. To what extent does SRL based studio affect design learners’ reported use of SRL strategies in their design learning?
3. Does SRL based studio have a significant impact on increasing awareness of SRL strategies among design learners?
4. How can students’ self-regulation influence their design performance?
5. How can an efficient learning environment be designed in terms of SRL strategies of students?

1.1 Aim and Scope of the Thesis
This study focuses on the self-regulated learning process in the third-year industrial design studio through scale inventory survey and interviews by conducting a designed toolkit in design studio in the Department of Industrial Design at Istanbul Bilgi University.

In the design studio, the conversation between instructor and students are the main reflective learning tools, however because of time pressure and so on, sometimes students may not get feedback on their project efficiently. On the other hand, students may come to the studio without any preparation, hence the instructor cannot comment on that project. In both scenarios, the student loses time, and his/her concentration and performance diminish. Educational goals of design studio and instructor, and the student’s personal motivation for achievement greatly influence the student’s affective experience during design projects. Pedagogical approaches of instructors that defines the educational goals of the studio, and individual approaches of students that influence motivational achievement of the students can be regarded as two main factors in project-based education in design studio.

Considering this, this study examined SRL in industrial design studios in order to find out how students self-regulate their learning and performance on studio projects with their instructors. Surveys and interviews with industrial design students will be used to answer the research questions stated in the previous section.

1.2 Purposes of the Research
The purposes of the research are presented as follows:

• To evaluate the impacts of the industrial design studio on students in terms of self-regulated learning strategies.
• To reveal how the industrial design studio instructor’s pedagogical approach and student’s individual ways of approaching design are related to learning processes.
• To revise and refine industrial design education in terms of individual differences between students and their awareness of themselves.
• To discuss how design education can benefit from SRL theories and approaches.
• To promote self-regulation skills of design students to make them telic designers.

With these purposes, this dissertation is framed within the formal undergraduate industrial design education in higher education system in Turkey.

2 Research Design and Activities
According to the research questions stated before, the main purpose of this study is to enhance the design performance of design students by using self-regulation theories. Two main key stimuli to sustain design performance in design studio are defined as pedagogical approach of the instructor, and individual ways of approaching design of the student (Kowaltowski et al., 2006). In traditional design education, learning occurs in between these aspects through the reflective conversation (Schön, 1992). As it is stated in the previous sections, this research is conducted to design an education toolkit based on SRL theories for both design students and instructors to increase the design performance in design studios.

To be able to reply the first research question “What is the level of reported use of SRL among industrial design learners before participating in SRL based learning environment in design studio?”, a deep understanding of the
participant’s learning activities was a necessity. Therefore, self-regulation levels of students were observed during a design studio for 14 weeks, and at the end of the semester a self-report questionnaire (Scale on Self-Regulation in Learning-SSRL) was conducted in 2017-2018 Fall Term. After the SSRL Questionnaire, 1-to-1 interviews with the students were conducted for the exploratory phase of the thesis in 2017-2018 Spring Term. Transcription and analysing of both SSRL and interviews are proceeding simultaneously. Therefore, the details about participants, questionnaire and interviews will be explained below.

2.1 Participants
The present study has been carried out with third year industrial design students at a private university in Turkey. To assess self-regulated learning approaches of students, it is important that the participants should have taken all two year’s courses in the curriculum of industrial design department including visualization and two design project courses. First-year students are not participating because they are taking general university curriculum requirements and do not take studios in industrial design. Students in the second year are not participating because they are only in their first industrial design studio and are less likely to have learned how to self-regulate their behaviours within studio settings and in terms of design learning because many of the second-year student’s projects are externally regulated by the instructors.

2.2 Measures
According to literature, many important studies related to SRL can be categorized as such: interviews (Zimmerman & Martinez-Pons, 1986), survey research (Pintrich et al., 1991), action research (Hubbard & Simpson, 2003), and observation and discussion (Hadwin & Oshige, 2011). Boekaerts and Corno (2005) define different instruments to assess self-regulation: self-report questionnaires, observations of overt behaviour, interview evidence, traces of mental events and processes, recording student motivation strategies as they work, keeping diaries, etc. More importantly, using one instrument to observe students’ progress in self-regulation is insufficient and it is suggested that a combination of instruments should be used for such assessment purposes.

Therefore, in this study, mixed research method was used, the data was collected via employing two distinct tools: self-report questionnaire (Scale on Self-Regulation in Learning-SSRL) and semi-structured interviews.

2.2.1 SSRL
As a self-report questionnaire, Scale on Self-Regulation in Learning-SSRL inventory was used to determine the level of self-regulative strategies used by design students to get quantitative data. As the first step of this study, the situation of the self-regulation was determined in design studio environment in terms of both instructors and students.

Self-report questionnaires are the most common measuring tools for SRL because of being easy to design, administer and score (Winne & Perry, 2000). These self-report scale studies (e.g. Self-Regulatory Learning Inventory, SRLI of Lindner et al. 1996; Motivational Strategies for Learning Questionnaire, MSLQ of Pintrich and De Groot, 1990; Pintrich et al. 1991; Self-Regulatory Learning Interview Schedule, SRLIS of Zimmerman and Martinez-Pons, 1986; and Self-Regulated Learning Skill Inventory, SRLSI of Heo, 1998) have focused on self-regulated learning skills of students at secondary and college level, however, they have different frameworks on cognitive, metacognitive and motivational dimensions (Erdoğan & Senemoğlu, 2016). In addition to this, they are in foreign language even if some adaptation studies (Büyüköztürk et al., 2004) of these scales can be found in Turkey, designing language of a scale and questionnaires should be in the related language, too. Motivated by that, Erdoğan and Senemoğlu (2016) developed and validated a self-report scale that can be used to evaluate self-regulated learning skills of university students (age 18 or above) in Turkey focusing on Turkish learners and their learning traditions. Besides, they handle more thoroughly the cognitive and metacognitive learning strategies together with the related motivational dimensions. The scale named Scale on Self-Regulation in Learning-SSRL consists of two sections, the self-regulated learning skills section covers 10 dimensions, which is exactly the same as those in Zimmerman and Martinez-Pons’s Self-Regulated Learning Interview Schedule (SRLIS), whereas the motivation section covers 5 dimensions.

2.2.2 Semi-Structured Interviews
The additional qualitative data was gathered to elicit learners’ reflections to determine SRL awareness during and following the training experience via semi-structured interviews. Additionally, personal experiences and observations made by the author during design studio meetings was used as supporting insights.
3 Expected Outcomes

There are two main expected results of this study; one focuses on design education and the other on self-regulated learning. Design education needs some changes because of its stereotyped and ambiguous pedagogical approaches. Education theories on self-regulated learning will create a productive design education process so that design students will graduate by distinguishing their skills of self-regulation.

In education discipline, design-based research is a popular subject. With this study, the process of designing an education environment from the point of view of the design discipline will be a unique approach and create a new knowledge in the area of SRL.

Additionally, this kind of learning environment can be established in any creative focused discipline, and also this approach can be a guide for education of other disciplines, too.

References


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**About the Researcher**

**Aysun Ateş Akdeniz** was born in Ankara, 1987. She completed her BSc (Hons) in 2010 and MSc with her thesis: "The role of trend studies for design processes in the context of Turkey" in 2015 in Istanbul Technical University, Department of Industrial Product Design. She is currently a PhD candidate in ITU and has been a research assistant at Istanbul Bilgi University since 2014.
PhD Pit-Stop: An Evaluation of Interior Design Education Learning Outcomes in Turkey through the Contents of Design Project Courses

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Keywords: interior design education; design pedagogy; program qualifications; interior design curriculum; interior design accreditation

1 Introduction

It is aimed to develop the interior design program on national level in order to educate the individuals who are able to use the knowledge and skills of the twenty-first century effectively and to meet the requirements of the twenty-first century with an up-to-date content at the international level. The program requirements are part of the interior design license in Turkey studied in different formats from each other, but there are details that have not been updated in years. Within the scope of the thesis, it is foreseen that the content of the project courses, which constitute the most intensive course group, should be developed with the aim of improving the qualifications of interior design program. In the project courses in interior design departments in Turkey, it is known that very different subject contents and design problems are examined. The main objective of this thesis, assuming the case in the study course contents belonging to the departments that have been accredited by international professional qualification institutions, is to update and develop interior design education in Turkey. It is considered important to integrate the current design problems that the project courses should include and the current solution approaches to these problems into the interior design curriculum.

Within the scope of the doctoral study, it is aimed to revise the project course content within the framework of international professional qualifications in order to develop the interior design education on a national scale. For this purpose, it is aimed to examine the learning outcomes that are determined by the international professional qualifications organizations and then the structure of the accredited interior design departments according to the qualifications determined by these organizations. In the research and data collection phase, in order to understand the structure of interior design education, the focus will be in general on the curriculum, and the behaviour of interior design students, in other words the learner profile. It is envisaged that students will create a step for rethinking the attitudes, thoughts and decisions within the education of interior design. Nowadays, we know that the significance of user-focused knowledge has increased in the development of systems. It is predicted that student-focused studies will be effective in improving design education. The characteristics of the new generation is also significant for this research. Within the scope of the research, the knowledge from the studio environment including the combination of theory and practice will be collected and interpreted. In order to develop the field of education of interior design,
which is a practical discipline, it is deemed necessary to understand and interpret the opinions, thoughts and tendencies of the actors of design education.

1.1 Literature

Educators constantly review curricula and course structures to be aware of changes in their fields. The update process helps educators better meet the needs of the individual and the profession (Myers, 1982, p. 19). When education programs are examined, differences can be seen even in education programs within the country. Professional organizations and some accreditation organizations carry out studies to standardize the education process, to ensure the quality of education and compliance with various criteria. Through these organizations, there is an international discussion of accreditation of vocational practice and training programs. In order to renew and develop the curriculum, the content of the courses and the competencies of the program should be questioned (Özsavaş & Güler, 2012). Competency is the knowledge, skill, attitude, understanding and judgment that a person shows at a predetermined level of competence (Bloom, 1961). Interior design project courses are aimed to gain the necessary qualifications for an interior design graduate. Ledewitz (2014) states that the design studio is the main tool for teaching the main elements of design education. The first is that the students acquire presentation and visualization skills. Another is that students learn the professional language. Exploring and explaining ideas through drawing is a new experience for students. Through the experiences in the studio, the design student gains the power of thinking and expression in design, while at the same time being able to dominate the common language of expression that addresses all disciplines under the roof of design.

According to Demirbaş and Demirkan (2003, pp. 437-438), most of the recent studies on the design studio (project courses) are based on computer-aided design or distance learning. Some other works deal with the design studio as a medium or with the process in the studio. There are studies examining a number of questions related to shaping the future of design and engineering education (Smith, 2009). The learning of design is reinforced by the design process in the studio environment and internalized by the student. Schön (1981) describes design as a language game in which drawing and speaking complement each other. Throughout the design process, the given design problem becomes a design solution, and a continuous dialogue between the student and the instructor strengthens the design process (Demirkan, 2016, p. 32). Kvan (2001, pp. 347-348) explains that design instruction usually begins with a design problem involving project characteristics, program attributes (duration, outputs) and objects. Design education, design knowledge, skills and practices to engage with the course include teaching and studio teaching (Sagun, Demirkan & Göktepe, 2001, p. 336). Project-based learning includes user-centred tools. With emphasis on learning instead of teaching, project-centred programs are recommended for students to learn self-management, manage their time and resources, and therefore make better preparation for professional practice (Altay, 2013, p. 142). Active components for effective studio communication are: design studio as a medium of communication, design task or problem, design knowledge, different media and people, and student designers and studio instructors (Paker-Kahvecioğlu, 2001). Project-based learning can be defined in various ways with different educational disciplines and levels. Projects are frequently used in K-12 level education, so it is a concept and teaching method that most students know (Mills & Treagust, 2003, p. 8). Despite the fact that there is a large number of work-related courses carried out in Turkey and in other parts of the world, it has not been possible to reveal study contents in which the subject is directly interior design projects.

Figure 1. A view of project course/lecture (Anadolu University Department of Interior Design, 2009).
2 Research Design and Activities

In the literature review part of the thesis, the general knowledge of design education, design knowledge, project-based learning, project and studio environment and pedagogy, which will form the body of design education, will be explained through a comprehensive search. The current CIDA (Council for Interior Design Accreditation) and ECIA reports will be reviewed for the creation of project course contents. In the scope of the thesis, totally twelve interior design departments, including six interior design departments accredited by CIDA in the USA and six interior design departments accredited by national accreditation institutions from Europe, were selected in the process of collecting data for the project course content suggestions. The related course contents of the departments will be accessed on the web. The criteria for the selection of schools are accredited by CIDA and the relevant national accreditation institutions, and as secondary criteria, priority is given to those schools that are ranked higher in international university rankings. A preliminary study was carried out by accessing the relevant data of some of the selected schools. On average, four or five project course contents from each school was accessed via the web. It is foreseen that a total of fifty project course contents will be included in the analysis. In the interior design departments, the project courses have the highest scope in terms of both ECTS/credits and course hours. According to the preliminary study carried out within three and four years of the undergraduate level of interior design departments, there are four or six project courses in one department. Six interior design departments, each from the US and Europe, were selected because it was predicted that it would provide sufficient data for content analysis, but this number could be increased according to the progress of the study. As a method, the course contents in the text form reached will be categorized and then the words and sentences will be analysed by content analysis method based on the conversion of quantitative data. Among the types of content analysis, tools for frequency analysis and categorization content analysis will be preferred. At the end of the content analysis, the order of significance and order of usage of the subjects and themes will be determined and relational comparisons will be made between the USA and Europe. The aim of the thesis is to provide a student-focused view of the project courses and their functioning. For this reason, based on a survey prepared by interior design students from five different schools will be carried out as field work in Turkey. The data collected by the survey technique will be analysed with the help of the appropriate program and these data including the students’ views will be interpreted with the purpose to develop the course content and program qualifications.

3 Expected Outcomes

- In Turkey, there is not an institution which has the authority to accredit the interior design departments as in the US. In this respect, to create an internationally prepared guide that will contribute to the accreditation processes which are important in terms of the quality of higher education in the field of interior design, that will benefit at the national level, and that will be used as a resource in the field of interior design education, more specifically, in project course contents and program qualifications.
- To be able to develop student-focused and innovative content for the interior design project courses that constitute the most important course group of the curriculum in interior design education programs.
- It contains the most up-to-date international regulations in the field of interior design; a general and up-to-date resource for undergraduate program qualifications at national level, with the framework to be established according to CIDA 2018 professional standards and the professional qualifications contained in the ECIA 2013 report.
- In line with the data collected within the scope of the thesis, to create a current and contemporary interior design program qualifications framework to use in national scale.
- Due to the fact that a publication directly related to the course content of interior design projects could not be reached in the literature, the results and recommendations report can be shared with international professional organizations (ECIA, CIDA, etc.) for the purpose of open access principle and interaction with stakeholders.

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About the Researcher

Özlem Kurt Çavuş was born in Turkey on July, 1989. In 2012, she graduated from, Anadolu University, Faculty of Fine Arts, Department of Interior Design. Since 2013 she has been working as research assistant at the same department. She completed the master’s degree program in Interior Design in Anadolu University Fine Arts Institute, in 2016. She continues to work as a research assistant and she is interested in the fields of psychology of space, design education, and design research.
PhD Pit-Stop: A Holistic Outcome-based Approach to Design Healthcare Systems

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1 Introduction

The healthcare system is struggling to address the challenges of long-term healthcare and the pursuit of well-being and mental health (Tsekleves & Cooper, 2017). Emerging trends such as holistic and community healthcare seem suitable healthcare practices to cope with these challenges. However, these trends require greater support from approaches such as system thinking (Jones, 2013; Peters, 2014). System thinking seems a suitable paradigm to support the complexity of healthcare design and development. System thinking promotes and supports the holistic understanding of the healthcare phenomena as an interrelated and adaptive socio-technical system (Jones, 2014; Carey et al., 2015; Caffrey, Wolfe & McKevitt, 2016).

A system thinking approach requires a holistic system understanding mindset by the different stakeholders of the system. This holistic understanding should permanently assist decision-making while designing systems. However, healthcare stakeholders find constants disagreements due to the conflict of values, goals and outcomes (Haynes, 2018). This lack of consensual agreement has implication even in critical decisions such as defining the purpose of the system. Defining the purpose of the whole system is critical because it provides a high order to guide the design process and offer well-defined goals (Jones, 2014). Therefore, it is essential to explore how to facilitate a consensual agreement about the system purpose, values and meaningful outcomes of healthcare within a holistic perspective.

Some system thinking approaches have applied visualisations to build consensual agreements. System visualisations are graphic representations aiming to map and communicate the complex relationships between the elements of the system (Jun, Kim & Lee, 2011; Jones & Bowes, 2017). In a broader perspective, visualisations have supported the discussion of complex issues and facilitating collaborative and multidisciplinary sensemaking (Crilly, Blackwell & Clarkson, 2006; Comi, Bischof & Eppler, 2014). For example, Cognitive Work Analysis (CWA) is a significant framework that uses visualisation to support the analysis and design of systems (Rasmussen, 1985; Stanton, Salmon, Walker & Jenkins, 2018). CWA provides a five-level structure that includes the system purpose, values and priority outcomes. However, it remains unclear how to build each of the CWA levels from a collaborative perspective.

This research aims to examine how a holistic approach can support participatory healthcare system design. This will be explored by developing and implement a system thinking, outcome-based support. This support should enable the
different healthcare stakeholders to negotiate and build consensus about the outcomes, values and purpose. Visualisations will be used as the primary research/design support to map the healthcare system.

1.1 Theoretical Perspectives in this Research
This research has conducted a literature review of the following main subjects:

1.1.1 Healthcare as a Complex Adaptive System
Healthcare is a complex system that has interdependent connections, multi-disciplinary agents, non-linear processes, continuous changes and unpredictable behaviours with social implications that create new patterns over time (Paina & Peters, 2012; Wilkinson, Goff, Rusoja, Hanson & Swanson, 2018).

- Cognitive Work Analysis: This structured framework has been adopted to guide the development of the support. It provides a systemic approach to analyse and configure the relationships between the purpose and the values and outcomes.

1.1.2 The Holistic Values/Outcomes of Healthcare
Outcomes in healthcare are used to monitor and make informed decisions. This research is proposing a holistic outcome approach that integrates a broad range of attributes from psychosocial aspects such as wellbeing and happiness; to behavioural, quality of care and biometrics, among others. This holistic outcome approach should capture meaningful dimensions for all stakeholders. The meaningful dimensions could emerge from peoples’ life aspirations, their deepest expectations, and desires.

1.1.3 Participatory Construction of Systems
A participatory perspective will ensure the integration of the different stakeholders during the whole process. This integration should occur by developing inclusive and democratic strategies. Some of the key strategies are:

- Value negotiation: Heterogeneous groups need to build consensus by confronting their meanings and reconciling the discrepancies of their values.
- Visualisations: This mapping and visual strategy facilitates collective sensemaking of complex situations and allows to represent abstract elements of the systems. Visualisations will become a dialectical device (Eden, 1994) to understand, construct and reflect on the system.
- Boundary objects: These flexible objects can be a common interface that enables consensus-based interprofessional collaboration. Representation of healthcare outcomes is being used as boundary objects in this research.

1.2 Research Questions
This research aims to answer research questions of two related aspects. This first aspect is about the facilitation method, while the second is about the complex healthcare system phenomenon.

About the method:

1. How can an outcome-based visualisation enable a participatory and holistic system understanding?
2. How to facilitate/systematise the analysis of the visualisations (visual data)?
3. How to control/consider the role of the researcher as a facilitator during the evaluation of the method?

About healthcare system design:

4. How could the most meaningful outcomes be participatory integrated to construct healthcare systems?
5. How to support system-level negotiation and decision-making based on the consensual outcomes of healthcare?
6. How could the holistic outcome be related to other elements/processes of healthcare systems?

2 Research Design and Activities
The Design Research Methodology (DRM) by Blessing and Chakrabarti (2009) has been used to determinate the main structure of this research methodology. The following strategies and methods have been proposed to address each of the four stages (Figure 1):
2.1 Completed Phases
The Research Clarification (RC) and Descriptive Study I (DSI) has been completed. For the RC, a preliminary study was conducted. The preliminary study was a workshop to explore how designers visualise complex system interaction using healthcare outcomes (Landa-Avila, Jun, Cain & Escobar Tello, 2018). The DSI consisted of outcome-based visualisation interviews with patients and providers. DSI has the following objectives: 1) to identify the most meaningful outcomes for the different stakeholders, 2) to explore how outcome-based visualisations enable the construction/mapping of healthcare systems and 3) to test and adapt the outcome-based visualisation tool.

2.1.1 Methods and Tools
Some tools were prepared to facilitate the visualisation sessions of the completed phases. Among these tools are the outcome cards (Figure 2a). The outcome cards present a variety of healthcare outcomes. The outcomes were selected based on a comprehensive literature review, but the list of outcomes and the physical interface are under revision and refinement as the research is progressing. For the DSI phase, an individual visualisation tool was created (Figure 2b). This interactive tool included outcome tokens and other system elements representations, such as places and people. This tool helped to generate individual visualisations of the healthcare system with patients and providers.

2.1.2 Data Analysis Approach
During this research, two main types of data are being collected. The first type is outcome-based visualisations. This graphical data is a type of system diagrams that contain related and grouped elements. The visualisations are being explored as a stand-alone piece of data, and a potential graphic analysis is being considered. However, there is a lack of literature about diagram analysis that supports the development of a reliable data process. Therefore, until now, the analysis of the visualisations is being conducted supported by the narratives of the participants.
The second type of data is the oral answers from interviews and the narratives of the visualisations. Both of them are being analysed using an inductive and critical realist perspective (Braun & Clarke, 2006). This perspective preserves the experiences of the participants in the limits of reality. An open thematic analysis has been conducted using nVivo software.

### 2.2 Future Phases
The Prescriptive Study (PS) and Descriptive Study II (DSII) still need to be completed. For the PS, a series of participatory sessions with different stakeholders are planned. During these sessions, the stakeholders will need to construct an outcome-based healthcare system and to propose interrelated strategies to achieve the agreed outcomes. The objectives of the PS are 1) to explore how different healthcare stakeholders negotiated discrepancies around healthcare outcomes meaning, value and purpose, 2) to identify outcome-related strategies for healthcare system design, and 3) to refine the visualisation facilitation strategy for healthcare system design. Finally, an initial evaluation of the framework will be conducted on the DSII phase. The objectives of DSII are 1) to evaluate how the proposed outcome-based framework has an impact on healthcare system design, and 2) to evaluate the impact of the proposed tools.

### 3 Expected Outcomes
This research expects to achieve the following outcomes:

- A holistic outcome-based framework that supports the design of healthcare systems. This framework should promote a better understanding of the differences among the meaningful outcomes and promote a system thinking visual thinking. This framework will be strengthened with different tools and strategies to engage the different stakeholders.
- A graphical data analysis protocol. Due to the intensive amount of visual data, it is expected to provide a protocol to analyse the visualisations. This protocol should cover academic and practical practices.

### 3.1 Implications of the Research Area
First, the outcome-based approach could promote the adoption of a system thinking approach in healthcare development. However, it remains unclear how much support will be needed to escalate, disseminate and sustain the strategies. Also, the inclusion of psychosocial aspects as critical dimensions in healthcare could promote a human lens mindset placing prevention and wellness on the top rather than illness. This research will also attempt to strengthened other well-establish system thinking approaches such as CWA. The facilitation strategy could encourage the adoption of CWA in healthcare design.

### 3.2 Contribution to Knowledge
This research will advance knowledge about how to how to map healthcare systems. This contribution will be made by 1) defining how to use outcomes as a mean to trigger the mapping process and 2) how to negotiate the conflict of values. The mapping process will be completed by related outcomes with other system elements. Also, a holistic understanding of the healthcare system will be provided by revealing the prioritised outcomes and values of healthcare. It is expected to clarify the meaning of social dimensions such as wellbeing, happiness and dignity within the healthcare system.

### References


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**About the Researcher**

I. Cecilia Landa-Avila Cecilia is a PhD student at Loughborough Design School. Her research interest is focused on humanising healthcare services by gathering approaches such as system thinking and social innovation. She currently explores participatory mapping methods for healthcare system design aiming to trigger meaningful discussions, to support negotiation of value trade-offs and to encourage a complex system awareness.
PhD Pit-Stop: Co-Developing STEM Activities by Using a Design Thinking Approach

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Keywords: STEM education; STEAM education; design thinking for educators; design thinking in K-12 education; co-developing STEM activities

1 Introduction

In the 21st century, the changes in technology and science affected the designers’ role. Designers have started to design societies, systems and they are expected to solve problems with other disciplines in an interdisciplinary environment by being a conciliator or facilitator. One of the fields that designers have contributed to is education, and in education, design thinking (DT) approach has been used in many areas such as curriculum design, instruction design or classroom design (Riverdale & IDEO, 2013; REDlab, n.d.). Since teacher activities have started to appear as a design activity (Brown & Edelson, 2003), the designers have been accepted as a guide for educators (McFadden, 2015) to prepare them for the 21st-century requirements. After reviewing the literature, many theses have been found about DT from the organization perspective mostly in the field of management (Junginger, 2006; Howard, 2015) and in the education field (De Campos, 2014). However, in the literature, there are no definite principles of DT approach or the way how it can be taught (Kimbell, 2011). Furthermore, most of the theses were made by people from the management disciplines but not from the design disciplines. It can be concluded from these studies that, the DT approach has been accepted as a strategic approach for innovation within organizations, however, the literature offers little insight about how DT approach is applied in education and whether it is creating a change or contribution in this field. Since DT is seen free from the context that can be applied in every discipline (Brown, 2008), regarding this review upon here, the process should be revised in different organizations or fields.

The traditional K-12 education has also changed and started to be replaced by integrated education such as STEM and STEAM approaches. STEM has emerged with the acronym of the first letters of the word of Science, Technology, Engineering, and Mathematics. Nathan and Pearson (2014) describe integrated STEM education as a different combination of STEM disciplines by emphasizing one field more than the other three disciplines. In Turkey, there have been STEM activities mainly in some of the private schools and workshops organized by STEM research centers. According to the exploratory research that I carried out to understand the situation of STEM education in Turkey, schools that implement the STEM education cover not only the four but all disciplines in their education. They also developed STEM education based on what they have learned from STEM research centers, while these centers focus on science and mathematics only. Furthermore, there are no enough sources for teachers other than science and mathematics related to the STEM approach.
2 Purpose and Research Questions

This thesis explores the effects of a design thinking (DT) approach on the development and implementation of STEM activities by teachers. Since DT has been used in many areas in educational context, DT can assist teachers to develop and implement STEM approach at schools due to its problem-solving process, its similarity with the STEM approach by involving 21st century skills (Cooper-Hewitt, 2014) and common mindsets (Carroll, 2015) and its relation to science, technology and engineering (Catterall, 2013). The study aims to understand how a DT approach can contribute to the STEM education which includes all disciplines and seeks answers to the following questions:

- How and to what extent can a DT approach be used for teachers’ developing STEM activities?
- How does a DT approach affect interdisciplinary collaboration among teachers in relation to STEM activity design and implementation?

3 Research Design and Activities

The research method suggested for this study is a case study in which co-design workshops and focus group sessions are held for in-service teachers. The empirical study consisted of three parts: literature review, exploratory research: developing a DT approach for STEM approach and co-developing STEM activities through the DT approach respectively. In the first part, a literature review was executed to understand the state of the art of STEM and DT approaches. Part 2 had three stages: the first stage included interviews with teachers and the school principals who executed a STEM approach. The second stage included participating in STEM workshop. The third stage included the development of a DT approach for the STEM approach. The purpose of the first and the second stages was to become familiar with the situation of the STEM approach in Turkey due to being an outsider to the education field. The data of the first and second stages was also analysed in order to be used in the third stage. In this stage, the literature review including massive open online courses (MOOCs) about DT approach, and additional literature about DT and STEM approaches was also utilized in order to develop a DT approach to be used in the co-design workshops.

In part 3, it was intended to develop and implement a DT approach to facilitate the teachers’ STEM activity design through conducting co-design workshops and post-workshop focus groups. This part comprised of the pilot study and two main studies. The pilot study was conducted with teachers in order to test the developed DT approach. After analysing the data of the pilot study, some changes to the DT approach were executed. After the pilot study, two main studies were conducted in the same school with the same participants. The first main workshop with the focus group session in the main study I was conducted with secondary school teachers to collaboratively design STEM activity and interdisciplinary lessons to see the effect of the developed DT approach on the STEM approach. After this workshop, teachers implemented the designed activities in one of the 5th grade classes to evaluate them. In this study, we confronted with some problems regarding the students, therefore, for the second study, besides teachers, I also involved students as stakeholders and I took their reflections and recommendations to realize the second study. Furthermore, at the end of the main study I, the data was analysed in order to make some changes on the DT approach and to define some strategies for implementing the STEM approach at school. As a result, the main study II with workshop and focus group session was conducted with the same teachers and the designed STEM activity was implemented in the same 5th grade class. The data obtained from the study was utilized in order to revise the DT approach along with answering the research questions.

In the main studies, we had some problems regarding the teachers’ inexperience about the interdisciplinary collaboration and STEM approach; they had difficulties in developing ideas and creating STEM activities. Therefore, I had to make interventions in both workshops while developing STEM activities, although, one of my purposes was to provide teachers a DT approach to be used for designing STEM activities by themselves. The DT approach I adopted for STEM activity design changed from the first to the second main study. After the second main study, I made further changes, however, the latest version has not been tested in another study.

4 Data Collection and Analysis

In order to achieve a complete understanding of this project, the research methodology was designed to utilize multiple qualitative research methods in which data was obtained from researcher notes based on observations in co-design workshops and STEM activities, focus group interviews and semi-structured interviews with students and teachers, SMS and WhatsApp messages and the discussions with students (Table 1). The result of this research was based on the analysis of the data gathered from all field studies. The collected data in the pilot study was analysed based on the thematic analysis due to involving only the focus group and the observation data. The collected data in
the exploratory research and in the main studies was analysed based on the template analysis method which is a style of thematic analysis due to the complexity and the huge amount of the data.

Table 1. Studies and data collection methods in this research

<table>
<thead>
<tr>
<th>Study</th>
<th>Data Collection Methods</th>
<th>Number of participants</th>
<th>Number of Interviews</th>
<th>Date of the study</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exploratory research</td>
<td>Interviews with teachers and school principals</td>
<td>Interview</td>
<td>14 teachers</td>
<td>16 individual interviews</td>
<td>Between 14 February 2017 to 24 March 2017</td>
</tr>
<tr>
<td>Participating to the STEM workshop</td>
<td>Interview, Observation</td>
<td>2 teachers</td>
<td>04-05 March 2017</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Case Study I: Pilot Study</td>
<td>Focus Group Interview, Observation</td>
<td>5 teachers</td>
<td>1 focus group</td>
<td>Workshop date: 07 and 08 September 2017</td>
<td>20 minutes</td>
</tr>
<tr>
<td>Case Study II: Main Study I</td>
<td>Interview, Focus Group Interview, Observation, WhatsApp and SMS messages, the discussion with students</td>
<td>5 teachers, 16 students</td>
<td>6 interviews with teachers before the workshop, 18 interviews with teachers after activities, 1 focus group with teachers after the workshop: 5 people, 1 focus group with students after activities: 6 people</td>
<td>Workshop date: 18 and 25 November 2017, Interdisciplinary courses dates: 30 November, 04, 05, 11, 12, 26 December 2017 and 08 January 2018, Activity date: 09 January 2018</td>
<td>8 hours 55 minutes</td>
</tr>
<tr>
<td>Case Study III: Main Study II</td>
<td>Interview, Focus Group Interview, Observation, WhatsApp and SMS messages</td>
<td>5 teachers, 16 students</td>
<td>9 interviews with teachers after the workshop, 2 focus groups with teachers after workshop and activity: 5 people; 1 focus group with students after activity: 8 people</td>
<td>Workshop date: 28 February and 01 March 2018, Activity date: 03 May 2018, Science fair: 05 June 2018</td>
<td>5 hours 56 minutes</td>
</tr>
</tbody>
</table>

5 Expected Outcomes

After making the initial data analysis, I found out that both STEM and DT approaches have similar characteristics such as interdisciplinary collaboration, human-centredness (student-centredness in STEM), teamwork, self-reflection, problem-solving, and hands-on activities according to teachers’ perceptions. Furthermore, I also explored the perceived role of the researcher as a designer from the perspective of teachers to define the researcher’s facilitator roles. As a result, the facilitator roles of the researcher had four impacts on the study: Facilitating the perspectives by changing the mindsets and the teaching habits to teach the STEM and DT approaches, facilitating the workshop process by managing and establishing a participative workshop environment, facilitating the STEM activity design process between the teachers who were empowered as stakeholders in the co-design process and lastly facilitating the implementation of the STEM activity between the teachers and students. Furthermore, teachers had also two roles during the process of the STEM activity design; being a designer in the STEM activity design and being a mediator between the students and the researcher for transferring the students’ data into insights for the STEM activity design. The result of the main study I also showed that students had an effective role in the implementation of the STEM approach, since the relationship between the students and teachers shaped the designed activities, the research process, and the DT approach, in other words, the designer’s and teachers’ decisions. In that point, students along with teachers are important in the implementation of a new educational approach and they should be considered as stakeholders.

As a result, in this study, the interdisciplinary STEM activities were designed with teachers by using a DT approach developed for the STEM activity design. Furthermore, teachers learned how to design a STEM activity considering their students’ needs instead of implementing a ready-made activity. In that point, the DT approach assisted teachers for getting familiar with students due to its human-centred, collaborative nature. Lastly, due to their busy schedules, the DT approach was found a time-saving method by teachers in the STEM activity design. Considering the perceived role of the researcher, the similarities between the DT and STEM approaches and all of the above findings, it can be
concluded that, the developed DT approach contributed to teachers’ developing STEM activities, in that point, integrating DT approach into the pre-service teacher education would be beneficial.

References


**Acknowledgments:** I would like to express my deep gratitude to my advisor Assoc. Prof. Dr. Fatma Korkut for her guidance and valuable support of my Ph.D. study.

**About the Researcher**

**Ahsen Öztürk** was born in Sinop. She obtained her bachelor’s degree from the Department of Industrial Design at Middle East Technical University (METU, 2003), and her master’s degree from Art Education Major at Ondokuz Mayis University (2014). Currently, she is working as an instructor at Ondokuz Mayis University and continuing her Ph.D. education in the Department of Industrial Design at METU.
PhD Pit-Stop: Co-Designing Gift in respect to Local Skills and Knowledge

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Keywords: gift; local skills and knowledge; co-design; research through design; sustainability

1 Introduction

Gift exchange is a repetitive behaviour of everyday life. We give and receive gifts during many rituals and social practices, which are both pre-determined and arranged to happen in a specific time (e.g. anniversaries, Mother’s day, graduations, weddings), or ad-hoc, like when we buy a souvenir for a friend to share feelings or to build up social networks. Theodor Adorno (1951/2005) describes the pleasure of giving and argues that “real giving had its joy in imagining the joy of the receiver” (p. 42). Echoing the words of Lacan and Hegel, Dilnot (1993) underlines the recognition as the most desired want, and therefore, the thing that the receiver gets besides the gift-object. “The object, no matter what its mundanity, is like a collective gift: it is issued for all of us, and its function or work is gift like in that its form embodies recognition of our concrete needs and desires” (p. 58). So, through recognition, a gift can act as a tool to indirectly improve human-to-human interaction.

1.1 Aim and Objectives

This study aims to identify the stakeholders in the gift exchange process and collaborate with them as co-designers through a research through co-design approach in respect to their local skills and knowledge in order to reveal the aspects of gifts that can play an important role for design practitioners and researchers. Accordingly, the main research questions are:

- How can we integrate local knowledge and skills into the co-design process?
- How and to the what extent can designers and local stakeholders collaborate to co-design gifts?
- What are the advantages and disadvantages of co-designing gifts based on local skills and knowledge?

1.2 Value of Gift

Anything can be a gift, yet nothing can replace it. Gift has a special destructive ability which can simply deny any economic value yet be cherished like no other commodities. “In fact, accepting a gift as a gift means that we give it a value that apparently takes it away from other realities” (Malo, 2012, p. 9). Gift is associated with human emotions, and that is why sending a flower bouquet with a message written by the florist (Demez, 2011, pp. 101-102) may not be impressive, in terms of emotional value, in comparison to receiving a piece of art made by the gift-giver. Don
Norman describes the difficulty of the emotional design and underlines that the “emotions are in the mind and bodies of the people and so we have to figure out how to make a product or service that delivers in the person the emotions that we care about” (NNgroup, 2016).

Shifting focus from customer, consumer or user to gift maker, gift giver and gift receiver encourages closer investigation of human behaviour and further discussions on the value of items that we design as the gift that, ideally, promote better human relations. Involving actors like gift giver, gift receiver and gift-maker, together through utilizing local skills and knowledge and improve their relations can assist to create unique designs with narratives and stories which will be emotionally durable and therefore sustainable.

1.2.1 A Gift for Preschool Children

Figure 1 illustrates an example of a series of emotionally valuable gifts, stuffed with a mix of preschool students’ and their teacher’s feelings, which are intrinsically imperfect, unique, personal, and durable (Rognoli & Karana, 2014, p. 153). Before Sezen Karazincir, a preschool teacher in Adana in Turkey, made these toys (Figure 1) and gifted them to her students, she had asked them to draw their dream toys. The results became toys which are, undoubtedly, full of indescribable emotional value (Yazar, 2016).

![Figure 1. The stuffed toy gifts created by a teacher from the drawings of preschool children (Yazar, 2016).](image)

These emotions are very different from what Desmet, Overbeeke and Tax (2001) describe as added emotional values, which can be perceived from physical attributes, form, appearance, texture or materials of objects. Unlike added emotional values, the emotions associated with these toys are intrinsic, communicable and have meanings only for the students (gift receiver/maker) and their teacher (gift giver/maker), and the only way for others to partially feel them, is empathy. “A small part of my being has been given to another for a small part of his or hers” (Csikszentmihalyi & Halton, 1981, p. 37). So, the value that is hidden inside these toys is very personal and it does not exist in similar stuffed toys in the market.
Comparing these toys with a souvenir, which is also a non-ordinary object that acts as a reminder of non-ordinary or extraordinary experience (Gordon, 1986) leads to further discussions about the emotions, values and meanings associated with these objects.

1.2.2 Souvenir
Souvenirs are among the objects that are generally accepted as gifts. There are two contrary perspectives in both academic and public perception related to souvenirs. While souvenirs are defined as objects that trigger the mind to remember good memories - the word itself means memory and to remember - they are criticized as mass-produced kitsch with which tourists have a misguided preoccupation (Lasusa, 2007), and fetish of the past with very little or no artistic and creative merit (Dorfles, 1969, pp. 167-169). To address this problem, researchers and design practitioners have developed different methods and techniques (Swanson & Timothy, 2012; Kaya & Yağız, 2015) “in such a way that the harmony of substance and essence will sustain” (Kaya & Yağız, 2012, p. 142). However, Norman looks at the souvenir from a very different perspective and highlights that “There is little intellectual depth, for the creativity and insight is part of the original, not the copy” (Norman, 2004, p. 46). He claims that if an item can evoke feeling and emotions, it does not matter whether they are kitsch or not; “our attachment is really not to the thing, it is to the relationship, to the meanings and feelings the thing represents” (Norman, 2004, p. 48).

Now if we simply focus on the stuffed toys explained in the previous section as the end-product and ignore their emotional value added to them through the act of gift making and exchanging, we cannot deny the fact that like souvenir the end results can be criticized as kitsch. In another words, the invaluable creative drawings of children, which are just a tiny reflection of their imagination, is dragged down and excluded from possibilities by simply transforming their 2D drawings into stuffed toys. Perhaps, even the teacher was not aware of the many aspects that the children’s original ideas might have had. For instance, the drawn creatures might have various special abilities that were ignored during their transformation into stuffed toys, or one might imagine a house to be edible, etc.

Thus, in this point the question is, how and to what extent design research can effectively contribute to creating a gift that can deliver emotions and meanings. In my opinion, the most challenging part is to find the line to build the balance between the gift as a thing and the gift as the carrier of the emotions and sentimental values.

2 Research Design and Activities
The following sections describe the planning of conducting two case studies.

2.1 Case I
The first case will attempt to design an item with gift quality in collaboration with local stakeholders in Safranbolu. Before starting the case, an initial discussion with a local expert was required to find the relation between the research questions and characteristic of the city. The next step of the study will identify the public and/or private organizations that would mostly benefit from developing gift items that, potentially, promote social and environmental sustainability with integration of inputs of local experts and local stakeholders. The main purpose of this meeting is to discuss practicality of the project aim, procedure, identification of individuals to work with, their roles, and anticipate the possible outcomes. Next, before initiating a co-design workshop, each participant will be informed about the research purpose to discuss and negotiate on the process and attributes of the gift that we can design together with other participants. In order to create a collaborative work, the role of each participant and stakeholder should be studied and specified before each session. After specifying the role of each participant, the first session will start. A meeting will be organized, and participants will introduce themselves by giving a simple and brief presentation about their expertise. The aim of the first meeting is to negotiate to draw a time-task plan. The whole process, including the next steps, from beginning to end will be carried out with collaboration of stakeholders. Each participant negotiates and inform others about the requirements, settings and outcomes from his/her perspective. For instance, while a candy producer may ask for hygienic settings, the gift giver may demand for wrapping materials and tools.

The process will be carried out based on several negotiations between the participants and the researcher. The outcome of the process will be analyzed based on the tangible designs and through a final interview or a focus group with participants.
2.2 Case II

Keshmoon (www.keshmoon.com) is an online bazaar founded by entrepreneur Mohammad Qaem Panah, who created a network with local saffron farmers in Qaen, a city in South Khorasan Province, Iran. The aim of Keshmoon is to provide a platform for local farmers to reach their customers directly and market their saffron, together with the associated products (Figure 2), so that farmers can get rid of dealers and sell their products for a better price. Each farmer in Keshmoon’s website has a profile (Figure 3) that includes details about his/her personal life, products, different stage of farming, etc. (Figure 4). Keshmoon claims that it does not grow saffron, nor buy any saffron from farmers to resell. It just seeks to find local farmers in Qaen and encourage them to not only grow their saffron without using any chemical substance, but also to use their water supplies more responsibly. Keshmoon provides farmers consultancy services and practical solutions during growing, harvesting, sorting, packing and delivering of their saffron.

Keshmoon is found to be an interesting case for this study. First, saffron has been always a precious gift for and from Iranians. It is a luxurious spice, extensively used in Iran like no other place in the world, which also represents and is tied in with many aspects of Iranian traditions and culture, including food, medicine, and hospitality. Second, Keshmoon has successfully managed to utilize accessibility and affordability of technology and online tools to build a strong relationship and bound between farmer (as the one who produces a special and local product/gift maker) and the buyer of saffron (user/gift giver), which was not possible until recent years. Finally, Keshmoon is determined to empower its local community of farmers together with raising awareness about environmental sustainability.

Figure 2. Keshmoon’s Gift Box/Story Box: Two grams of saffron, including a brochure that introduces the farmer and describes his life, four packs of 0.1 grams of saffron (buyer can gift them to others), a small cotton bag (woven by hand in Qaen) to protect saffron from direct light, a wooden pounder (made in Qaen) for grinding saffron, wooden tweezers for picking saffron filaments easily. (www.keshmoon.com/package/view?id=1)
Figure 4. Screenshot from a farmer’s webpage prepared by Keshmoon in English.

Figure 3. Screenshot from a farmer’s webpage prepared by Keshmoon in English.
3 Expected Outcomes

This paper presented and justified the need for studying and developing the ways that designers can utilize to identify local knowledge and skills of stakeholders in order to collaborate with them and co-design products that have the gift quality and promote environmental and social sustainability. The field research of this study will consist of a series of meetings, interviews and workshops that engage stakeholders as co-designers. This approach will reveal the experience and role of each stakeholder through co-designing a product that has the gift qualities. The entire process of this field study will assist to reach insights and expose different levels of knowledge (Sanders & Stappers, 2012, pp. 52-63). The co-design processes will be the key components of this study. It will focus on co-design as a means of designing with people instead of for people (Sanders & Stappers, 2014), making an analysis of what already exists, and also providing insights into how things can be designed.

References


About the Researcher

Milad Hajiamiri Ph.D. candidate; received his bachelor’s and master’s degrees from Middle East Technical University. Milad studies the ways to co-design gifts utilizing local skills, knowledge and stakeholders. Currently he is an instructor tutoring design courses at Karabük University Department of Industrial Design.
PhD Pit-Stop: Involving Users in the Development Process of Social Robots

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Keywords: human-robot interaction; child-robot interaction; participatory design; user-centred design

1 Introduction

My master’s thesis focused on children’s motivations for playful interaction with a prototype version of a robotic toy. The features of the robotic toy that intrinsically motivate children for interaction were investigated through qualitative analysis of video recordings of play sessions (Dönmez, 2017). The types of interactions we observed were; physical interaction, facial expressions, verbal communication, and visual engagement. In conclusion, four factors were identified to have an effect on children’s intrinsic motivation for an engaged interaction with robotic toys:

1. Answering the evolving needs and abilities of children;
2. The ease of bonding;
3. Playfulness; and
4. Clarity of responses and multiple feedback.

The emotional expressions that a robotic toy has, is found to be significantly important for attention grabbing and fun. Especially for younger children, the importance of physical interaction was significant while the older children’s expectations were gathered around having an intelligent game opponent that is less predictable and more versatile, can stimulate and challenge the child without invoking stress, and can introduce new abilities within time as the interaction progresses.

The findings of this study aimed to create a guidance for those who participate in the development of robots for children, in creating engaging interactions for children for interaction. The method for this study was participant observation. Children were observed during their interaction and video recordings were conducted. Through qualitative analysis of these play sessions, the conclusions were drawn.
Two main things have grasped my attention after completing the work. Firstly, how and when we involve the user of such smart products into the design phase. As in this study, the user is introduced to the product after a working prototype is finished. This situation leaves little space for improvements as the development process is already complete. Similarly, in most of the user studies conducted within the field of Human-Robot Interaction, the user is involved in the testing stage when there is a completed or a prototype version of a robot. The other significant aspect of this study for me was the impact of social bond and the importance of emotions to support the intrinsic motivation of children or adults to interact with a robot. The excitement towards the robotic toy’s expressions created a social bond and even motivated children to imitate the robot’s behaviours (Dönmez, Börekçi & Gielen, 2018).

In my PhD research, I would like to focus on answering these questions:

- How could the end users of social robots be involved at an earlier stage of development as participatory designers?
- How could involving users at an earlier stage of development contribute to the long-term intrinsic motivation of users and social bonding?

2 Background

Human-Robot Interaction (HRI) focuses on understanding, creating and evaluating the interactions between robots and humans and the problem of HRI is to understand and design the interactions between humans and robots. (Goodrich & Schultz, 2007). When we look at the application of domestic robots today, we see a wide range of products from robotic vacuum cleaners to robotic toys for children and assistant robots for the elderly (Ray, Mondada & Siegwart, 2008). For children, we see robot applications for entertainment, education and recently therapeutic robots that are for example developed for children with autism (Woods, Dautenhahn & Schulz, 2004).

The development process of such technologies requires a long time and effort. Figure 1 shows the stages of development over time. The first phase involves planning and creating mock-up models. As the process progresses, the users usually are involved at a later stage to test the products. The reason for this is because there is need for a certain physical prototype, which takes a long time to develop and make it work. One method to overcome this, is using a Theatrical Robot (TR). By using this method users can test the interaction at an earlier stage compared to other approaches. In this method, a prototype of robot does not exist but the interactions are imitated by a professional actor or a mime artist dressed as a robot (Robins, Dautenhahn & Dubowski, 2004). A study conducted with children with autism interacting with an adult and a theatrical robot, showed that the children’s preference leaned towards interacting with a Theatrical Robot rather than an adult (Figure 2). This method allows the researchers to involve the user at an earlier stage of the development process since a prototype is not required to be developed. Even though this technique involves the input of users, it still limits the physical appearance of the robot only as a humanoid.
Another common research method is the Wizard-of-Oz technique. When a basic prototype is developed, the Wizard-of-Oz approach is used with a hidden human operator who controls the actions of the prototype robot (Maulsby, Greenberg & Mander, 1993). This method is usually used when the physical embodiment of the robot is complete but the sensory and cognitive developments are still ongoing. This research provides strong benefits when it is combined with qualitative research. However, as shown in Figure 1, the user is still involved at a later stage of development so the adaptations of the results could be limited.

3 Research Design and Activities

A number of methods are illustrated in Figure 1 on how the development process of robots progresses. To create a long-term motivation for interaction, users of such robots should be involved into the process of development. The methods applied in HRI as shortly described, limits the contribution of end-users to the development of such robots. The research for this PhD, is to investigate how to involve the users at an earlier stage using participatory design method. Zimmerman and Forlizzi (2014) describe an approach to involve research through design as developing the robot holistically, which means rather than advancing the technology, focusing on the interaction qualities and engaging features such as expressions and dialog systems. This approach shows the potential of possible contributions from other fields to HRI studies.

4 Expected Outcomes

The results of this study are expected to create a space for users’ involvement at an earlier stage of development of social robots. This is expected to have a positive contribution to social bonding of end-users and improve long-term intrinsic motivations to interact with a social robot. This approach will have a contribution to HRI studies and robotics companies could benefit from this in the future.

Acknowledgements: I would like to thank my supervisor Naz A.G.Z. Börekçi for her insights and contributions.

References


**About the Researcher**

Yasemin Dönmez received her bachelor’s degree in Industrial Design from Middle East Technical University (METU) in 2013, and later graduated from METU/TU Delft International Joint Master of Science Program in 2017. Her research interests include human-computer interaction, human-robot interaction, and child-robot interaction.
PhD Pit-Stop: Design Thinking Learning Object Design

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Keywords: design thinking; learning experience design; learning object

1 Introduction

Design thinking courses are increasing in higher education as an interdisciplinary, learner-centred approach. Design thinking (DT) is defined as the mindset, which is the process from problem definition to the problem solution. This mindset can remediate the present and future needs, which appears by progressing technologies (Meinel, Leifer & Plattner, 2011). The learning approach of design thinking courses is based on design education and is fed by other disciplines. Design thinking education adopts constructivist learning approach (Scheer, Noweski & Meinel, 2012, p. 14), and has skill-based, effective and cognitive outcomes (Taheri, Unterholzer, Hölzle & Meinel, 2016). The constructivist learning approach is based on constructing new knowledge on prior knowledge by learners’ initiative (Piaget, 1970); the knowledge is gained through individual experience (Piaget, 1970; Kolb, 1984; Fosnot & Perry, 1996) by the practitioner’s reflections on their actions (Schön, 1982).

Design thinking education is applied in the perspective of seven fundamental mindsets: 1) focus on human values; 2) showing not telling; 3) creating clarity from complexity; 4) getting experimental and experiential; 5) being mindful of processes; 6) having bias towards action; and 7) collaborating across boundaries (Plattner, Meinel & Weinberg, 2009). The exploratory field research indicates that learners have a problem in being mindful of their learning processes. This situation causes a decrease in the motivation of the learner and the learning quality of the course. The user experience dimension of the learning process can be framed as a product-centred, interaction-centred and user-centred experience like a constructivist alignment approach. The learning process is designed by defining Intended Learning Objects (ILOs), planning Teaching and Learning Activities (TLAs) and evaluating the Assessments (ATs) depending on the constructivist alignment approach (Biggs & Moore, 1993; Spelt, Biemans, Tobi, Lunning & Mulder, 2009). TLA, which is introducing the learning object (LO) and activities to reach the learning goals, has an essential role in the constructivist learning approach as the knowledge is constructed through this experience (Biggs & Tang, 2011; Scheer, Noweski & Meinel, 2012).

The dissertation is based on the hypothesis that, design thinking course learning objects, designed from a user experience perspective, can improve the learning quality by increasing learners’ motivation and allowing them to be mindful of their learning processes. In regard of this, the dissertation firstly aims to explore the design thinking learning motivation of the learner, design thinking learning process in higher education and the learning outcomes of the course; then discusses user experience factors of the learning object. The dissertation focuses on design thinking...
learning experience in higher education and aims to explore the relationship between learning outcome and learning objects. Therefore, the dissertation searches for an answer to the following main research question and three sub-questions, with the necessity of empirical research:

- What is the relationship between cognitive learning outcome and learning object design in constructivist design thinking learning in higher education?
  - What are the design dimensions of the design thinking learning object in the user experience perspective?
  - How can design thinking learning objects be evaluated?
  - How can cognitive design thinking learning outcomes be evaluated?

### 2 Research Design and Activities

The dissertation considers design thinking learning process as the constructivist learning approach in interdisciplinary higher education, in the focus of user experience dimensions regarding pedagogy and design literature. User experience approach defines the general frame of the dissertation and constructivist theory provides a theoretical basis for learning. Besides, learning planning is framed by the constructivist alignment (Biggs & Tang, 2011) approach. In this context, learning experience is accepted as an iterative process in which the learner is involved with learning activities in the perspective of intended learning objectives and which ends with learning evaluation. The learning appears with the learning activities that the learner has an active role in the constructivist learning process; therefore, learning objects interaction and learning object design have a significant role in learning.

The dissertation has been designed through the research questions in the frame of the post-positivist paradigm in the frame of parallel mixed research methodology. The literature and the exploratory research include design factors of design thinking learning object, which is improved by user experience dimensions. The quantitative and qualitative data has been used at the same time and in similar intensity during the research process. Design thinking cognitive learning outcomes and participants’ learning motivations are analysed by content analysis methodology via reflective writings of the learners with the convenient cognitive taxonomy. Learning object design evaluation is analysed by Learning Object Review Instrument (LORI) methodology, which is appropriate for the defined user experience factors. Therefore, the strengths of mixed research methods provide to correlate data type; quantitative data has been used in order to reveal performances of design thinking learning object and qualitative data has been used for exploring the understanding of the learning experience.

The univariate pre-test/post-test experiment has been planned with the mixed research methodology. The experiment is designed as a univariate empirical experiment to compare learning outcomes in two courses with the variables of learning objects designs. The testing group has been chosen as the interdisciplinary participants of the higher education Design Thinking course. Due to the exploratory structure of the research, empirical research has been designed to collect and analyse data gathered from the participants using questionnaires. The control group has been accepted with a pre-admission test before the experiment. The independent variable is the design thinking cognitive learning outcome and the dependent variable is the learning object design. The manipulation has been applied to the learning object design and interpreted by the learning outcomes. Qualitative data is converted to numeric data and compared with the qualitative data.

Design thinking learning experience’s empirical part is modelled as univariate experiment model with pre-test and post-test with learners’ reflective writings. Reflective writings were applied as an online structured questionnaire to model the cognitive and affective levels. Experiment model focuses on the relationship of the independent and dependent variables by monitoring the outcomes of variations in the controlled situations. There are two random test groups in the post-test control group model. One group is the control group, and the other is the testing group.

The empirical part of the dissertation has been implemented in the interdepartmental Design Thinking course at Yaşar University. The course includes two projects; the first project is used for the pre-test and the second project is used for the post-test. Participants of the 2018-2019 fall and spring semesters, 39 students, wrote their reflections on their learning processes via online questionnaires. The data was analysed with content analysis using the cognitive taxonomy. Besides, the reflective writings were also used to understand the learning motivations from a user experience perspective. The dissertation discusses the contributions and the differentiation between learning outcomes and the learning objects reviews, which is evaluated at the end of the semester. The pre-test/post-test structure of the experiment shows the participants’ cognitive reactions to the learning object design and learning quality.
3 Expected Outcomes

The dissertation consists of five chapters: introduction, theoretical framework, research design, findings, and conclusion. Introduction chapter describes the scope, aim and background of the research. Besides, this chapter underlines the significance of the dissertation by the research questions to be addressed. The following chapter, theoretical framework, includes literature review on design thinking, user experience, learning objects and related pedagogic literature. This chapter starts with a general review on design thinking learning than consider the learning process in the user experience perspective. The chapter finishes with the product level of the learning process with learning objects. This chapter aims to provide general approaches, definitions, discussions and also proposes to fill the gaps in those areas.

Research design chapter includes the empirical part of the dissertation: data collection and analysis methods are given in this chapter. Also, the experiment, participants and the instructional design are detailed in this chapter. The following chapter, findings, include the experiment and analysis outcomes; the outcomes are discussed in the frame of research questions. Conclusion part, visits the main research question, learning object and learning outcome relationship, evaluates the dissertation in general, proposes design thinking learning object design, and makes suggestions for the learning outcomes of design thinking courses, also indicating future studies.

This dissertation aims to indicate the potential areas in between design and pedagogy literature. The research contributes to design thinking learning, learning object design and user experience theory. Hopefully, it will open up a new discussion on alternative methods in this field and inspire learning object designers, learning planners and researchers to explore the future possibilities.

References


About the Researcher

Can Güvenir After obtaining his bachelor’s degree from Anadolu University, Department of Industrial Design, he presented his master’s thesis, completed in Istanbul Technical University in 2014, at the National Design Research Conference. He started his PhD in Istanbul Technical University on design thinking. Can Güvenir Design Studio has been giving design consultancy since 2011, and Can is also a part-time lecturer in Yaşar University Department of Industrial Design.
PhD Pit-Stop: Facilitation of Design Students’ Tacit Knowledge Construction - An Interpretive Research in Interior Design Studios

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Keywords: tacit knowledge construction; interior design studio; interpretive qualitative research

1 Introduction

As studios in design education remain the sites for experimentation and knowledge application, they also act as facilitators of tacit knowledge acquisition. Tacit knowledge, though an internal and self-directed constructed process is also a socially-constructed act (Mareis, 2012) that is orchestrated through the dynamics of the studio learning environment. What is often given less prominence in the design act of doing is the act of critically conversing that enhances tacit acquisition. On a broader scale it influences what we call the praxis of design -taking design as an activity to a higher level (Ulughlu, 2000).

My PhD study is an exploration of the acquisition of tacit knowledge through the social dynamics of the design studio, based on Donald Schön’s theory. Spatial understanding as an example of the tacit component in interior design is not yet fully explored. My aim is to study interior design students’ process of spatial knowledge construction developed over the years of their education using a student-centric approach. By doing so, the study can contribute towards the disciplinary knowledge of interior design by seeking to understand its unique tacit language and how it is acquired. Critical conversation in the studio is one such method of its acquisition.

Studio interactions, which facilitate spatial knowledge construction, can also act as the primary site for rehearsing and shaping critical conversations. This develops confidence in students to participate in discourses beyond the disciplinary boundaries and extend their learning beyond the studio. Thus, the research can inform expanded interactive and social learning spheres.

In terms of pedagogy the findings of the research can help in suggesting effective teaching and learning strategies that can develop students’ self-efficacy as a learner and designer.

The main research questions are:

- How do tutors facilitate interior design students’ construction of tacit knowledge?
- How do interior design students construct their knowledge of interior spaces?
• How do social interactions in the interior design studio facilitate students’ construction of tacit knowledge?

1.1 Literature Review

1.1.1 Constructivism

According to the constructivist theory, knowledge and meanings are constructed from the interpretation of experiences, reality is constructed through the interactions of people and their world in a social context and that these constructions change with new experiences and in new situations (Guba & Lincoln, 2005; Mertens, 2010).

Constructivism has both cognitive and social dimensions such as Jean Piaget’s cognitive model, Vygotsky’s Zone of Proximal Development and Bruner’s Scaffolding theory. Through social negotiation students are exposed to multiple perspectives where they have to be critically aware as well as defend their own position thus making them active and independent learners (Driscoll, 2005).

Constructivism is easily applicable in studio pedagogy because of the nature of design and the learning environment. Donald Schön’s theory of reflective practice was formulated in the unique setting of the architectural studio where he studied how the studio master and student engage in a reflective conversation with the situation resulting in reframing of the problem. Problem-solving, which triggers reflection-in-action, is a way to explicate tacit forms of learning (Schön, 1985). Spatial knowledge is one such example of tacit knowledge.

1.1.2 Tacit Learning

Definitions of tacit knowledge may be summarized using the following words: implicit, non-verbal, inarticulate, uncodified, intuitive, embodied, unexplained, and knowledge that is difficult to transfer (Wong & Radcliffe, 2000, p. 494). Due to the difficulty in communication, tacit knowledge is often demonstrated and relies on the learner’s ability to interpret the meaning of the demonstration. Through the concept of indwelling the tacit is embodied and internalized within the knower (Polanyi, 1966, pp. 5-16).

Mareis (2012) highlights the socio-cultural dimension of tacit learning. Tacit knowledge is collective, differentiated and context-specific (Loenhoff, 2014) and shapes the sensibilities and dispositions ingrained in the individual (Mareis, 2012, p. 69).

Tacit learning therefore includes both the act of doing as well as sharing of experiences.

1.1.3 Studio Pedagogy

The design studio, according to Shulman (2005) is the discipline’s signature pedagogy. It is an informal setting where the focus is on the design artifact rather than on the instructor. Unlike some other pedagogical settings, instruction, collaboration, critiquing and experimenting are all equal sources of knowledge in the design studio (Shulman, 2005).

However, the nature of ill-defined design problems, the rather unmethodical problem-solution design processes and the difficulties in tutors’ articulation of their tacit knowledge make teaching and learning in a studio setting problematic (Ferreira, 2018).

1.1.4 Critical Conversations in the Studio

The desk crits are the core of tutor-student exchanges in the studio. How the tutor facilitates a critical conversation and determines the active construction of tacit knowledge. It depends upon the role of tutors (McDonnell 2016), the types of discussions that range from structured to supportive (Ulugoğlu, 2000), and the use of visual language and meta-language that explicates tutors’ expertise (Heylighen, Bouwen & Neuckermans, 1999).

Informal interactive settings such as peer to peer conversations are equally crucial in tacit knowledge construction as they provide exposure to multiple perspectives, act as a testing ground for ideas and rehearsing arguments, build confidence, and give a sense of fraternity (McClean & Hourigan, 2013).

Online platforms that are effective in sharing experiences prolong learning beyond the studio and enhance tacit knowledge construction; these are future directions for the study.

A theoretical framework was created based on learning theories and pedagogical models mainly based on constructivism, and design theories such as Schön’s Reflective Practice. The above along with a categorization of spatial notions and contexts (not elaborated here) form theoretical frameworks that guide the data collection process.
2 Research Design and Activities

An interpretive qualitative approach was considered appropriate due to the nature of the research questions and the aim of the study. The strategy of inquiry is an embedded case study. The BA programme of the Environment and Interior Design discipline of the School of Design, HK PolyU forms the case, the studios in each year of study are the natural settings and the learning processes of selected students in the case are the units of analyses.

A total of eight students and their respective tutors participate in the study. Data collection methods are observation of studios (Figure 1, Left), interviewing the participants, focus group interviews (Figure 1, Right) using audio recordings and photographs, experience sampling using social media and document analyses.

![Figure 1. Left: Studio observations. Right: Focus group interview.](image)

Data collection was conducted in stages. I am currently in the last stages. My preliminary analytical process consisted of transcribing, creating timelines, developing conceptual frameworks for coding, running the raw data through MAXQDA, and memoing. Analytical categories were formulated in relation with the research question. The categories are to be linked and re-categorized for synthesizing findings and developing insights.

3 Expected Outcomes

Through the deconstruction of students’ spatial knowledge construction process investigated through critical conversations in the studio, it is expected to identify and compare how tacit components are taught (the methods) and learnt in different years of the programme. These could be through the medium of verbal dialogues, visual drawings and materiality unique to interior design.

The results could help in generating a framework that can help explicate tacit learning. The study can recommend improvements in teaching, learning and assessing of spatial design. The framework may be applied to other design disciplines but it would require validation through a quantitative study which is under consideration.

Acknowledgements: I am thankful to the students and faculty of the Environment and Interior Design programme, School of Design, The Hong Kong Polytechnic University for their willingness to participate in this research, and also to Dr. Henry Ma my chief supervisor for his valuable guidance and constant encouragement.

References


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About the Researcher

**Aruna Venkatesh** is a PhD student at the School of Design, The Hong Kong Polytechnic University. She has a Graduate Diploma in Architecture and Masters in Design Education. Having worked in the interior design field, her current interests lie in design pedagogy research, which she hopes to pursue as a future career option.
PhD Pit-Stop: Design of Spatial Pedagogical Tools for Fostering Number Sense

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Keywords: spatial thinking; spatial visualization; number sense; manipulatives

1 Introduction to Spatial Thinking

Spatial thinking is crucial to the student’s success in science, technology, engineering, and mathematics (STEM). It is hence being incorporated into many formal curriculums in the recent times (NCTM, 2000; NRC, 2006; Uttal et al., 2013; Davis, 2015; Burte, Gardony, Hutton & Taylor, 2017). However, spatial skills are not a single, unified construct (Voyer, Voyer & Bryden, 1995); they are defined in myriad ways across the literature. According to Linn and Peterson (1985), spatial thinking is not a one-dimensional ability but rather an amalgam of various factors, such as spatial perception, spatial visualization, spatial orientation and mental rotation (Charcharos, Kokla & Tomai, 2015). According to another of the more recent studies, spatial thinking involves the location and movement of objects and ourselves, either mentally or physically, in space. It is not a single ability or process but refers to a considerable number of concepts, tools, and processes (NRC, 2006).

Further, according to Newcombe (2010), spatial thinking is concerned with the location of objects, their shapes, their relation to each other, and the paths they take as they move. It further encompasses skills such as spatial visualization (SV), mechanical reasoning, spatial language, and spatial working memory. Lauer and Lourenco (2016) describe spatial ability as involving mental transformation, reorientation, spatial relations, spatial short-term memory, and again, spatial visualization.

Regardless of the different definitions of spatial thinking, all forms of spatial skills require some kind of manipulation or rotation of mental imagery (Loring-Meier & Halpern, 1999). The element of spatial visualization best describes this. Also, since it was the most common element among the various definitions of spatial thinking, our study primarily focusses on it. SV is the skill of building and manipulating mental representations of two- and three-dimensional objects and perceiving an object from different perspectives (NCTM, 2000, p. 41). It is the “ability to mentally manipulate, rotate, or twist, or invert a pictorially presented stimulus object” (McGee, 1979, p. 893; Van Garderen, 2006). It encompasses spatial transformation, which in turn includes tasks like mental rotation, mental translation, and perspective taking (NCTM, 2000).

Mental rotation (MR) is considered as a type of multistep spatial visualization task, that specifically focuses on the ability to look at an object or a picture of an object and to visualize what it might look like when rotated in 2-D or 3-D.
Ekta SURENDER

space (Casey, Lombardi, Pollock, Fineman & Pezaris, 2017). Mental translation (MT), on the other hand, is the mental manipulations of spatial representations involving mental movement of wholes (NCTM, 2000), i.e., mentally moving the pieces without rotating them, a simpler task as compared to MR (Gunderson, Ramirez, Beilock & Levine, 2012). Thirdly, perspective taking entails imagining a new point of view in an environment or taking a new point of view on an object (NCTM, 2000). Our study has focused only upon the mental rotation and translation aspects of SV, since they are found most closely related to math achievement in children.

2 Number Sense

Number Sense (NS) development of children is another crucial aspect of mathematics teaching and learning. It is the foundation for all higher-level mathematics (Feikes & Schwingendorf, 2008). A lack of it has been stated as the cause for student’s failure in algebra in higher classes (Boaler, 2015).

The literature of mathematical cognition and mathematics education defines NS in myriad ways. According to Berch (2005), NS constitutes an awareness, intuition, recognition, knowledge, skill, ability, desire, feel, or expectation; it can be a process, conceptual structure, or mental number line. According to Dehaene (1997; 2001) and Geary (1995), number sense is considered to be much more complex and multifaceted in nature. It comprises a deep understanding of mathematical principles and relationships, a high degree of fluency and flexibility with operations and procedures, a recognition of and appreciation for the consistency and regularity of mathematics, and a mature facility in working with numerical expressions. According to Prof. Jo Boaler (2015), Stanford School of Education, NS is again closely linked to fluency with numbers, which was defined as (Parish, 2014, p. 159) “knowing how a number can be composed and decomposed and using that information to be flexible and efficient with solving problems”.

To make an in-depth and rigorous study of the NS competency, the study has been restricted to only the aspect of flexible combining and partitioning of numbers as defined by Fosnot and Dolk (2001).

Flexible approach to combining and partitioning numbers involves knowing that two quantities, such as 6 objects and 5 objects, can be combined by partitioning 5 into 1 and 4, combining the 4 with 6 to make one unit of 10, and adding the remaining 1 to make 11. It also involves, for example, combining 26 objects and 25 objects by partitioning both numbers into their respective tens and ones, combining the tens, the combining the ones into tens (if there are enough ones), and then combining the tens with the ones (Ontario Ministry of Education, 2014).

3 Relationship between Spatial Skill and Math Achievement

The relationship between spatial sense and mathematics has been established by a number of studies (Young, Levine & Mix, 2018). The meta-analysis by Uttal et al. (2013) of 217 research studies investigating the magnitude, moderators, durability, and generalizability of spatial skills training also suggest that spatially enriched education could pay substantial dividends in increasing participation in mathematics, science, and engineering. Thus, it is no longer questionable that spatial and math abilities are related. However, due to the existence of multiple facets of spatial as well as math abilities (Lohman & Kylloinen, 1983), ambiguity still persists as to which of the spatial abilities are related to which of the mathematical ones; thus, leaving scope for further research (Van Nes, 2009; Mix & Cheng, 2012). Out of these several existing math abilities, the NS aspect in particular, and its possible correlation with early spatial sense (SS) has been addressed by even fewer studies (van Nes, & van Erde, 2010; Rittle-Johnson, Zippert & Boice, 2019). For example, few recent ones have shown that spatial visualization (in particular the mental rotation and mental translation ability), is closely linked to improvement in the number composition and decomposition aspect of NS (NCTM, 2000, p. 41; Mix et al., 2016; Lowrie, Logan & Ramful, 2017; Rittle-Johnson et al., 2019). However, despite this theoretical evidence, there is a dearth of explicit teaching instructions and educational aids that are consciously designed based on the correlation of these specific spatial and math abilities (Ontario Ministry of Education, 2014; Davis, 2015). While the literature does provide spatial tools, such as the hundreds board system, base 10 blocks, ten frames, number rods, etc., and activities such as dot cards, dominoes, hundred squares, etc., these primarily focus on the building of mental representations and not so much on their mental manipulation. On the other hand, tools such as tangrams and construction blocks like Legos, do foster mental manipulation, but it is independent of NS.

Another aspect which makes this study unique is as follows; the above-mentioned tools spatialize the numerical magnitude aspect of numbers while maintaining the visual number form, i.e., the numeral representation of a number (Kadosh & Dowker, 2015). For example, a number rod for the number “2”, represents 2's magnitude aspect by its
length, and visual aspect by the same numeral “2”, which is printed on the rod as shown in Figure 1. Thus, tools spatializing both the magnitude and visual number form of a number are few or non-existent.

Thus, the objective of the study was, considering numbers as entirely spatial entities, to design a spatial learning manipulative which fosters an understanding of NS (particularly of number composition and decomposition) through SV (Mental Rotation, Mental Translation) in early years, and also derive the design criteria for designing of such a tool.

4 Research Design and Activities

4.1 Research and Design Questions
The research questions of the study are:

1. How can numbers be seen as spatial entities, with both the magnitude as well as the visual number form aspects?
2. What should be the characteristics of spatial learning aids that foster number sense?

To explore the numbers as shapes, the designer followed an action research method to arrive at triangles as the appropriate shape for the study and thereafter derived the design question, as follows: “Considering numbers as 2D geometric shapes (i.e., as triangles) with both the magnitude as well as the visual number form aspects, design a spatial tinkerable manipulative that fosters an understanding of no relationship (no composition and decomposition) through SV (primarily mental rotation and translation).”

4.2 Chosen Study Group
The study is being conducted with preschool children aged between (4-4.5 years old), belonging from a lower socio-economic stratum. Young children are chosen because their understanding of numbers is still underdeveloped, which sets a firm ground for the study to introduce numbers as spatial entities.

4.3 The Research Method Followed So Far
Due to the dearth of already existing manipulatives and similar studies with pre-schoolers, the designer conducted a preliminary study with eight pre-school children. The objective of this study was first, to assess the suitability and success of the study with such younger age group; and secondly to get some idea about how to go about designing the targeted learning manipulative. An action research method was followed during this study, through a workshop for over a month. The workshop began with a predefined plan and manipulatives, both of which changed the course of the workshop.

At the end of the workshop, the designer was able to ascertain that the concept was accepted well by the students, as they not only enjoyed it but also showed improvement in their post-workshop spatial as well as NS scores. This evaluation was done with the help of a pre- and post-test analysis.

5 Future Research and Expected Outcomes
The workshop has provided the designer with the necessary design criteria that have to be considered while designing the final manipulative. The designer now aims at designing a final manipulative by holistically incorporating the obtained criteria, in addition to ensuring its allegiance to the research objectives. This manipulative would then be introduced to a greater number of students, again through a workshop, followed by a pre-test post-test analysis. The
study ultimately expects to design a spatial manipulative which successfully fosters NS in children, in addition to being able to determine the final design criteria for creating such a tool.

References


**About the Researcher**

**Ekta Surender** is a Ph.D. scholar at design program, IIT Kanpur. Having exposed to the worlds of both logic and creativity, i.e., engineering and design, I consider myself a tinkerer and a creative problem solver. I believe that design is not just about *how it looks*, but also *how it works*. I have been exploring the potential of design in the field of education- having designed learning tools for science education earlier, now I am delving into the world of mathematics.
**PhD Pit-Stop: Human-Material Interaction - Examining the Material Agency Concept in Making Processes**

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**Keywords:** material agency; practice-led research; craft; felting

1. **Introduction: Material as a Vibrant Entity**

The motivation of this doctoral research is to promote more sustainable and respectful ways to co-exist with nonhumans, such as animals, nature, and materials. The environmental crises we are witnessing indicate that sustaining life on earth requires taking immediate action from multiple perspectives. Finding new ways of co-existing with other entities is a significant part of these actions as life on earth is formed with many entities. Understanding the renewed ways of co-existing can guide us on joining in the flow of continuous changes rather than instrumentalising nature and animals for human needs. Accordingly, in my doctoral research, I examine human material interaction in craft-design processes to clearly demonstrate that humans need nonhumans for their existence. Examining this interaction within craft-design context is useful since through making our bodily experiences bring the co-dependency of humans and nonhumans into light. I believe that we need to shift our thinking from a human-centred perspective to having multiple entities as essential actors of our experiences and existence to transform our life into a more inclusive and sustainable one.

Accordingly, to elaborate on the concepts of co-existence and dependency between humans and nonhumans, this research investigates the ways in which humans interact with the material and how these interactions affect our thinking, making, and essentially being in this world. To understand the active affection of the nonhumans, this research employs the concept of material agency as its frame. As Jane Bennett (2010) perceives matter is a vibrant entity in its individuality. Bennett argues that the power of different materialities enables materials to gain agencies within their independent or collaborative existences. Through their agencies and capabilities, things can act differently under various conditions, time, and spaces. Sociologist Andrew Pickering (2005) argues that the agency of matter accumulates new configurations for human-nonhuman relationships. Pickering claims that material, artefact, knowledge and social transformations evolve together and structure each other’s development. Correspondingly, this active affection between humans and nonhumans significantly contributes to constructing our thinking and experiences in the world.

In the context of making, materials are already a distinctive component, and accordingly, its role has been tackled to understand the maker’s relationship with the practice, material, and society (Risatti, 2007; Adamson, 2013; Sennett, 2013), emergence of the artefact (Bolt, 2007; Ingold, 2010; Nimkulrat, 2010; Malafouris, 2013) or ways to interact
with artefacts (Latour, 1988; Pickering, 2005; Karana, et al., 2015). Following artist and art theorist Barbara Bolt (2007) and anthropologist Tim Ingold (2010), this research emphasizes the co-emergence of the final form from the togetherness of human intentionality and material agency. Similarly, this research unfolds a scale where humans are not positioned as the sole decision mechanism of creative practices but rather comakers together with materials and other participating entities. As a continuation of these discussions, in this research, I examine material’s activeness within different settings to illuminate its impact. These settings differ from each other with the skill stage of the maker, making environment, and the purpose of making. Accordingly, to have a holistic understanding, this research perceives the coupling of several entities and components as entanglement and advocates for nonlinear and complex relations in which togetherness of several entities form each other’s existence in dynamic ways (Barad, 2003; Ingold, 2010; Hodder, 2012). With a focus in felt making, this study illustrates making as an entanglement of various connected elements while specifically arguing for material’s active participation in that landscape.

To examine the interactions, I bring the concepts of material agency, experiential knowledge, and reflective making together to thoroughly understand how the material affects our experiences (Figure 1). Accordingly, the main research question lies in the intersection of these concepts: how does material actively affect human existence and their experiences, thinking, and being in this world? In order to investigate this question comprehensively, three sub-questions are generated. These questions study making and material relationship at three expertise levels and unpack layers of the co-emergence of artefacts:

1. How do expert makers interact with the material during making and how do their bodily movements develop in relation to material movements?
2. How can the agency of the material become a source for developing own way of making and designing for competent makers?
3. How can novice makers learn a craft skill through following the agency of a material?

Each sub-question generated a study and the studies are conducted with makers who are at different skill stages. The first sub-question was investigated with expert makers with embodied material knowledge who followed the flux of the material, the second sub-question was investigated with a competent maker, who had certain material knowledge and experience to handle material interactions, and finally the third sub-question was investigated with novice makers, who acted as curious observers and, at the time of the study, had their initial meetings with the material.
2. A Designerly Way to Study the Activeness of Material in the Context of Felt Making

In this research, the interaction between maker and material is examined within the context of felting. Felting is a nonwoven textile that is made by entangling wool fibres. Felting utilizes basic techniques of pressure and friction between wool fibres. In this process applying hot water and soap catalyses felting (Burkett, 1979). Felting can be done even without any additional tools and its making techniques have remained to be similar since the early examples. I believe this situation indicates its material-ness and provides a nice example to study human material interaction. Accordingly, this research follows a case study methodology which enables conducting deep examinations in one complex field, in this example felting, that can produce knowledge to be applied in other fields (Muratovski, 2016, pp. 49-50). Case studies investigate a topic in its real-life context (Yin, 1981, p. 98) by providing concrete examples to answer how questions (ibid., p. 109).

As in this research design the knowledge about material’s activeness is acquired through experiences, practising felt has been implemented as part of the research. Accordingly, felting has been implicated as part of the research. Employing a practice-led approach provided close contact to examine the significant effects of the material and its transformations. Within the case study methodology, the practice-led approach enables understanding the interactions through bodily experiences and contributes to articulating abstract concepts. Accordingly, in this research design, I, as a practitioner-researcher, make felt to generate research questions through the reflective making processes (See also Schön, 1991). Having a twofold role of being a researcher and designer also enables a comprehensive understanding (McNiff, 2008). Accordingly, practice becomes a vehicle to explore and to contribute to knowledge through hands-on experiments (Mäkelä & Routarinne, 2006, p. 13). Together with examinations through felting, each study also had its own methods of collecting data. In these studies, qualitative research methods have been employed such as semi-structured interviews, participant observation, and facilitating the making processes.

2.1 Three Studies

My doctoral dissertation will be a compilation of three articles and an introductory essay. For this, a conference paper (Aktas & Mäkelä, 2017) and two articles have been published (Aktas, 2019; Aktas & Mäkelä, 2019). Each publication focuses on one study and the studies are summarized below (Figure 2).

![Figure 2. Three sub-questions and the studies they developed, their context, and the preliminary results.](image)

Currently, I have completed the first two studies in the premises of Aalto University (Table 1). After designing the studies and collecting data, the research outcomes were published in peer-reviewed journal articles. For Study 3, the data is collected from the novice makers to reveal how we start thinking with the material in a way that respects non-humans and builds sustainable relationships with them.

<table>
<thead>
<tr>
<th>Objective</th>
<th>Study Setting</th>
<th>Status</th>
<th>Research Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>understanding the field of felting</td>
<td>Interviews with eight expert felt makers</td>
<td>Completed</td>
<td>Conference paper: Craft Dynamics: empowering felt making through design, at NORDES conference (JUFO 1).</td>
</tr>
</tbody>
</table>
3. Expected Outcomes and Further Steps

We naturally understand the world from a human perspective through our experiences, however, the crises indicate that to be able to sustain life on earth we need more-than-human ways to be. This research provokes new ways of looking at the world from a larger perspective that acknowledges other kinds of agencies as well. This shift in thinking aims at overcoming the boundaries between different forms of existence. Considering the depletion in natural resources and growth in need for creating new, reusable, eco-friendly, and recyclable materials, this research can inspire research in material sciences in terms of its methods and methodologies. As new materials are continued to be developed, this research can become a methodical example for developing ways of employing unexplored features of new materials. However, this thinking, I believe, can be applied in the discussions that are not limited to design. This research promptly promotes renewing perspectives in a world facing many human-made problems. A wider perspective can overcome hierarchical binaries such as human and nonhuman, static and active, given and constructed that are the main causes of our current crises.

References


**About the Researcher**

**Bilge Merve Aktaş** is a doctoral candidate at the Department of Design at Aalto University. She holds a BSc degree in industrial product design and an MA degree in design technology and society. Her research interests cover topics like textile crafts, materialities, material agency and maker movements.
PhD Pit-Stop: Improving Driver Experience for METU Campus Shuttle Buses

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Keywords: driving environment; eye tracking; idea generation; scenario building; design ethnography

1 Introduction

Motor vehicles are a part of the wider road traffic system which includes the infrastructure, regulations, and road users such as drivers and pedestrians; road traffic is also among the safety critical systems. Around 95% of the traffic crashes are attributed to driver behaviours (NHTSA, 2008; cited in Meixner & Müller, 2017). These behaviours are defined as the lack of driving skills or expertise, and faulty driver behaviours such as lapses, errors and violations (Sümer, Lajunen & Özkan, 2002).

Safety problems caused by vehicles and road environment are considered almost as miniscule when compared to driver behaviours. Shinar (2007, p. 730) acknowledges the “tendency -especially on the part of authorities- to blame the driver for crashes that may in fact be due to other system failures.” In a way, vehicle technologies are developed for improving the traffic safety by compensating driver behaviours. Yet in-vehicle technological advancements also have the potential for causing distraction, confusion and frustration for the drivers.

Future autonomous vehicles are illustrated as the ultimate solution to the safety problems; however, “there is no panacea (goddess of healing) in traffic safety” (Shinar, 2007, p. 728). Even if all of the vehicles will eventually become autonomous and traffic safety is achieved, transition stages such as driver assistance systems and semi-autonomous vehicle interfaces are required to be designed complying with the human nature. Yet as Hassenzahl (2008, p. 11) noted, human “nature was often viewed narrowly in terms of perceptual and cognitive processes and the ability to perform with efficiency.”

Since the road traffic safety is known as a significant problem area, there is a vast amount of research for improving it. However, research regarding vehicle interfaces, driving and traffic safety is dispersed among the various disciplines and therefore, it is challenging for designers to incorporate information into actionable knowledge. In addition to incorporating information from different domains, designers need specific user information for different types of driving, which is professional bus driving -particularly METU shuttle buses- for this study.
1.1 Aim and Scope of Research

The aim of this study is to develop a suitable method that can be facilitated during the idea generation phase for improving driver experience of buses. In addition:

- This study recognizes vehicles as a part of the complicated traffic system that also involves road users and environment (road infrastructure, signage, regulations, etc.). Safety is the most critical concept for this system and safety problems occur as a result of the interactions between the system elements instead of a single element.
- Human nature and driver experience need to be at the centre while developing assistive driving technologies. For this reason, driver experience for a specific driving type (professional bus driving) will be framed. As a result, fully autonomous vehicles are not within the scope since humans are not responsible for driving in that scenario.
- The method is aimed for both informing and inspiring designers during participatory design workshops. Delivering the information in the form of journey maps, problem scenarios, inspiration cards, and personas may offset the complexity and improve the immersiveness of the information.

1.2 Research Questions

1. What problems do the bus drivers experience during their daily routines and vehicle interactions that incite safety problems?
2. How might these problems be addressed with vehicle automation technologies?
3. How might this study help designers conduct their practice while considering these problems by integrating vehicle automation technologies?

2 Research Design and Activities

Steps of the study are planned as: (a) conducting a user research for current METU Campus Shuttle Buses, (b) incorporating the findings into a driver experience framework, and (c) delivering the findings to designers and engineers during idea generation workshops.

User research for the bus drivers was conducted in the form of field research. A driver experience framework is being developed based on literature review and user research findings. Participatory workshops are planned with both designers and engineers who can potentially be involved in project development teams.

2.1 Field Research Data Collection

Field data was collected by observations, interviews and naturalistic eye tracking recordings. Observations and interviews were held both in the buses and at the settlement area of the METU Directorate of Transportation (DoT). DoT was visited eleven times; shortest visit duration was around 3 hours and the longest was around 7 hours. The visits took place both on weekdays and weekends, during both day and night shift hours. Remarks from casual conversations with the drivers and from observations while travelling by shuttle buses were recorded as written or voice memos. All of the formal interviews were voice recorded. DoT visits yielded around 8 hours and 30 minutes of interview recordings and around 1 hour of voice memos.

In addition, eye tracking data of the drivers was recorded during routine ring driving. The device used for data collection was a Tobii Pro Glasses 2 wearable eye tracker. A total number of 19 ring tours from 11 drivers were recorded. Total duration of the recordings were 17 hours and 36 minutes. Ring routes are different on weekdays and weekends, which is shown on the campus map in Figure 1 (left and right).

2.2 Eye Tracking Data

Output from the data analysis software, Tobii Pro Lab, can be either in the form of .csv (comma-separated values) format file which can be further analysed with the help of MS Excel and/or other software, or in the form of data visualisations. An example of data visualisation output, which is called gaze plots, can be seen in Figure 2. In this figure, numbers indicate the sequence of the eye movement of one participant during the 26 seconds of a recording. Number 1 indicates the very first point the participant looked at (fixated on) on the scene. Radius of the circles increase as the participant looks at (fixates on) that point for a longer period of time and it is considered that the participant is paying more attention to that point.

The same 26 seconds of data for one participant were also exported as a .csv file and examined with MS Excel software. Data was filtered down to fixation points on the three mirrors of the bus with the validity score equal to or
higher than 0.8 however, there were still 6760 rows of data that needed to be interpreted. The amount of data is not manageable considering the total duration of more than 17 hours of recordings. Therefore, manual analysis is anticipated as a more suitable method for this study.

![Shuttle route for week days](image1.png)  
![Shuttle route for weekends](image2.png)

**Figure 1.** Left: Shuttle route for week days. Right: Shuttle route for weekends.

![Gaze Plots for 26 seconds of reversing the bus](image3.png)

**Figure 2.** Gaze Plots for 26 seconds of reversing the bus.

### 3 Expected Outcomes

As mentioned before, the expected outcome is a method that is aimed for both informing and inspiring designers hence the information needs to have sufficient coverage including literature, interview, and eye tracking data without being strict and overwhelming to leave room for creativity. Possible means for conveying information can be journey maps, scenarios, personas, and annotated eye tracking video footages, as seen in Figure 3.

User journey maps are visual depictions of the experience of a user while interacting with a product or a system, and it “can shift an organization’s focus from an operational, system-centred view to the larger context in which products and services are used in the real world” (Martin & Hanington, 2012, p. 196). These maps can focus on scenarios of the whole lifecycle or a specific usage period of a service or a product. Typically, a user journey map contains information about the persona, specific scenario, steps of the scenario, *behaviours, thoughts, and feelings* of the persona, and insights and opportunities gained with the help of the map (Gibbons, 2018). These groups of information are represented as rows and columns on the map. Columns represent the steps of the scenario, and rows represent the different types of information about that specific step.

Scenarios are recommended to be collected with ethnographic inquiry, which “seeks to enter the world of another person or persons, imposing no expectations and making no assumptions” (Carroll, 2000, p. 527). It is considered as a superior way for gathering scenario data (Ackroyd & Hughes, 1992; Fetterman, 1989; both cited in Carroll, 2000) since it can reveal significant problems. It is also considered to have a potential for revealing *exotic error scenarios* (p. 258).
An exploratory workshop will be conducted with the aforementioned materials to gather feedback about the framework and to facilitate idea generation. During the workshops, driver experience framework will be delivered together with scenarios in order to explain the context of the study. Since scenarios will be built upon the actual user data, they will refer to current and past situations. In order to offset the focus on past and enable ideation on positive near futures, possible technologies will be presented to the participants.

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PhD Pit-Stop: Material Information Platform for Environmentally Friendly Products

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Keywords: industrial design; eco-design; product attributes; material attributes; material information platform

1 Introduction

Materials selection phase plays a pivotal role in product development, which is driven by consumers’ needs and manufacturers’ requirements. Hence, material research is decisive in achieving competitiveness and success in the market. Moreover, advances in contemporary technologies have a paramount influence on how new materials are invented and developed. New trends, lifestyles and expectations along with the new regulations imposed by the governments –environmental concerns related to products’ usage and disposal in particular– complement this process. Therefore, environmentally friendly materials are getting more attention as substitutes for the common ones that have become a threat to humanity and to the environment.

The aim of this thesis is to develop an assistive classification method that collects, aggregates and matches product requirements –based on both consumers’ and manufacturers’ preferences– and offers designers substantial information and suggestions regarding environmentally friendly materials and their features matching with the consumers’ and manufacturers’ preferences. Bearing in mind the literature findings for various assistive material selection tools such as material classification (Ashby & Johnson, 2002) and MDD (Material Driven Design) (Karana et al., 2015), a different approach which offers the most suitable alternative materials (environmentally/eco-friendly ones in particular) meeting the product requirements is proposed as a basis for an assistive material information platform (MIP). The product specification phase is a primer in the industrial design process (Pei, 2009, as cited in Whitehead, 2015, p. 23), and it triggers the structure of the product design process in which the designer defines the flow of the upcoming phases based on his/her findings, knowledge and experiences. Therefore, in the material selection process, the proposed model aims to emulate the human decision-making process, in this case, the decision-making process for product driven design (PDD) and development. Moreover, the aim of this thesis is to develop the aforementioned model into an open source MIP, whereby information can be gathered from various sources and designers’ experiences.

In order to investigate the functionality of the proposed platform for material selection, the following challenges should be considered:
• The challenge of meeting diverse and conflicting requirements and preferences in the product development process, which led to the possibility of product driven design in the material selection process via decision-making criteria and mechanism.

• Extending the associative description concept (Karana, 2009) as a method for matching product attributes with material attributes (Ashby & Johnson, 2002), and/or developing other similar approaches for selecting the most appropriate material for a designated product.

• The challenge of proposing the most suitable multi-criteria decision making (MCDM) method and machine learning tool concerning the logic of human decision-making process.

2 Research Design and Activities

The structure of the PhD research consists of five stages:

1. The first activity introduces the problem, the goal of the study, the current/contemporary literature findings and the research questions related to the industrial design process, material selection methods/tools and the potential tools which can be used for the information platform.

2. The second activity discusses the potential of product driven design (PDD) as a means towards the material selection process via decision-making criteria and mechanism. Furthermore, the outcome of this activity should suggest a procedure concerning the future activities related to the material selection process based on PDD.

The procedure is structured as following: Firstly, the product attributes (Ashby & Johnson, 2002) are compiled based on the designers', manufacturers' and consumers' requirements (Phase 1) (Figure 1). Then, the process of mapping the product attributes onto attributes of a generic material is developed according to the associative description concept proposed by Ashby and Johnson (2002) and later developed by Karana (2009) (Phase 2). Considering the previously identified product and material attributes (Phases 1 and 2) (Figure 1), the design process extracts fixed and alternate material attributes based on designers', manufacturers' and consumers' requirements and preferences (Phase 3) (Figure 1). In Phase 4 (Figure 2), a material criteria chart based on the fixed and alternate attributes is developed in order to generate suitable material alternatives.

3. The third activity (Figure 2) relates to the feedback obtained in Phase 5 where each matching material can be analysed in more detail in order to closely test the suitability of it to the prescribed task. Here, the focal point is on the development of an open access material library that can be filled in with information by the consumer, designer and manufacturer. This task will be related to the previous activity, particularly in the phase of recommending the suitable MCDM tools and machine learning algorithms for achieving the best possible outcome in the material selection process. Based on the feedback from the consumer, designer and manufacturer the process can be further developed or reverted back to any of the previous phases. The last phase of the fourth activity will engage the repetitive activities for different types of products to investigate the functionality of MIP.
4. Based on the literature review on MCDM tools and machine learning algorithms, a hybrid model for the material generating process will be proposed. In addition, this activity will summarize the results of the literature related to the previous work on the methodology used in material selection process and the developments in the assistive technology MCDM (Keeney & Raiffa, 1975; Hwang & Yoon, 1981; Keeney, 1982; Bohanec & Rajkovič, 1990; Yoe, 2002) and artificial intelligence (e.g. machine learning).

5. Activity five will summarize the findings and discuss the proposed method for exploring the possibility of developing it into an open source MIP whereby information can be gathered from various sources and designers’ experiences.

3 Expected Outcomes

The outcome of this research offers an answer to the role of material selection in the industrial design process. Furthermore, the identified analogy for product and material selection in the design process while selecting the most appropriate material for a predefined task, pointed out that when mapping product attributes to material attributes and further transposing them onto material criteria, special attention should be given to selecting and discerning fixed from alternate criteria. The outcome points out the possibility and constructiveness of developing an analogously structured procedure/concept for selecting the most appropriate material for a designated product, simultaneously fulfilling the consumers’ and the manufacturers’ requirements.

Having all previously presented aspects in perspective, it can be concluded that an assistive platform based on product requirements provides the approach for material selection and delivering the most suitable materials in product development process. In the process of material selection, the proposed platform aims to mimic the act of human decision-making, in this case the decision-making process for product driven design and development. Such a platform has the potential to serve as a tool primarily for industrial designers, researchers and manufacturers since it saves time, keeps up with the constantly changing information and gives more accurate results than the personal experience.

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**About the Researcher**

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PhD Pit-Stop: Investigation of the Border as a Space of Becoming - Passages
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Keywords: border; passage; urban daily life; modernization

1 Introduction
In a period of changing relationships, interpersonal and social interaction and communication, the establishment of public or urban space needs to be rearranged to support new everyday habits and movement. The concept of border is not only defined as termination, separation area, blocker, controller, and static, but it is also defined as an approach area, that which goes beyond, contains both sides, is connective, and allows a permeable relationship area.

The boundary between the two heterogeneous environments has its own identity, different from the environments between which it is situated. On the one hand while connecting the two streets / milieu, on the other hand, meaning, identity of those two milieus in the city may not continue. The rhythm changes between the two mediums it connects. Sometimes it slows down; sometimes accelerates, changes the texture. This distortion opens up a space both spatially and temporally in urban continuity, thus allowing the unpredictable, the unplanned. How does that third situation, which is unexpected or derives from its constituent environments, affect everyday life in the city and what are the dynamics, conflicts and potentials that constitute this effect? These questions are the main motivation of the study. Can it be said that the space has inoculate urban space and daily life? Just like vaccine it is animator, increasing efficiency / potential, and transformative, also increasing the possibilities of urban space.

Starting with these questions, in this study I chose the passage that also has dualities like the border itself, which can simultaneously provide contradictions as an intermediate space, in order to investigate how the border, as an open space participating in the reproduction of urban space as a social process, is an urban generator. What makes this selection critically important is that these passages challenge the existing rhythm of the everyday life. What I am arguing is that they have brought a new dynamism to the urban context. They do not only represent a new rhythm, but also narrate the social, economic and cultural contexts. Here I used the passage as a definition of space that describes and represents the transition spaces. Passages connecting two different streets or environments by definition, as in other cities, accommodate and produce flow; movement as an urban interior space, represents speed by creating short cuts within the city. On the other hand, the niche within the city can be a halt, a standing area. For this, Deleuze's (2010) concept of being based on differences and Bourdieu's (1991) emphasis on sociological emergence of change are read mutual. Here I utilize Deleuze's notions and emphasis on assembly, flow and change, Bourdieu's habitus, inhibition
within the area and habitus, and inactivity / stasis. Thus, space and its production can be examined intertwined with daily life.

Along with these approaches, I am aiming for a holistic evaluation considering the relationship between actors and architectural product underlined by Tafuri (1986). It is critical to think and discuss through multiple actors, taking into consideration the ownership of the place, the architect, the person or capital of the place, the current owners or tenants, the users of daily life, and the individuals and groups or society that reproduce the place daily (Tafuri, 1986). It is important that the passages to be examined within the scope of the study are historical development, spatial evolution, social meaning and role of the city in Istanbul.

In the selected examples, the transition function does not necessarily have to be the main design input; it can establish a transition area as a return of the position of the designed space in the city or a secondary function of the space that supports the main function. The main determinants of the choice here between heterogeneous environments, forming an identity of its own, in Istanbul, Turkey's modernization process is selecting venues representing the spatial angle. In this context, taking into consideration that the number of working areas can be increased during the study process, Hazzopulo Passage (1871), Odakule Passage (1976), Büyük Beşiktaş Bazaar (1985) and Kanyon Shopping Center (2006) were selected as the research areas. Although their scales are different from each other, considering the years they were built in, they are large-scale projects within their own period.

Questions and Challenges

- Are the passages designed today, or are they the spandrel (Žižek, 2011), in other words residual space of another design and is it established informally?
- How can the potentials of borders as spaces be utilized in the design process? What describes the identity of the boundaries as space?
- Is the power of the passages to represent and transform the daily life of the city still valid?

Keywords: modernity, border, being, identity, public and private space, property.

2 Research Design and Activities

It is not sufficient to examine the boundary that is conceived as a space only with its physical properties and to comprehend its effects on the city and its daily life. A holistic approach requires an interdisciplinary inquiry. For this purpose, it is necessary to define the physical characteristics of the space by mapping the daily life practices, and create motion diagrams. It is also important to understand the concept of identity, experience and indirect experience of the modern individual and society. On the other hand, Pierre Bourdieu’s concepts of habitus and space are used for the sociological understanding of space; Anthony Giddens to understand the concept, experience and indirect experience of the modern individual and society; that David Harvey (2010) describes the postmodern period to reinforce this; Walter Benjamin’s (2002) concepts and techniques are used to create a critique of modern city and everyday life by making space a vehicle. It is read from the relations of space and capitalism presented by Manfredo Tafuri for the factual understanding of the underlying conditions of spatial production, and the assembly concept of Gilles Deleuze to understand the open space to form.

3 Expected Outcomes

I hope to reveal the effectiveness of the selected transition spaces within the city by investigating the changes in physical characteristics, usage patterns and movement diagrams within their own processes. Here, I describe the activity of this space as a kind of vaccination to the city and investigate the interaction of this space with the city and daily life. Rather than being a template for space design, I aim to diversify the areas of discussion that trigger the design. Passages are used as a tool for grasping the boundary and the boundary as space, and it is desirable to adapt the information obtained in different space typologies.

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**About the Researcher**

Canan Ganiç graduated in 2011 from Istanbul Kültür University, Faculty of Architecture with a first. In 2014, she completed her master’s thesis titled with “Art Spaces’ Relation with Urban Boundary: The Case of Karaköy” at İTU. Between 2014-2017, she participated in architectural design studios with Asst. Prof. Dr. İpek Akpınar at İTU. She took part in the architectural competitions individualistically and with different groups as students and professionals; she won various awards. For 4 years she worked at TEMPO and has been working in Reyhan Ganiç Architecture since 2015. She currently continues her PhD studies at İTU.
PhD Pit-Stop: Aesthetics of Ecological Commitment - A Pragmatic Typology

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Keywords: pragmatic aesthetics; political ecology; material culture; ethnography; counter-culture

1 Introduction

This doctoral research questions the characteristics of aesthetic properties in sustainable design practices. On one hand, in the last forty years, designers have not been immune to normative tools generated by environmental policies. The concept of sustainability has been applied particularly to the choice of materials (Bertrand, Favard & Fel, 2015) with similar aesthetic properties to Modern Movement ones. A significant aesthetic shift was not observed since the ecological turn (Hosey, 2012). The same policies require citizen commitment, building a community between human beings, and also with others, non-humans, for ecology. However, the properties of modern aesthetics are highly criticized to be against these requirements.

On the other hand, criticisms against the Modern Movement and environmentalism showed that ecological commitment can take shape in another aesthetic. The aesthetics of wear and tear, the production process (bodies) and the results (materials), defeats the distinction between nature and culture. Also, the aesthetic properties of ecological alternative initiatives have opposite qualities of those promoted by the principles of Western sustainability. The paradoxes between policy goals and their aesthetic consequences, but also, between norms and counter-culture practices, drive designers to contradictory practice for ecology.

This research postulates that ecological commitment depends on the possibility of an aesthetic of wear and tear -the ability of materials to transform, to age, to show the use process and the passing time. The doctoral project is an attempt to answer the following research question: what kinds of aesthetic properties and aesthetic approaches contribute to ecological commitment through design practice?

1.1 Aesthetics and Ecological Commitment: Key Terms and Concepts

The contemporary conception of the aesthetics is mainly influenced by the field of art, marked, since the Kantian turn, by antirealism and the question of beautiful and sublime (Saito, 2007). However, the practice of design and the ecological issues linked intimately to daily life and action, are not compatible with art-centred aesthetics, its tools, and frameworks (Saito, 2007). With an anthropological approach to aesthetics, from a pragmatist (Dewey,
2010; Sennett, 2010) and a realistic perspective (Rehault, 2009) we can investigate aesthetic issues on design practices and ecological challenges.

Ecological commitment is an action taken by individuals and groups to undo the distinction between nature and culture and to re-establish the continuity between humans and non-humans in a cultural and practical level in order to build an inclusive community. Actions undertaken for ecology touch different spheres of daily life like social, economic, material, consumption, energy-saving, cultural changes, gender equity and so on.

2 Ethnography of Ecological Commitment

2.1 Theoretical Framework and Methodological Approach
To answer those research questions, related to this hypothesis, we identified two theoretical frameworks which enable us study the material components—and more specifically the aesthetic property—of commitment. We combined the pragmatic sociology of Laurent Thevenot (2006) and the anthropology of art of Alfred Gell (2009) to conduct this fieldwork. Both of them treat ethics and aesthetics, humans and non-humans, action and its trace as equals. These theories show that 1) the observations of action and practices allow to identify, 2) the state of material environment and bodies, and then, 3) describe their aesthetics properties. Also, both of them show that this kind of knowledge is not reachable with traditional discursive tools and naked-eye observations. The visual ethnography is the appropriate approach to collect this kind of data. The photography is a form of anthropological knowledge, and a full scientific research tool (Piette, 1996). Its capacity to reproduce a specific moment of empirical reality according to Roland Barthes (1980) gives us the possibility to investigate the aesthetic properties of the collected situation.

2.2 Fieldwork Parameters
We considered concrete utopias as defined by Yona Friedman (2015) as the authentic expression of ecological commitment. We used the literature of utopian studies based mainly on northern western cultures (e.g. Schaer & Sargent, 2000) to identify them. Our selection criteria were 1) an explicit commitment to ecology; 2) established at least one year ago; 3) situated in urban areas, cities with more than two million habitants and a density of more than 4000 persons per one square kilometre. We identified four, non-exclusive, forms of ecological commitment: 1) communities, 2) communitarian houses, 3) groups of persons following the principles of different kind of ecological movement (e.g. degrowth, simple living, zero waste), and 4) individuals who follow YouTube channels, blogs, websites about ecology and improve their ecological print.

The fieldwork includes a self-managed activist squat in Istanbul (Don Kişot), a self-managed cultural and social center in Berlin (ufaFabrik), a self-managed neighbourhood in Copenhagen (Christiania), a communitarian house in Montreal (15 roommates), six persons and two couples following the principles of simple living in Montreal and a self-ethnography performed in the light of ecological practices observed in these fieldworks. The selected twelve cases have some asymmetry. Some are public some private spaces, the observations of bodies, artificial components and activities are not equal. But they are complementary and have some continuity. In this sense, they form a coherent whole as pointed by Jacques Gutwirth (1978).

The ethnography was conducted between 2014 and 2016. The shortest has taken six hours and the longest, sixty hours approximately. We framed our observations with the framework described below without sticking to it. We collected two kinds of data: visual and textual. The photographic data which reproduces the aesthetic properties was contextualized through a field notebook where the researcher recorded her semi-conducted interviews, described her experience, the progress of the day, her impressions, insights, and thoughts about those practices undertaken.

We developed both inductive and deductive methods to analyse the 206 selected photos collected in twelve cases. We first identified the data in which the aesthetics of wear and tear is present, as posited on our hypothesis. Second, we collected the aesthetics properties that every case revealed. Third, we realized a free transversal categorization to reveal other aesthetics features thanks to a global approach to whole data. Finally, the photos played two different roles during the analysing process to identify the aesthetic properties of ecological commitment: a medium to reproduce the empirical reality and mnemonic support to remind the researcher of the aesthetic experience of places and actions. We combined the photographic data to an ethnographic story, based on photographic and textual data for each case. We analysed photos by inspiring us from the photography description proposed by Albert Piette (1996).
AESTHETICS OF ECOLOGICAL COMMITMENT
A pragmatic typology

These thirteen non-exclusive aesthetic properties are connected to each other. Their presence and the possibility of their emergence engage people towards the others, the things, and themselves. They also depend on people commitment. Their engaging agency is its intrinsic ecological properties.

Aesthetics of already there
Assembly, repair, accumulation and overlay

Aesthetics of touch
Being close to things and others (taking care of them)

Aesthetics of temporal mixity
Past, present and future

Aesthetics of slowness
Taking time

Aesthetics of wear and tear
The capacity of bodies and materials to change

Aesthetics of the limit
The border as a tool

Aesthetics of doing
Temporary disorder

Environmental aesthetics
Mixing organic to artificial

Aesthetics of the creative and scriptural gesture
Surfaces as media for expression

Aesthetics of motion
The diversity of gesture and postures

Aesthetics of diversity
Plastic plurality (colors, textures, material, shapes)

Aesthetics of displays
Paper, tape, words

Aesthetics of the community
Presence and plurality of people

Yapruk Hamarat
Ph.D. outcomes - January 2019
Translated (Hamarat, 2019, p.420)

Figure 1. A pragmatic typology of aesthetic properties of ecological commitment (Hamarat, 2019, p. 420).
3 Outcomes

3.1 Research Results: A Pragmatic Typology
Towards an anthropological approach to aesthetics, from a pragmatist and realistic perspective, this research argues that ecological commitment depends on particular aesthetic properties. The results show that the aesthetics of wear and tear is a transversal quality of these environments. It was identified in artificial and natural materiality, but also in gestures and bodies in motion. The analysis also reveals twelve other aesthetic properties crucial to ecological commitment. The results show plastic diversity, gathering people, active and engaged bodies, mixity between organic and artificial, but also between past, present and future material culture and other aesthetic properties. These properties are common qualities of an environment where people are committed to ecology. This knowledge allowed to shape an experimental typology of ecological pragmatic aesthetics with 13 aesthetic properties (see Figure 1).

3.2 Design Education and Politics
This pragmatic typology can be both seen as a reflexive framework to design and an evaluative tool to analyse the aesthetics of the sustainable design. First, the knowledge produced is for designers and other actors of artificial environment producers to improve our production tools, visions and schemes. Second, it allows us to take a critical look at sustainable design practices. It contributes to a richer understanding of ecology and aesthetics, enlightens the oppressive and engaging nature of aesthetic properties. Aesthetics is a lever for social and cultural transformations but it is often driven by ethics. The anthropological dimension of aesthetics is still unrecognized, and the potential of pragmatism and realism are marginal beside the subjective conception of aesthetics. Finally, this work aspires to contribute, on a theoretical level, to the relationship between aesthetics and commitment, and explore the possibility of a policy to drive artificial environment design.

References

About the Researcher

Yaprak Hamarat is a designer researcher who uses ethnographic approaches for social innovation projects in several areas such as ecology, citizenship, urbanity, and recently, digital health and library studies. She studies the anthropological link between aesthetics and politics, develops a pragmatic aesthetics driven design approach to improve ecological and civic commitment. After her studies in arts, product, and transport design, she worked in France and Canada. She held lecturer positions at Université de Montréal (CA) and Université de Nîmes (FR).