Nov 17th, 12:00 AM

Designerly Research: Towards Design's Own Research Paradigm.

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Design research draws on different research paradigms from both the sciences and the humanities. Two empirical works about design research at the doctoral level demonstrated the emergence of a research paradigm distinct from research in the sciences and the humanities.

The first empirical work was a comparative study of ten Ph.D. programmes in design. The selected cases were from different geographical-cultural contexts. The study of each case was divided into three parts: the study of the programme, the study of a selected Ph.D. thesis and an interview with the coordinator of the programme or with a Ph.D. supervisor.

The second empirical work was the study of thirteen research cases that included design project(s). The cases were selected from Ph.D. programmes that permitted the inclusion of design project(s) as an integral part of the research. The study of each case was divided into two parts. The first part was the study of the thesis. The second part was the study of the research process. In the second part of the study a visual method was adopted. The participants were asked to represent their research processes and results in a structural schema.

The main findings demonstrated the existence of different aspects in some of the selected cases that distinguished design research from research in the sciences and the humanities. These aspects were: the process developed for the definition of the research problem/question; the nature of the research process which was solution-focused rather than problem-solving; the abductive and constructive thinking that guided the progress of the research; the combination of design project(s) and empirical works as a part of the methodology of the research; and the different kinds of knowledge developed.

In this paper I will discuss these main findings about the characteristics of an emergent paradigm in design research, a designerly research paradigm, based on the results of the two empirical works.

DESIGNERLY RESEARCH: TOWARDS DESIGN'S OWN RESEARCH PARADIGM

Current State of Design Research

The state of research in any area of study can be judged through the body of knowledge that has been produced and published in that area (Archer, 1981; Cross, 1999a; Findeli, 2001). Archer (1981) commented on the result of a study about design literature developed at the Royal College of Art: "It is sometimes argued that a test of the existence of a distinctive discipline is the presence of an organised literature containing all the essential ideas in that discipline such that a suitably qualified entrant to the discipline can master its content without depending on the literature of other disciplines. By this test, Design Research is not yet a distinctive discipline."[1]

Almost two decades after, in an article about design research, Cross (1999a) declared: "Design research is alive and well, and living in an increasing number of places. I find encouraging evidence for this the growth of research-based journals in the design world over the last ten to fifteen years. […]. Compared with the academic design scene in the 1970s, we now have a rich culture in which to grow our design research seedlings."[2]

The statement of Cross (1999a) was sustained two years later by Findeli (2001) and Buchanan (2001). Findeli (2001) argued, in an article about design education, that a look at the recent literature in design could be enough to reach the conclusion that the general design landscape[3] is safe, quiet and serene. Buchanan (2001) stated, in a brief report about the *Doctoral Education in Design* conference held in October 1998 at Ohio, that "design has reached a watershed moment in its development as a field of inquiry."

Current State of Doctoral Research in Design[4]

Design research is mainly practiced in two different contexts, in professional practice and in the academic environment (Roth, 1999). In the academic environment design research takes place within graduate programmes, research programmes, units of research, laboratories, etc. The focus in this paper is on doctoral research in design.

Recent years have witnessed a rapid development in doctoral education in design worldwide (Durling and Friedman, 2000). Doctoral research in design is therefore regarded as a young field of inquiry relative to other doctorates in already established disciplines with long histories of research tradition. Discussions and debates about doctoral research in design are a recent phenomenon. The first international conference *Doctoral Education in Design* took place in the autumn of 1998 at the Ohio State University. The intention of its organisers, was to initiate a discourse on doctorates in design (Durling, 2003). The second international conference *Doctoral Education in Design: Foundations for the Future* was held in 2000 at La Clusaz in France. The third *Doctoral Education in Design* conference was held in 2003 in Tsukuba in Japan. While these three conferences focused on doctoral education in design, the general topic of design research has been a central theme in many research-based design journals and in many international design conferences held in the past few years.

The nature of doctoral research in design was among the central themes discussed in the conferences cited above. It is evident that a coherent picture of the nature of the Ph.D. in design, how it operates in different contexts and how it is related to existing Ph.D.s in other fields of study does not exist, but different perspectives do exist. In fact, in his keynote address to the first *Doctoral Education in Design* international conference held in 1998 at Ohio, Buchanan (1999) posited the question: "Should the doctorate in design be modelled

on the traditionally established doctorates in other fields, or should it be shaped in a new way that may better serve the future of design?"

A year later, in the introduction to the special issue of *Design Issues* dedicated to design research, Findeli (1999) declared that the purpose of that special issue was to seek and explore some additional answers to the question: "Do the design disciplines have a scientific and / or academic status of their own, distinct enough from other disciplines to require and justify the use of specific methodologies when carrying out design research? In other words, we questioned the possibilities, the necessity, or the relevancy, for design to develop original methods for research without loosing sight of its claim for scientificity, i.e. for yielding what Pierre Bourdieu calls 'an explicit and systemic knowledge'."

This question was originally raised during the international conference *No Guru, No Method* held in Helsinki in 1996. The questions raised by Buchanan (1999) and Findeli (1999) were very similar, but formulated in different ways. The claim for an approach to doctoral research in design distinct from existing approaches in other fields of study is the main issue addressed in this paper. To address this question, it is first necessary to articulate an in-depth understanding of the existing approaches to doctoral research in design.

Methodological Approach

Two different strategies of inquiry have been adopted for the empirical part. The first one is the comparison of case studies of ten Ph.D. programmes in design selected from different geographical-cultural contexts. The second one is the comparison of thirteen research cases including design projects. The combination of a literature review and the empirical works constituted the methodological approach of the research, and the movement back and forth between the theoretical analyses and the empirical ones guided the research process.

Case studies of Ph.D. programmes in design[5]

Criteria for the Selection of the Programmes

A widespread view of the current state of doctoral education in design necessitated the selection of Ph.D. programmes from different geographical-cultural contexts. The contexts where a considerable number of graduate programmes in design were found were taken into consideration: northern America, Asia, Australia and Europe[6]. The number of selected universities in a particular country depended on the average number of Ph.D. programmes in design offered in that country[7] (see table 1). Another criterion for the selection of the programmes was the consideration of the best practices[8] in doctoral education in design.

	1 < n < 5	5 < n < 10	n > 10
Canada	■		
U.S.A.		■	
Japan		■	
Australia		■	
France	■		
Germany	■		
Great Britain			■
Italy	■		

Table 1. The approximate number (n) of Ph.D. programmes in design in relative countries.

Structure of the Case Study
Each case study was divided into three parts[9]. The first part was the study of the Ph.D. programme: entry requirements, period of study, curriculum (philosophy, intention, content and sequence of study), research (areas of research, groups/units of research and research phases) and people involved. The second part was the study of a selected Ph.D. thesis: structure of the thesis, motivation, aims of the study, methodology, results and contribution. The third part was the development of an unstructured open interview with the coordinator of the Ph.D. programme or with one of the doctoral supervisors.

Case Studies of Research Processes Including Design Projects[10]

Criteria for the Selection of the Cases
The first criterion was the selection of different geographical-cultural contexts for the development of the study, which were the same as the first empirical work. The second criterion was, obviously, the selection of Ph.D. programmes in design that permitted the inclusion of design project(s) or a practice component within the research. Finally, the criterion for the selection of the research cases from each programme was restricted for a practical reason, which was the limitation in the number of available cases. This was due to the fact that including design project(s) within the research process is an approach only recently adopted by Ph.D. programmes, with only very few exceptions[11].

Description of the Method
The method used for the second empirical work was the visual representation of the research process. Participants were asked to represent in a structured schema the phases of their research processes following a chronological order (see figure 1). The use of visual representations as a method of research has a very long tradition in research into design thinking (Cross, 1999b; Dorner, 1998, 1999; Lawson, 1979, 1980; Oxman, 1994, 1996, 1997, 1999; etc). The main tools used for such representations were schemas, sketches, drawings, and techniques such as models and CAD (ibid.).

Among the cognitive theories which emphasize and exploit the approach of visual representation of processes , Oxman (1999) refers to the theories of “creative cognition” (Finke, Ward and Smith, 1992) and the theory of “representation-redescription” (Karmiloff-Smith, 1995). In the former, the emphasis is on the interaction between visual and conceptual content in characteristic strategies in design thinking. In the latter, the emphasis is on the conscious construction and exploration of the cognitive structures of schema (Oxman, 1999).

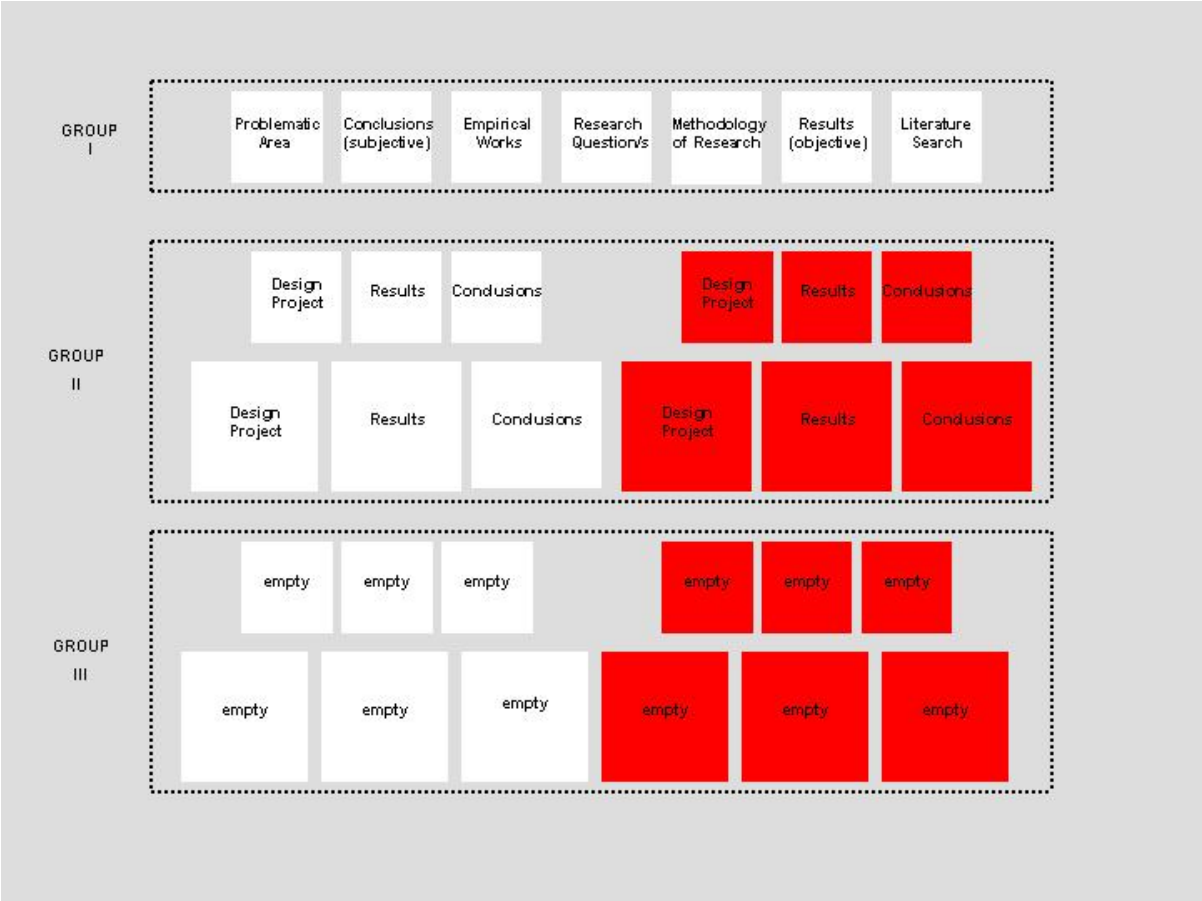

Figure 1. The blocks to be used for the representation of the research process.

Data Collection and Evaluation

in the second empirical work the study of thirteen cases in order to develop generalizations presented a limitation for the research. In similar design research situations (Badke-Schaub and Frankenberger, 1997; Dorner, 1998; Dorner, 1999; Oxman, 1999), different strategies were framed to "[…] reveal what is specific for one individual and what is not." (Dorner, 1999). The strategy framed for this empirical work was that only visual representations which were found similar in more than one case were taken into consideration for further understanding and generalizations.

Three Approaches for Design Research

The analysis of the data collected during the empirical works sustained and brought more depth to the idea of the existence of a plurality of approaches to doctoral research in design. Taking into consideration the philosophical assumptions underlying these programmes, three major approaches were identified: the sciences and humanities research approaches, the "practice-based approach" and the "practice-centred approach" (see table 2).

	Sciences and Humanities Approaches	Practice-Based Approach	Practice-Centred Approach
Univ. of Alberta			
MIT			
Chiba Univ.			
Univ. of Sydney			
ENSAM Paris			
Univ. of Wuppertal			
Open Univ.			
Royal College of Art			
Sheffield Hallam Univ.			
Politecnico di Milano			

Table 2. Research approaches adopted by the selected Ph.D. programmes in design.

The Sciences and Humanities Research approaches

The sciences and humanities research approaches were the only accepted approaches to doctoral research in five of the ten Ph.D. programmes (see table 2). It is the systematic and methodical approach to research. This is research done according to an established plan or procedure, and dominated either by the sciences research culture or by the humanities research culture. In the sciences, understanding is based on observation, measurement, the formulation of hypothesis and testing of theory by further observation or experiment (Archer, 1979). In humanities, understanding is based on contemplation, criticism, evaluation and discourse (ibid.).

The research processes were articulated in the sequence of the following phases: description of the problematic area or the research topic; articulation of a research question or a particular interest; development of a review of literature; framing of the methodological approach; application of the methodology; presentation of the results; articulation of the discussion; statement of the research contributions; the proposal of future work. Different strategies were adopted during the research processes, such as the case study, the historical approach, protocol analysis and ethnography. A variety of qualitative and/or quantitative methods was used in each strategy of research.

The Practice-Based Approach[12]

A practice-based approach to doctoral research in design was identified in the cases where the development of design projects was considered, not as the objective of the research, but as an integral part of the process. The main characteristic of this approach was the built-in flexibility of the process, since there was no commitment to a rigid plan or procedure of research. Instead, a path of discovery through design practice was followed in seeking new understanding.

In the studied practice-based Ph.D. theses, action research underpinned and guided the research processes. Unlike action research as developed in qualitative research settings, in the studied cases the 'action' took place through the development of design projects[13] that resulted in conceptual or working prototypes. These projects were considered as a terrain or source that informed understanding and guided the evolution of the research process. This approach was applied in situated research settings requiring flexibility, intentionality, responsiveness, interventions and participation, in order to deal with fuzzy research questions. Research processes were iterative, reflective, interpretive and dialectical.

Permanent constructions took place between the researcher and the evolving research situations. These constructions were the guiding force of the research process. This kind of research process is mainly based (Avenier and Nourry, 1999) on a logic of "interactive

rationality" (Ponssard, 1989), a "principle of incompletion" (Hatchuel, 1994), and an "interactionist conception of communication" (Giordano, 1997). In some cases one project was undertaken, in others a series of projects was developed. The combinations of different research phases with design projects resulted in three different kinds of research processes: linear processes, parallel processes and cyclic processes (see figures 2, 3 and 4).

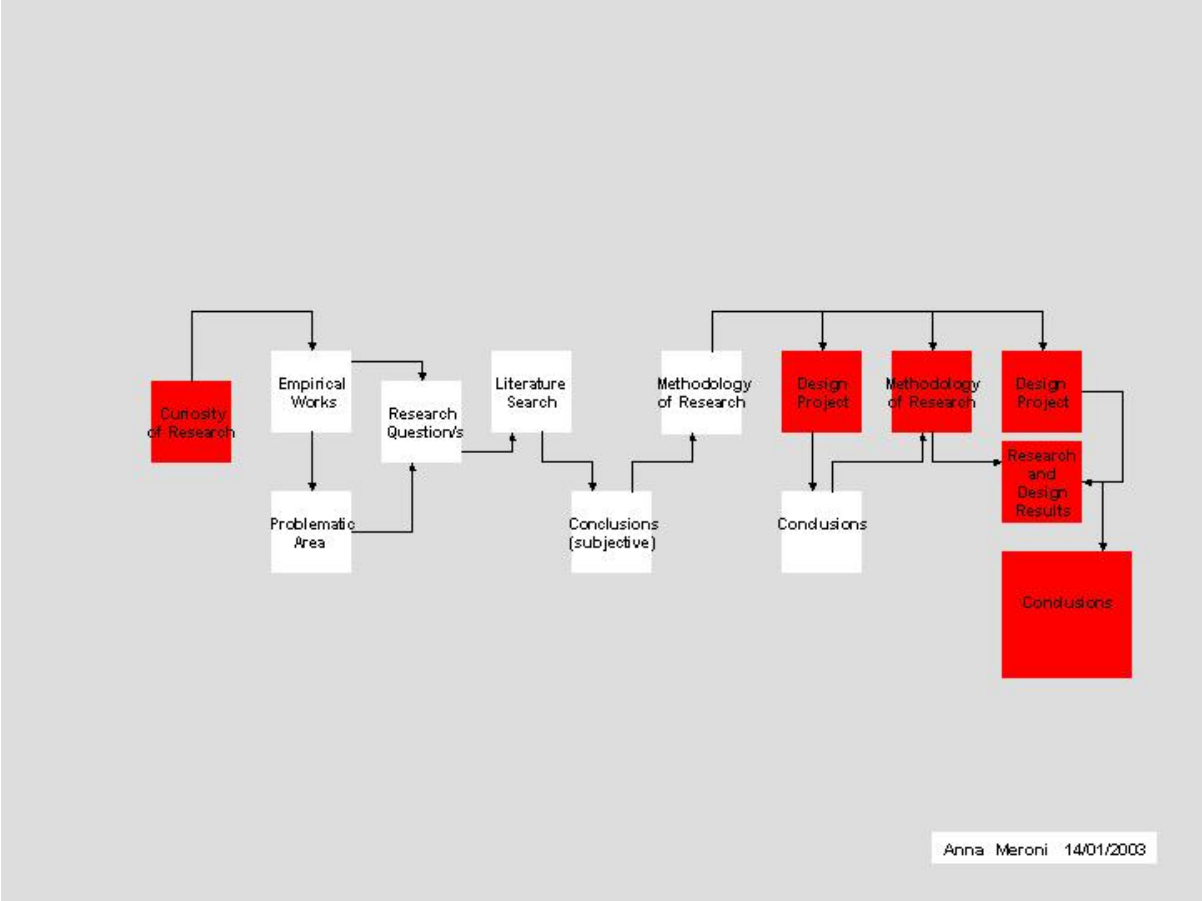

Figure 2. Schematic representation of a linear research process (Meroni, 2003).

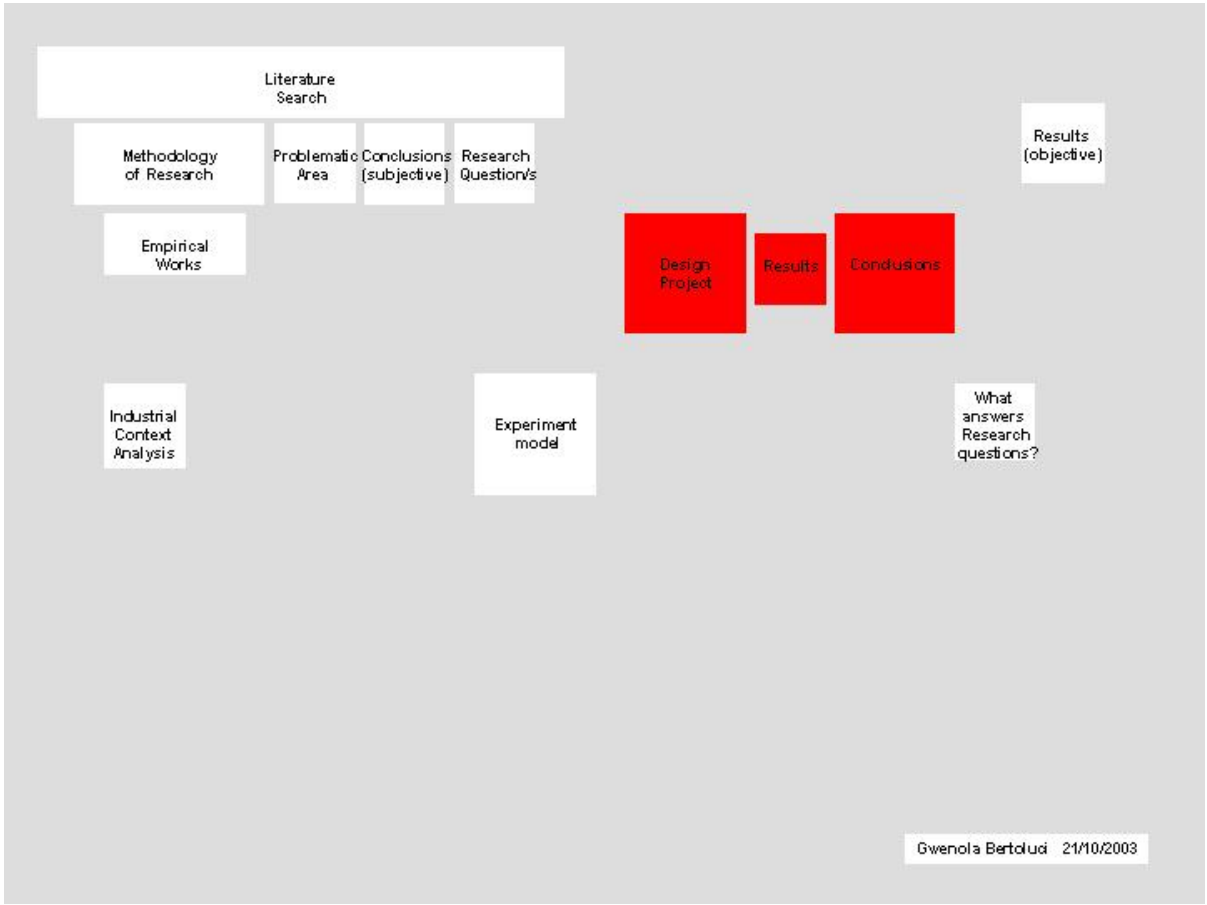

Figure 3. Schematic representation of a parallel research process (Bertoluci, 2003).

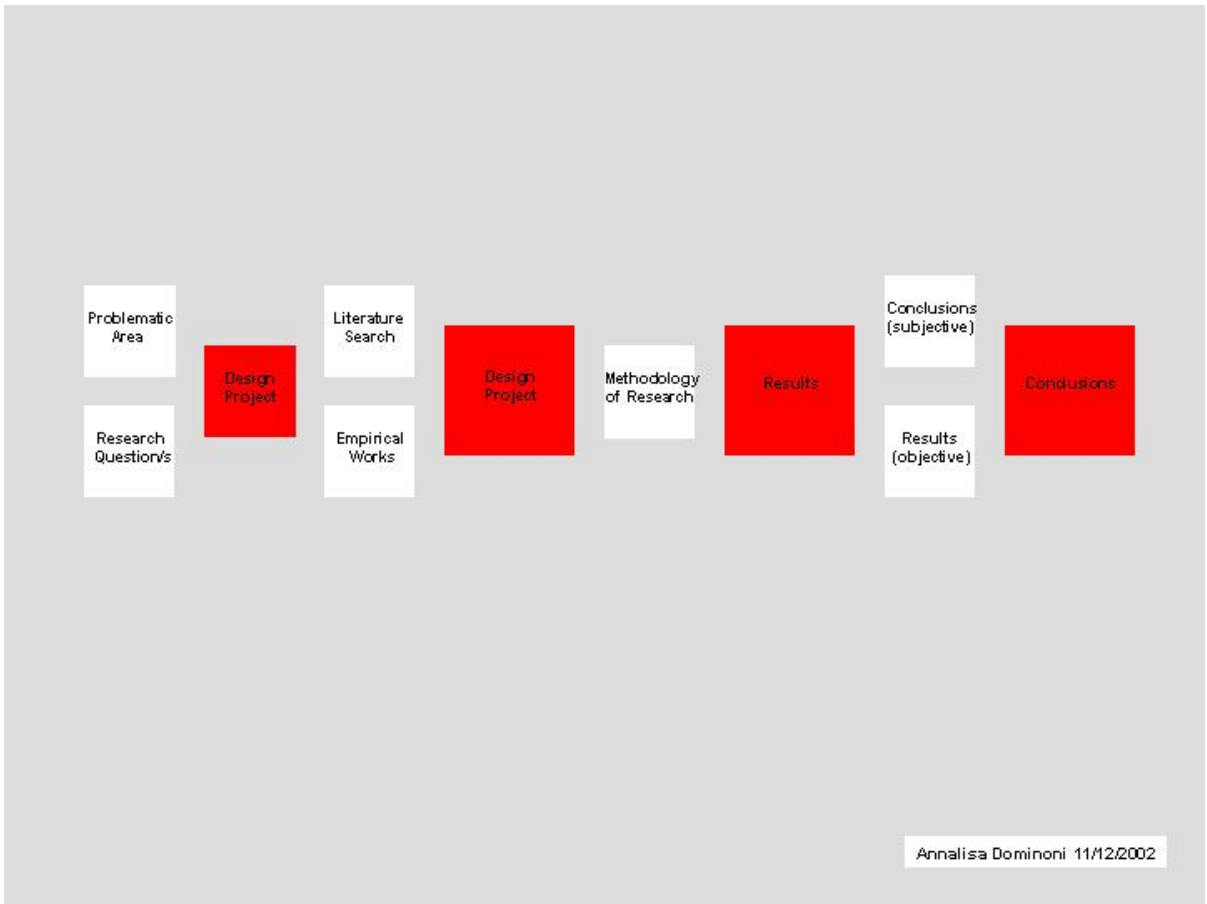

Figure 4. Schematic representation of a cyclic research process (Jacqueson, 2003).

The Practice-Centred approach[14]
In this recent approach to doctoral research in design, the development of advanced design project(s) was considered as a form of research. Therefore the product(s) development phases constituted the doctoral research processes. These processes were articulated in different ways, depending on the design area concerned and the prototypes to be developed. What was common in the three studied cases was the procedure underlying the processes of prototype development. This procedure followed the sequence: analysis, synthesis, concept, development and the evaluation. The methods used were also relative to the particular areas of design practice involved.

About the problems related to this approach, Findeli (2000) states: "It has no scientific recognition (and this, in my view, is justified), since there is usually no discourse attached to it, no intention of generalisability except technological, and no 'accumulative' effect in the theoretical realm (theory building is not its goal)." This approach to doctoral research in design represents the most debated and criticised one.

Towards Design's Own Research Paradigm
Many authors have attempted, in different ways, to articulate and justify an approach to design research 'grounded' in design practice (Davis, 2003; Dominoni and Trabucco, 2000; Findeli, 1999, 2000b, 2001; Findeli and De Coninck, 2002; Franz, 2000; Glanville and van Schaik, 2003; Hummels and Overbeeke, 2000; Newton and Marshall, 2000; Seago and Dunne, 1999; Sevaldson, 2000; Sheth, 2000; Yammiyavar, 2000; etc.). The two empirical works revealed that a very similar approach to design research is already practiced in several Ph.D. programmes. It was entitled "*recherche-projet*" at the University of Montreal, "*ricerca progettuale*" at the *Politecnico di Milano*, "Ph.D. by project" at the Royal College of Art, etc. It was referred to in this paper by the term "practice-based approach".

The second empirical work contributed to a better understanding of the underlying principles and characteristics of the practice-based approach to doctoral research in design. These had many similarities with the main aspects of the "designerly ways of knowing" (Cross, 1982): "designers tackle 'ill-defined' problems; their mode of problem-solving is 'solution-focused'; their mode of thinking is 'constructive'; they use 'codes' that translate abstract requirements into concrete objects; they use these codes to both 'read' and 'write' in 'object languages'", and the "designerly mode of inquiry" (Archer, 1981): "The idea that there exists a designerly mode of inquiry, comparable with but distinct from, the scientific and scholarly modes of enquiry seems to be defensible […]. Design, like Science, is a way of looking at the world and imposing structure upon it. Design, then can extend to any phenomenon to which we wish to pay designerly attention, just as Science can extend to any phenomenon to which we wish to pay scientific attention." The following are among these similarities:

"Designers tackle 'ill-defined' problems" (Cross, 1982)
One of the aspects of "the designerly ways of knowing" is tackling 'ill-defined' problems (Cross, 1982). The studied Ph.D. cases, which adopted the practice-based approach for doctoral research in design, involved dealing with 'fuzzy' research problems. These problems were very specific, and depended on particular research situations. Their definition necessitated the development of different 'actions' (see figure 5). An 'ill-defined' problem could be considered as a 'fuzzy' problem and vice versa, since their characteristics are similar to what is commonly known as "wicked problems"[15].

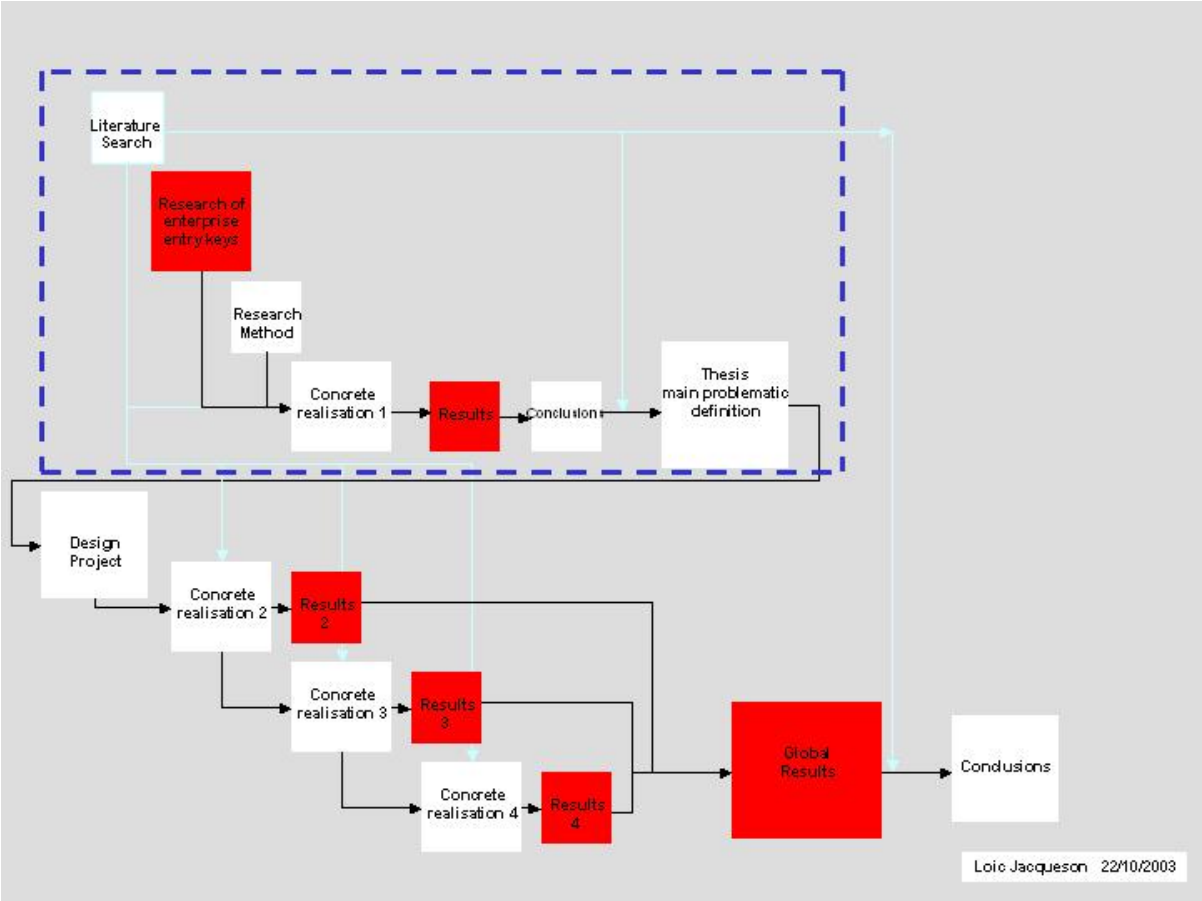

Figure 5. Schematic representation of the research phases related to the problem definition (Jacqueson, 2003).

"Their mode of problem-solving is 'solution-focused'" (Cross, 1982)
Another aspect of "the designerly ways of knowing" is that the mode of problem-solving is 'solution-focused' (Cross, 1982). The studied research processes, which adopted the practice-based approach to research, did not focus on verifying a specific hypothesis or on answering a basic research question. In these research settings, the focus was on dealing with fuzzy problems. Once these fuzzy problems became less fuzzy, through the research process, the latter shifted towards reaching a better situation as a 'plausible' solution. In other words, instead of focusing the research on the analytical in-depth study of the nature of the problem, they tried to discover the nature of the problem by experimenting different solutions through design projects.

"Their mode of thinking is 'constructive'" (Cross, 1982)
The designerly ways of knowing were also characterised by a 'constructive' mode of thinking. In the practice-based approach action research underpinned and guided the research processes. 'Action' took place through the development of different kinds of design projects, which were considered a terrain or source that informed understanding and guided the evolution of the research process. Permanent constructions occurred between the researcher and the evolving context situations. These constructions were the guiding force of the research process. These situations required flexibility, intentionality, responsiveness, interventions and participation. Research processes were iterative, reflective, interpretive and dialectical. In these research settings, the kind of thinking is mainly 'constructive.' Constructive thinking is distinct from inductive and deductive kinds of reasoning, and is related to 'abductive' reasoning[16] according to Cross (1982).

“They use ‘codes’ that translate abstract requirements into concrete objects”
“They use these codes to both ‘read’ and ‘write’ in ‘object languages’” (Cross, 1982)
A pattern-constructing feature has been recognised at the core of design activity, (Archer, 1979, 1981; Alexander, 1964; Alexander et al, 1979; Cross, 1982; Hillier and Leaman, 1976; Levin, 1966), a kind of learning to think in a “sketch like form” (Cross, 1982) where abstract requirements are turned into concrete objects. This pattern-constructing feature has been referred to as a kind of code[17] (Cross, 1982; Hillier and Leaman, 1976) that enables designers to translate individual, organisational and social needs into physical artefacts. Archer (1979, 1981) refers to it as a modelling medium in design, distinct from notation in science and language in humanities.

This characteristic of the designerly ways of knowing was also found in the practice-based approach to design research. In these research settings the development of different kinds of projects was not the objective of the research. On the one hand, these projects were used to translate the requirements derived from particular individual, organisational or social situations into conceptual or working prototypes. On the other hand, these design projects were used for the embodiments of ‘messages’ in conceptual or working prototypes.

“[…] there exists a designerly mode of inquiry, comparable with but distinct from, the scientific and scholarly modes of enquiry […].” (Archer, 1981)
Therefore, it could be argued that the practice-based approach to design research is leading towards the definition and articulation of a kind of designerly research which is different from research in the sciences or the humanities since it advances knowledge partly by means of design practice. In this kind of research a designerly attention was given to different represented phenomena. Design projects constituted an integral part of the research process, and were used to capture, analyse, explore and transmit ideas through sensibility, invention, validation and implementation. Abductive thinking underpinned and guided the research process, the aim of which was not to test a hypothesis, to answer a research question or to discover some reality, but to invent ‘plausible ideas’ of represented phenomena though design practice.

Notes

1. The study was published as an appendix to the paper "A view of the nature of design research" presented by Bruce Archer in 1980 at the *Design: Science: Method* conference. The study was developed by Dr. Sebastian G. Lera. The sources were of two kinds: bibliographies and abstracts indexes. He referred mostly to publications in English of the period 1970-1980. Refer to: Archer, B., 1981. A view of the nature of design research. *In*: J. Robin and J. A. Powell, eds. *Design: Science: Method. The Design Research Society Conference, Portsmouth, 1980.* Guilford, United Kingdom: Westbury House, pp 30-47.

2. Refer to the article: "Design research: a disciplined conversation", published on a special issue of *Design Issues*, which was dedicated to design research, volume 15, number 2, pp 5-10.

3. The author meant by "design landscape": design education, design practice and design research, as he specified later in the same paragraph, p 5. Refer to: Findeli, A., 2001. Rethinking design education for the 21st century: theoretical, methodological, and ethical discussion. *Design Issues*, volume 17, number 1, pp 5-17.

4. The focus on this paper is on the Ph.D. degree based on supervised research in programmes which might include a taught component. Other forms of doctoral education, such as the Ph.D. by Publication and the Professional Doctorate, were not subject to this inquiry.

5. The selected Ph.D. programmes were:

- From northern America: In Canada, the University of Alberta (case 01), the doctoral programme in *Art and Design*; In the United States of America, the Massachusetts Institute of Technology (case 02), the doctoral programme in *Design and Computation*;
- From Asia: In Japan, Chiba University (case 03), the doctoral programme in *Science of Design and Architecture*;
- From Australia, the University of Sydney (case 04), the doctoral programme in *Design Computing and Cognition*;
- From Europe: In France, *the Ecole Nationale Supérieure des Arts et Métier Paris* (case 05), the doctoral programme in *Conception de Produits Nouveaux*; In Germany, the University of Wuppertal (case 06), the doctoral programme in *Computational Design*; In Great Britain, the Open University (case 07), the doctoral programme in *Design and Innovation*; the Royal College of Art (case 08), the doctoral programme in *Interaction Design*; and Sheffield Hallam University (case 09), the doctoral programme in *Art and Design*; In Italy, the *Politecnico di Milano* (case 10), the doctoral programme in *Industrial Design and Multimedia Communication*.

6. An unpublished research developed by the author in 1999 at the *Politecnico di Milano*, focused on the mapping of undergraduate and postgraduate design programmes offered in different geographical-cultural contexts. One of the results of the study was that the majority of Ph.D. programmes in design were found in northern America, Australia, Europe and Japan, and that most of these programmes were launched during the 1990s

7. In the countries where there was no clear idea about the number of Ph.D. programmes, the interviewed professors provided an approximate number. This was the case in Canada, Japan and Germany. One university was selected from each country with an exception of three universities from Great Britain.

8. Individuating the best practice in doctoral education in design was approached in various ways in the selected countries. In Britain for example, the selection was based on the results of the official national assessment of research, the 2001 Research Assessment Exercise; In the U.S.A., the Ph.D. programmes offered at the Massachusetts Institute of Technology are without a doubt among the country's best practices in Ph.D. education. It is the same for the selected Ph.D. from Chiba University in Japan and the one from the *Politecnico di Milano* in Italy. In other contexts the Ph.D. programmes were selected for their good reputation, which depended in some cases on the important number of Ph.D. candidates and Ph.D. graduates, in other cases on faculty members very well known for their contributions to the design discipline.

9. For a detailed description of the structure and content of the case studies and the detailed results, refer to: Saikaly, F., 2003. Design re-thinking: some issues about doctoral programmes in design. *In*: *5th European Academy of Design Conference: Techne: Design Wisdom, Barcelona 28-30 April 2003*. The paper can be accessed on: http://www.ub.es/5ead

10. The selected cases were:

- Marchand, A., 2003. *Bionique en Design: Approche Revisitée et Perspectives Nouvelles*. M.Sc. thesis. University of Montreal;
- Bertoluci, G., 2001. *Proposition d'une Méthode d'Amélioration de la Cohérence des Processus Industriels*. Ph.D. thesis, ENSAM Paris;
- Jacqueson, L., 2002. *Integration de l'Environnement en Entreprise: Proposition d'un Outil de Pilotage du Processus de Création de Connaissances Environnementales*. Ph.D. thesis, ENSAM Paris;
- Leborgne, C., 2001. *Proposition d'une Démarche Anthropocentrée de Conception de Produits Nouveaux Basée sur l'Usage et Destinée à une Meilleure Intégration, par l'Ergonome, des Besoins et des Attentes des Usagers*. Ph.D. thesis, ENSAM Paris;
- Nouiga, M., 2003. *La Conduite du Changement par la Qualité dans un Contexte Socioculturel. Essai de Modélisation Systémique et Application à l'Entreprise Marocaine*. Ph.D. thesis, ENSAM Paris;
- Ollendorff, C., 1999. *Construction d'un Diagnostic Complexe d'une Bibliothèque Académique*. Ph.D. thesis, ENSAM Paris;
- Swinford, R., 2004. *Personal Communication Devices. Realising the Extensions of Man*. M.Phil. thesis, Royal College of Art;
- Whiteley, Graham Paul, 2000. *An Articulated Skeletal Analogy of the Human Upper-Limb*. Ph.D. thesis, Sheffield Hallam University;
- Dominoni, Annalisa, 2001. Disegno Industriale per la Progettazione Spaziale. Ph.D. thesis, Politecnico di Milano;
- Faicchia, Mario, 2002. *Weightless Projects. Projects for Space*. Ph.D. thesis, Politecnico di Milano;
- Ingaramo, Matteo, 2002. *Lo Sviluppo delle Attrezzature per il Lavoro Intellettuale: un Percorso di Ricerca Progettuale tra Metodo e Pratica*. Ph.D. thesis, Politecnico di Milano;
- Meroni, Anna, 2000. *Il Cibo Disegnato. Un Nuovo Ambito Disciplinare per il Disegno Iindustriale*. Ph.D. thesis, Politecnico di Milano;
- Palmieri, Stefania, 2001. *Progettare con il Cliente. Nuove Modalità di Interazione con il Cliente nei Processi Progettuali*. Ph.D. thesis, Politecnico di Milano.

11. For example, the doctoral programme *Conception de Produits Nouveaux* of the *Ecole Nationale Supérieure des Arts et Métiers Paris*, in which all the doctoral research has had a practice component since the programme started in 1982.

12. This approach to doctoral research has been given various names by different universities and organisations. It was first identified and defined by research councils and higher education councils in both Great Britain and Australia as “practice-based doctorate”. This was the motivation for using this term in this paper. Two of the thirteen cases were considered practice-centred research, since design practice was considered as a form of research (Whiteley, 2000; Faicchia, 2002). In one case, even though a design project was included in the research, the latter was based on the scientific approach, and the design project was considered as a site for the application of the research (Palmieri, 2001). The ten other cases were practice-based research (Marchand, 2002; Bertoluci, 2001; Jacqueson,2002; Leborgne,2001; Nouiga,2003; Ollendorff, 1999; Swinford, 2004; Dominoni, 2001; Ingaramo, 2002; Meroni, 2000).

13. By design projects the development of conceptual or working prototypes, design methods or design tools is intended.

14. The term “practice-centred approach” was used in this paper with reference to the *Art and Design Research Centre* from Sheffield Hallam University, a pioneering centre in this approach to doctoral research in design.

15. According to Broadbent (2002), wicked problems is a term borrowed from Popper and re-contextualised by Rittel in the mid-1960s. For more details, refer to the paper: Broadbent, J., 2002. Generations in design methodology. *In*: D. Durling and J. Shackleton, eds. *Common Ground: Design Research Society International Conference, London, United Kingdom, 5-7 September 2002*. Great Britain: Staffordshire University Press, p 6.

16. Cross (1982) quoted March (1976) who argues that constructive thinking is related to what Charles S. Pierce called ‘abductive’ reasoning and not to deductive and inductive reasoning. Refer to: March, L. J., 1976. The logic of design and the question of value. *In*: L. J. March, ed. *The Architecture of Form*. United Kingdom: Cambridge University Press; and Cross, 1982. Designerly ways of knowing. *Design Studies*, volume 3, number 4, p 225.

17. A code different from both verbal and numerical codes.

Acknowledgement
I thank Dr. Silvia Pizzocaro my supervisor for her support. I also thank all the persons who collaborated in the development of the case studies. This research was funded by the Italian Ministry of Foreign Affairs - *Direzione Generale per la Cooperazione allo Sviluppo*.

References

ALEXANDER, C., 1964. *Notes on the Synthesis of Form.* Ph.D. thesis. Cambridge, Massachusetts: Harvard University Press.

ALEXANDER, C., et al, 1979. *A Pattern Language*. New York : Oxford University Press.

ARCHER, B., 1979. The Three Rs. *Design Studies*, volume 1, number 1, pp 18-20.

ARCHER, B., 1981. A view of the nature of design research. *In*: J. Robin and J. A. Powell, eds. *Design: Science: Method. The Design Research Society Conference, Portsmouth, 1980.* Guilford, United Kingdom: Westbury House, pp 30-47.

AVENIER, M.-J., and NOURRY, L., 1999. Sciences of the artificial and knowledge production: the crucial role of intervention research in management sciences. *Design Issues*, volume 15, number 2, pp 55-70.

BUCHANAN, R., 1999. *Title*. *In*: R. Buchanan, D. Doordan, and L. Justice, eds. *Doctoral Education in Design, Ohio, 8-11 October 1998*. Pittsburgh, Pennsylvania: The School of Design, Carnegie Mellon University.

CROSS, N., 1982. Designerly ways of knowing. *Design Studies*, volume 3, number 4, pp 221-227.

CROSS, N., 1999a. Design research: a disciplined conversation. *Design Issues*, volume 15, number 2, pp 5-10.

CROSS, N., 1999b. Natural intelligence in design. *Design Studies*, volume 20, number 1, pp 25-39.

DAVIS, D., 2003. A working model for postgraduate practice based research across the creative arts. *In*: D. Durling, and K. Sugiyama, eds. *Doctoral Education in Design, Tsukuba, Japan, 14-17 October 2003*. Tsukuba: University of Tsukuba, pp 15-24.

BADKE-SCHAUB, P., and FRANKENBURGER, E., 1997. Modelling design processes of groups in industry: an empirical investigation of cooperative design work. *In*: D. Harris, ed. *Engineering Psychology and Cognitive Ergonomics. Job Design and Product Design*. Aldershot, United Kingdom: Ashgat.

DOMINONI, A., and TRABUCCO, F., 2000. Project research: when the project is inherent to the research. *In*: S. Pizzocaro, A. Arruda, and D. De Moraes, eds. *Design Plus Research, Milano, Italy, 18-20 May 2000*. Milano, Italy: the Ph.D. programme in industrial design, Politecnico di Milano, pp 129-138.

DORNER, D., 1998. Though and design – research strategies, single-case approach and methods of validation. *In*: E. Frankenberger, P. Badke-Schaub, and H. Birkhofer, eds. *Designers – the Key to Successful Product Development*. London: Spinger.

DORNER, D., 1999. Approaching design thinking research. *Design Studies*, volume 20, number 5, pp 407-415.

DURLING, D., 2003. Introduction. *In*: D. Durling, and K. Sugiyama, eds. *Doctoral Education in Design, Tsukuba, Japan, 14-17 October 2003*. Tsukuba: University of Tsukuba.

DURLING, D., and FRIEDMAN, K., 2000. Introduction. *In*: D. Durling and K. Friedman, eds. *Doctoral Education in Design: Foundations for the Future, La Clusaz, France, 8-12 July 2000.* Stoke-on-Trent: Staffordshire University Press, pp 1-2.

FINDELI, A., 1999. Introduction. *Deign Issues*, volume 15, number 2, pp 1-3.

FINDELI, A., 2000. 28 November 2000, Re: Frayling's "categories." *PhD-Design* [online]. Available from: phd-design@jiscmail.ac.uk [Assessed on 15 September 2002].

FINDELI, A., 2001. Rethinking design education for the 21st century: theoretical, methodological, and ethical discussion. *Design Issues*, volume 17, number 1, pp 5-17.

FINDELI, A., and DE CONINCK, P., 2002. Une formation universitaire de recherche en "Design et Complexité." *In*: *Les Sciences de la Conception. Enjeu Scientifique du XXI° Siècle. En Hommage à Herbert Simon, Lyon, France, 15-16 Mars 2002*. Lyon, France: INSA Lyon.

FINKE, R. A., WARD, T. B., and SMITH, S. M., 1992. *Creative Cognition, Theory Research and Applications*. Cambridge, Massachusetts: MIT Press.

FRANZ, J., 2000. An interpretive-contextual framework for research in and through deign. *In*: D. Durling and K. Friedman, eds. *Doctoral Education in Design: Foundations for the Future, La Clusaz, France, 8-12 July 2000.* Stoke-on-Trent: Staffordshire University Press, pp 65-71.

GIORDANO, Y., 1997. L'action stratégique en milieu complexe: quelle communication? *In*: M.-J. Avenier, ed. *La Stratégie Chemin Faisant*. Paris: Economia, pp 141-182.

GLANVILLE, R., and van SCHAIK, L., 2003. Designing reflections: reflections on design. *In*: D. Durling, and K. Sugiyama, eds. *Doctoral Education in Design, Tsukuba, Japan, 14-17 October 2003*. Tsukuba: University of Tsukuba, pp 35-42.

HATCHUEL, A., 1994. Les Savoirs de l'intervention en enterprise. *Entreprises et Histoires*, number 7, p 70.

HILLIER, B., and LEAMAN, A., 1976. Architecture as a discipline. *Journal of Architectural Research*, volume 5, number 1, pp 28-32.

HUMMELS, C., and OVERBEEKE, K., 2000. Actions speak louder than words: shifting from buttons and icons to aesthetics of interaction. *In*: S. Pizzocaro, A. Arruda, and D. De Moraes, eds. *Design Plus Research, Milano, Italy, 18-20 May 2000*. Milano, Italy: the Ph.D. programme in industrial design, Politecnico di Milano, pp 284-290.

KARMILOFF-SMITH, A., 1995. *Beyond Modularity*. Cambridge, Massachusetts: MIT Press.

LAWSON, B., 1979. Cognitive strategies in architectural design. *Ergonomics*, volume 22, number 1, pp 59-68.

LAWSON, B., 1980. *How Designers Think*. London: architectural Press.

LEVIN, P. H., 1966. Decision making in urban design. *Building Research Station Note EN51/66*. Garston, Herts, United Kingdom: Building Research Station.

NEWTON, S., and MARSHALL, T., 2000. Grounding research in practice. *In*: D. Durling and K. Friedman, eds. *Doctoral Education in Design: Foundations for the Future, La Clusaz, France, 8-12 July 2000.* Stoke-on-Trent: Staffordshire University Press, pp 417-424.

OXMAN, R. E., 1994. Precedents in design: a computational model for the organization of precedent knowledge. *Design Studies*, volume 15, number 2, pp 141-157.

OXMAN, R. E., 1996. Design by representation: a model of visual reasoning in design. *Design Studies*, volume 18, number 4, pp 329-347.

OXMAN, R. E., et al, 1997. A conceptual network of web representation of design knowledge. *CAAD Futures'97*. Dordrecht, Netherlands: Kluwer Academic Publishers.

OXMAN, R. E., 1999. Educating the designerly thinker. *Design Studies*, volume 20, number 2, pp 105-122.

PONSSARD, J.-P., 1989. Interactive plans for extensive games. *Theory and Decision*.

ROTH, S., 1999. The state of design research. *Design Issues*, volume 15, number 2, pp 18-26.

SEAGO, A., and DUNNE, A., 1999. New methodologies in art and design research. *Design Issues*, volume 15, number 2, pp 11-17.

SEVALDSON, B., 2000. The integrated conglomerate approach: a suggestion for a generic model of design research. *In*: D. Durling, and K. Sugiyama, eds. *Doctoral Education in Design, Tsukuba, Japan, 14-17 October 2003*. Tsukuba: University of Tsukuba, pp 163-170.

SHETH, S., 2000. Refocusing praxis. The problem for design research. *In*: S. Pizzocaro, A. Arruda and D. de Moraes, eds. *Design plus Research, Milano, 18-12 May 2000.* Milano, Italy: the Ph.D. programme in industrial design, Politecnico di Milano, pp 366-369.

SAIKALY, F., 2003. Design re-thinking: some issues about doctoral programmes in design. *In*: *5th European Academy of Design Conference: Techne: Design Wisdom, Barcelona 28-30 April 2003*.

YAMMIYAVAR, P., 2000. Is industrial design research really different from other research? *In*: S. Pizzocaro, A. Arruda, and D. De Moraes, eds. *Design Plus Research, Milano, Italy, 18-20 May 2000*. Milano, Italy: the Ph.D. programme in industrial design, Politecnico di Milano, pp 251-257.