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Rethinking pedagogy for iterative design process learning and teaching

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Abstract: *Product Design as an academic discipline is a relative newcomer to higher education. As a result it has had to adapt to the teaching practices and organisation already in place in Universities. However, with the viability of the current business model of higher education under threat from economic pressures, the dominance of established practice could conceivably be challenged, suggesting the time is right for a review of Product Design education as it operates within academia. Product Design educators need to focus on developing an innovative, practical approach to the organisation of learning based on sound design practice-based principles and provide leadership in pedagogy rather than adapting to the pedagogy of others. Design is a unique discipline that can impact on other disciplines as it is necessarily predicated on ideas of leadership and innovation. The role of Product Design in higher education should not deviate from that. Product Design has a real world heritage that is characterised by realistic, considered, innovative thinking. This paper is a reflective opinion piece, suggesting how that thinking could be applied to redress an imbalance in teaching design process to facilitate a more real world experience for the benefit of students and confidence in the discipline as a whole.*

Keywords: Learning spaces, workshop, computer-aided design, integration, pedagogy.

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Introduction

Over the last twenty-five years, Product Design education has graduated from professional training into a recognised academic subject in higher education, but there has been a cost. Design has had to be manipulated to fit with conventions of higher education teaching across traditional disciplines. Project work has been increasingly divided down to fit into a modularised method of teaching whilst design research has skewed from practice-based research towards the study of the ontology of design.

Design, as an applied subject, has its own particular approaches and ideas that underpin professional practice as well as design research, and inform teaching. These approaches and ideas are not common with other disciplines, differentiating it from more established areas of study and research in Universities. However, the pressures to conform to the structure and teaching organisation of these established academic disciplines, and of trying so hard to be taken seriously as a research discipline, have altered the focus and pedagogy of Product Design teaching to the point where it is in danger of losing its identity, as highlighted by Crisp (Crisp: 2011) and argued by Loy (Loy: 2012).

Until recently, this trend looked set to continue with discipline academics advocating the distancing of design from its professional roots to gain acceptance in the more elite higher education establishments, such as the G8 in Australia, but then economic factors intervened. The downturn in the economy in the Western world has re-ignited the need for innovative, effective design professionals to contribute to a manufacturing-based economic drive to move Europe and America out of the recession (for example, Obama investing in additive manufacturing in Ohio as widely reported, for example in Science Magazine in 2012 and the UK government identifying growth in the manufacturing sector as vital for recovery, as discussed in BDO, UK in 2012). Combined with this, has been the uncapping of places in University systems and increased competition to attract students now paying substantially for their education in countries such as the UK and Australia. As a result, graduate destinations are gaining in importance again, in comparison to recent years, and the ability of graduates to work effectively in manufacturing, particularly with new technologies and global markets, is having an impact on the direction of discipline thinking, both in research and teaching.

Overall, it is a good time for a rethink for the discipline. Time to pause in the relentless pursuit of acceptance and conformity in the University education system, and step back from the imposed methods and philosophies of teaching practice that Product Design lecturers have found themselves subject to. Time to re-evaluate the knowledge base of the discipline, the learning priorities for future designers and how these can be best achieved, irrespective of how teaching is organised at the moment in other disciplines. With a strong reiteration of the values and principles of Product Design as a base, approaches to design teaching can be redefined to support the subject, not merely to conform to established practices in higher education teaching, but to lead the way to new practices in learning and teaching in higher education instead of following those that are already in place.

Redesigning Design teaching

Product Design (defined here as the study of problem solving with a focus on production) is a unique discipline. Its challenge is to combine two opposites – art and engineering – and to work with a constantly shifting viewpoint. Successful designers move between creativity and process effortlessly, without allowing one or the other to dominate, throughout every stage of a project. It is recognised in Product Design teaching research that immersive, experiential learning workshops allow the students to emulate this approach and develop strategies for left brain, right brain shifts in thinking whilst mapping, planning and applying problem solving techniques to complex situations. However, this approach does not lend itself to the modular organisation of learning in current, conventional University teaching. Units or courses in a structured undergraduate program taught week-by-week and organised into teaching sessions, subdivided into lectures and tutorials, are the dominant paradigm. Immersive workshops rarely fit. In trying to create a conventional academic discipline out of Product Design, there is a danger of it losing the rigour and integrity of its characteristic project based, client focussed approach.

What if designers were given the rethinking of the teaching of Product Design as a design task? What would be the outcome of initial research? How would the return brief differ for the basic redesign of Product Design University teaching? What would the design intent look like?

The key to effective Product Design teaching is to provide learning opportunities that encourage an iterative design process that moves the student between the objective and subjective, the practical and the theoretical, the imaginative and the critical throughout their work and does not create artificial divides or impose a linear process.

The divisions that generally exist in Product Design education now, are in part due to the convention of allocating specialist-teaching areas along units, rather than across them, with single lecturers responsible for teaching an entire, isolated course within a semester and rarely across courses. By dividing teaching in this way, discipline specialists are inevitably inclined to detach their own teaching focus from the holistic nature of design that is at its core. This can create an imbalance in the design learning experience and allows for specialist areas to develop in ways that are divorced from an applied design thinking approach.

In the drive to understand and pin down design process, both for teaching and for research purposes, there is a danger that the holistic, iterative nature of design practice is reduced to a didactic systematic methodology approach. In addition, by dividing out skills, theory and design studio there is a fragmentation of design process that is difficult for the student to recover from.

Even within a design project based module there is a problem with instilling iterative practice if it is a single course stream within a program as it has little opportunity to build the depth of thinking and iterative research and development needed to give the project experience credibility. Tornado thinking, where a repeated cycle of primary and secondary research, creative thinking and critical evaluation informs design development, moving it towards a conclusion, is based on all aspects of design practice being applied throughout the project, not consecutively but concurrently. To promote this thinking over an entire program, there needs to be a greater awareness of the role of year co-ordinators, stream co-ordinators (who track the revisiting, progression and accumulation of ides and skills vertically through the

degree program), the rethinking of the allocation for specialists to ensure that their expertise is spread across units, rather than delivered in isolation along units of work (a move that also supports research specialisation), the reinforcement of assessment practices that embrace failure as a teaching tool for experimentation (Kelley, Littman, Peter. 2001) and the changing of physical spaces to support positive working practices.

If the basis of inculcating a rigorous, iterative practice is to ensure a holistic approach to project work, then the combining of theory and practice seamlessly to inform thinking is essential in facilitating that combining of opposites – art and engineering – and a constantly shifting viewpoint. To promote the successful movement of designers between creative thinking and practical and research based processes repeatedly throughout the entire project, rather than in lineal stages, means a breaking down of compartmentalised teaching, and a refocus on genuine iterative cycling through 2D and 3D, practical experimentation, lateral thinking and research based informed reasoning all the way through.

Proposed design intent as the basis for the redesign of the University teaching of Product Design:

What – Create situations that enable – ensure - integrated teaching, re-imagine course organisation to promote an iterative, creative, practical, and theoretically informed design process. Create a culture of making based on experimentation throughout project work, break down barriers to integrated learning through making, break down learning silos such as CAD teaching, integrating it into design studio rather than teaching it as a separate set of units.

Why – The basis for Product Design education is to create a constantly shifting viewpoint, an ability to think creatively throughout a project (not just at the beginning), to map and use whatever tools are the best to move a project forward and test its validity (at every stage), to research practically in 3D and using secondary research to inform design development throughout the full distance of the design project – at every stage in every possible way.

How – Reorganise teaching by specialists across courses rather than along them. Facilitate team teaching and the provision of lecturing staff in the role of consultative expert for the students at every stage of a design project, irrespective of a unit structure. Rethink the curriculum to work across specialist areas, not along them. Rethink learning spaces to encourage working across specialist areas for genuine iterative design development – no dedicated computer labs, for example, but rather combined spaces with CAD and advanced technology alongside studio space with easy access to physical workshops that are set up as experimental stations. Break up lecture / tutorial structures where they exist in favour of student centred learning and use blended learning to encourage proactive learners. Create assessment that rewards integrated practices.

Distortion of the balance in learning for Product Design education

Computer Aided Design

The advent of computer-aided design has changed contemporary design practices over the last three decades. The emergence of new technologies has presented additional challenges to design educators wanting to equip graduating design students with the best possible skills to compete in the workplace. Design educators have to evaluate a bewildering array of competing CAD design packages and select the most relevant of these to include in their curriculum. CAD tools are complex and can be slow to master and can take up a significant proportion of a student's time spent in the design education environment. The inclusion of more complex CAD packages and the teaching of these new technologies in the design curriculum have often come at the expense of other more traditional design tools such as workshop activities.

There is an expectation now that all Product Design graduates will have an expertise in 3D digital modelling and this has become a focus in education that is popular with students. Increased confidence and skills in 3D digital modelling is in itself a positive, but stepping back from looking at the skills in isolation, there is a growing danger of a disconnect between screen and design process that is a particular feature of current students. Modern design tools have an ability like never before to present a conceptual idea as a seemingly real product. If these tools are used well it is often nearly impossible to distinguish between a rendering of a concept and a real product itself. So convincing is this technology that companies use it to market products rather than photograph the real product itself. Design educators, as well as students, have to guard against being seduced by the technology and the seemingly miraculous results it turns out and for some students, these results can become an end in themselves, with the presentation of a conceptual design as if it were real. Impressive digital models can become a metaphorical chequered flag for design students at the expense of genuine discovery and design development through more traditional means, such as studio drawing and studio material making, materials and process exploration and working models made for testing.

Screen based games and online social media, such as Facebook, Twitter and You Tube, have led to a generation of students who are increasingly immersed in computer-based activities. They are comfortable in the virtual arena like no generation before them. As Web 2.0 (interactive online media) becomes the dominant paradigm for everyday interaction for this age group, interaction with people and objects in the real world has to compete with those that are web based as even forays into the real world tend now to be expressed through online sharing. With this immersion, there is a danger of a growing disconnect between this age group's abstract view of the world interpreted through the computer screen and their experience of the environment they physically interact with. This possible disconnect has implications for teaching design and for the attitudes and understanding of their interactions as professional designers, where they are likely to be increasingly involved in designing objects in one country and having them made in another. Products that are made in a distant place, in ways that are unseen, as part of a mass production system that seems beyond the control or influence of the individual removes the sense of control of the designer and therefore

the sense of responsibility – both for it being brought into existence and for its fate at the end of life. A lack of understanding of how objects are fundamentally constructed reduces the likelihood that young designers will design for disassembly to allow materials to be reclaimed.

For Product Design students, this disconnect used to be addressed (prior to advanced CAD and the modularisation of university teaching over project based blocks of learning) in their education by hands-on, workshop based project work at each stage of development. In creating a product to a point where it could be readily understood by other people, it was necessary to engage with practical model making, and during that engagement develop an understanding of construction and material properties that informed thinking, design decision making and research planning (Velasquez: 2009, Romiszowski: 2009). This is no longer the case. It is now possible to create 3D digital models to communicate ideas to others that look as if they are fully resolved even if actually they are not. Students are increasingly keen to model their work on screen over producing any physical reality (and increasingly over drawing too), as the results are seductively impressive, even when they are not based on any realistic understanding of what they actually represent.

This is exacerbated in CAD teaching because the conventional lab style layout in CAD rooms has lines of computers, without any facilities for studio drawing or modelling to take place during their use. This reinforces the idea that students can develop their designs on computer without reverting to hand drawing or any form of physical modelling. This is a concern in teaching, as CAD used in isolation can give Product Design students a distorted view of their product ideas. CAD represents a mathematical ideal that cannot exist in reality, for example, where students zoom in on a 3D CAD model to an unrealistic level. A gap of 0.001mm can look like the Grand Canyon as opposed to reality where the gap is infinitely small and beyond any level of tolerance even the most accurate manufacturer can achieve. As part of their education, the students need to learn to fully understand this reality even whilst they utilise the breathtaking capabilities on the software. What does a gap of 0.001mm look like? How does the 1kg of material specified on screen feel like in reality? As teaching becomes more modularised and specialised, with more specialist CAD courses emerging, such as haptics or algorithm based, the relationship of CAD to any design process is further distanced. This trend needs to be reversed for integrated design learning with CAD as an embedded, not separate, process.

Workshop practice.

Workshops in education are increasingly seen as rigid, dangerous places with the growing number of restrictions surrounding their operation, and are expensive to run, but ideally, students should feel as at home in the workshop as they do in the classroom. Students need to spend time in the workshops in order to feel comfortable and at home in that environment, to create confidence so that learning through making becomes second nature. In order to do this, students need be introduced to tools and materials as early as possible in their education and have workshop practice an inherent part of their everyday learning so that this confidence and knowledge can be developed and reflected on by the students in informing decisions. However, workshop practice has become less of a feature of Product Design education with the problems highlighted above and also the growing sophistication of 3D computer modelling. Students increasingly choose to spend their time in CAD labs with traditional workshops seen as antiquated in comparison and only for final model

making, yet, as the principles of the Bauhaus underline, there is value in students interacting with materials in the earliest stages of a project. Alfred Barr, in the preface of his book on the Bauhaus, describes experimentation with materials as -"essential to the student of design experience - at first confined to free experiment and then extended to the practical workshop" (Bayer, Gropius, Gropius: 1972).

Students who are taught 3D digital modelling in isolation from an integrated workshop experience lose the value of a sense of approximation about materials, processes, ergonomics and construction in favour of the perceived levels of accuracy that digital technology offers. Students of the 'computer generations' could potentially begin to see judgments made by their own eyes as somehow inferior to those made through digital technology. This flawed idea should be recognised and challenged in Product Design education to ensure that students have confidence in their own judgements. For Product Design education, creating an enhanced relationship with the physical (and emotional) realities of that world is fundamental to build skills upon. In addition, with regards the CAD / workshop relationship, it is important that both aspects support the value of learning from failure as part of studio project work. With models that require handwork, the models can be a disappointment to students unaccustomed to working with their hands and students are often tempted to ignore these models in favour of models created using CAD technology. Yet as unfinished as these physical models may be, they are where students are really learning about how materials behave, and how difficult it is to manipulate them with any degree of success.

The role of the rounded modern professional designer is to pre-empt or foresee potential problems with individual designs using a combination of experience and knowledge gained through research and experimentation. It is difficult to see how students unfamiliar with manufacturing processes and different materials can successfully design products that contain these very materials.

New technology has become so convincing that it can seduce students into a false confidence about the validity of their design and yet, in contrast, undermine students' confidence in their ability to work through problems through physical experimentation as a tool to assist in the design process. It is unrealistic to substitute free experimentation with materials with a design development process confined to modern technology, as seductive as it is. This experimentation with materials should not be limited to any one stage of the project, with students free to transition between the various learning modes with a minimum of hindrance.

One of the benefits of this transitioning is that it can be used to prevent or break any kind of deadlock the designer may encounter during a project. Changing one tool for another and making progress in another area is often difficult to do but pays dividends. It is often these forays into other areas that can progress a design and are essential for design teaching. Seeing CAD modelling as iterative within a practical design process brings it back into a positive, contributory role in design project work. Equally, the introduction of advanced technology for digital fabrication, where machinery can be placed in a classroom setting and combined with CAD work contributes to breaking down the possible resistance to learning through making that students feel when they have to enter an alien environment to undertake such work.

Creating facilities for supporting iterative design education

Design teaching facilities tend to be physically divided into distinctly separate areas – studio, computer lab, workshop, library and lecture theatre. The first four are all involved in the facilitation of student centred project work (Biggs, Tang: 2007, Aknes: 2004). Transitioning between these areas, however, is not always easy, in part because of University timetabling and the organisation of specialist teaching and in part because the spaces are predominantly designed as dedicated to one specialist area of teaching. For example, University programs invest in high specification computer laboratories that typically consist of rows of screens facing a teaching screen. Rarely are tables included in labs for students to switch between working on screen and working in sketchbooks or on craft models. Even more rarely will a situation exist where students can work seamlessly between lab, studio and workshop. Lecturers must currently choose between a lab environment, studio environment or workshop for their classes. Even if the timetable and demand on spaces allowed all three to be provided for a single course, the likelihood is that they will be located in different parts of a building (for example, workshop on the ground floor, computer labs in a more secure, dust free environment on higher levels) whilst libraries tend to be centralised with no opportunity for lecturers to 'borrow' enough books for a class activity or be near enough to the studio for students to research in as a direct part of the project activity.

If Product Design as a discipline is to take control of its learning paradigm, this separation needs to be challenged to promote genuine, integrated learning opportunities for the students and break down the idea that these activities can be learned and applied in isolation. The four areas of studio, CAD lab, workshop and library need to be brought together into a new space for teaching design where students can transition seamlessly between them all. Without it, students will tend to view each learning area in isolation and not carry their understandings between them.

Using assessment as a tool for changing practice

The assessment challenge for design educators is to not only organise specialist teaching across courses for an integrated design learning experience, but to create assessment that equally supports that integration, rebalancing the design process, encouraging learning through making and away from instant design resolution (Harman, McDowell: 2011, Eshun, Graft-Johnson: 2011).

The design process is described and documented (Popovic: 2004], as a combination of problem solving and reflective practice. A vital part of this design process is having ongoing progress to reflect upon and students and professional designers alike can be at a loss for inspiration, feeling they have to complete one process before moving onto the next. The benefit for students in integrated learning is that students learn to move freely between modes and media.

In contrast to practices in a linear, progressive model of a project's development, workshop activities in a tornado thinking, integrated approach to design should not be restricted to the latter stages of a project but rather should be introduced at the outset to expose students to a culture of making and experimentation. Instead of adhering to traditional models of industrial practice, learning through making should be a significant learning part of a much more holistic

process with students being free to move between workshop and studio, with activities between these places to be much more integrated.

The challenge presented to design educators is how, in the light of these difficulties, to re-integrate and encourage learning through making and shift the emphasis of assessment to reflect the importance of that learning through making, and away from 'instant', visualisation based, design resolution.

Assessment needs to be managed so that the vital nature of learning through making can be brought to the fore as an inseparable part of the design process. To do this, the assessment model must move the emphasis from 'finished' objects and the idea of 'completely resolved' designs, towards a weighting that rewards learning through experimentation. Assessment tasks that promote engagement of materials outside their traditional uses would be an example of how to foster a culture of making and experimentation. The expectation that students can learn about how materials react when manipulated based on research theory is akin to teaching someone to learn to swim in a classroom. First-hand knowledge of the type gained through repeated exposure to materials and tools is vital for this type of knowledge to take root. Rather than reducing students' time spent in the workshop, an integrated learning experience should be in place that increases it and promotes a 'culture of making' with students confident in their ability to make and design.

Typically current Product Design students explore ideas and develop designs through sketching and move directly from sketching into CAD where designs are resolved to a level where they can be rendered for presentation and final submission. The emphasis of student design work tends to be on presentation for final submission rather than on genuine evaluation through rough modelling and testing of design ideas through making. In design education concept books have been used a means to show evidence of the importance of the design process and to shift some of the emphasis from the outcome itself. Photographic documentation can also be used to show evidence of iterative models and testing through making. What are necessary are better ways to celebrate and reward the lessons learned through repeated failures, particularly when a final outcome has not been reached. In addition, assessment should support the uncertainty and effort that students would have to embrace to move between studio, computer based work, workshop and library research more seamlessly than specialist units of learning currently allows. This reorganisation of assessment would involve specialists contributing to marking combined assessment matrices. This would bring its own challenges but should ensure a more effectively moderated assessment model.

Conclusion

Product Design in academia has a small window of opportunity to take advantage of the current academic climate to wrest control of the subject from dominant, more established disciplines and their practices. Instead of focussing on selling design principles and practices into other disciplines, Product Design educators need to focus on building a stronger foundation for the future of the discipline within academia so that it does not gradually become diluted and eventually lost. The way to do this is through a practical approach to the organisation of learning based on sound design practice principles developed in the industry based subject and provide leadership in pedagogy rather than adopting and adapting to the pedagogy of others. Design is a unique discipline that can impact all other disciplines, it is necessarily

predicated on ideas of leadership and innovation. The role of Product Design in higher education should not deviate from that. University education is floundering in a mire of past practice that is holding it back from responding to the real world needs that are impacting its economic viability. Product Design should be proud of its real world heritage and realistic, considered, innovative thinking and apply it to its own practice in education to lead the way to new practices and new approaches.

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