Approaches to Design Research: Towards the Designerly Way

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Abstract
The main objective of this paper is to argue about the emergence, in the master of research and PhD programmes in design, of an approach to design research distinct from research in the sciences and humanities. Two empirical works were developed. The first was the case studies of ten PhD programmes in design from different geographical-cultural contexts. The second was the case studies of thirteen research processes that included design project(s) as an integral part of the research. The main findings demonstrated the existence of three different approaches to design research in the master of research and PhD programmes in design. The characteristics of one of these approaches, the practice-based approach, were found very distinct from the characteristics of research in the sciences and humanities. In this paper I will describe these main characteristics with reference to concrete examples of research cases. I will also argue why the main aspects of the practice-based approach to design research are leading towards the definition of a designerly way of researching.

Key words
Approaches to design research;
Sciences and humanities research approaches;
Designerly ways of knowing;
Designerly way of researching.

Key Terms
Research
The context of this paper is design research taking place in master of research and PhD programmes in design. All master and PhD programmes where design practice per se is a form of research are not a part of this discussion. Rather, the subject of this paper are master and PhD programmes in design where research is intended as follows (AHRB, 2003/2004):

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1 The focus here is on the Ph.D. degree based on supervised research in programmes which might include a taught component which is subject to formal assessment. Other forms of doctoral education, such as the Ph.D. by Publication (UKCGE, 1996) and the Professional Doctorate (UKCGE, 2002), were not subject to this inquiry.
“It must define a series of research questions or problems that will be addressed in the course of the research. It must also define its objectives in terms of seeking to enhance available knowledge and understanding relating to the questions or problems to be addressed.

It must specify a research context for these questions or problems to be addressed. It must specify why it is important that these particular questions or problems should be addressed; what other research is being or has been conducted in this area; and what contribution this particular project will make to the advancement of creativity, insights, knowledge and understanding in this area.

It must specify the research methods for addressing the research questions or problems. It must state how, in the course of the research project, it will seek to answer the questions, or advance available knowledge of the problem. It should also explain the rationale for the chosen research methods and why it is considered that they provide the most appropriate means by which to answer the research questions.”

**Paradigm, Methodology, Strategy and Method of Research**

The terms paradigm, methodology, strategy and method of research will be used in this paper as they were defined in the *Handbook of Qualitative Research* (Denzin and Lincoln, 2000) and in *The Paradigm Dialog* (Guba, 1990):

A paradigm is a basic set of beliefs that guide action (Denzin and Lincoln, 2000; Guba, 1990). It encompasses four concepts: ethics, epistemology, ontology and methodology (Denzin and Lincoln, 2000). A methodology of research encompasses the different strategies of research selected by the researcher. In some research settings only one strategy of research is used, in others, several research strategies are used. The movement back and forth between the strategies of research and the literature is also an important part of the methodology of research. Ethnography, case studies, etc. are examples of strategies of research. A method of research is a tool used to collect and analyse empirical material such as the interview, the interpretation of documents and material culture, etc.

**The Third Area of Human Knowledge**

A review of the relevant literature about design research reveals that there are no common definitions of design and design research among design researchers (Buchanan, 2001; Friedman, 2000; Margolin, 1999; Owen, 2000; etc.). Rather, the consideration of design as a distinct discipline became a very common and accepted issue (Archer, 1979a, 1979b, 1981; Buchanan, 1998; Cross, 1982, 1999a, 2000a; Jones, 1998; Owen, 1998; etc.). What is agreed on is that design belongs to a third area of human knowledge “[…] concerned

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2 “Ethics asks, how will I be as a moral person in the world? Epistemology asks, How do I know the world? What is the relationship between the inquirer and the known? […]. Ontology raises basic questions about the nature of reality and the nature of the human being in the world. Methodology focuses on the best means for gaining knowledge about the world.” (Denzin and Lincoln, 2000).
with the making and doing aspects of human activity [...] distinct from the sciences and the humanities.

The issue of the “third area” is not new, as Archer (1979b) stated: “it has a distinguished tradition going back through William Morris all the way to Plato.” In fact, many other theoreticians argued that design is distinct from science and art, and that design as a discipline is distinct from sciences and humanities disciplines as reported in the following quotations:

- Alexander (1964) “Scientists try to identify the components of existing structures, designers try to shape the components of new structures;”
- Gregory (1966) “Science is analytic; design is constructive;”
- Simon (1969) “The natural sciences are concerned with how things are [...] design on the other hand is concerned with how things ought to be;”
- and lately by Owen (2000) “design is not science, and is not art – or a branch of any other discipline. It has its own purposes, values, measures and procedures;”
- Narvaez (2000) “The study object of many sciences, among them the physical and natural sciences, encompasses everything that is, in turn, their field of action whereas design, as it has been interpreted and particularly taught reveals some differences;”
- and Nelson and Stolterman (2003) “[...] design is not a subset or derivative of science, or a form of art, nor is it a mid point between the two. We hold the idea that design is its own tradition of inquiry, as well as action and is among the oldest of traditions.”

The list is too long, but Bruce Archer (1979a, 1979b, 1981) and Nigel Cross (1982, 1999a, 2000a, etc.) are among those theoreticians who touched interesting points of this argument. Archer (1979b, 1981) argued for “Design” as the third area of human knowledge distinct from the sciences and humanities, where the term “Design” is used in a sense that goes far beyond the day-to-day meaning which designers, architects and others assign to it, but (Archer, 1979b): “[...] Design, in its most general education sense, where it is equated with Science and the Humanities, is defined as the area of human experience, skill and understanding that reflects man’s concern with the appreciation and adaptation of his surroundings in the light of his material and spiritual needs.”

In justifying the existence of this area of knowledge distinct from both the sciences and humanities, Archer (1979a, 1979b) argues for the existence of a different approach to knowledge and of a different manner of knowing,4 which is distinct from those in the sciences and humanities: “Where Science is the collected body of theoretical knowledge based upon observation, measurement, hypothesis and test, and the Humanities is the collected body of

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3 This is what Bruce Archer discussed in his article “The Three Rs” published on the first issue of Design Studies, volume 1, number 1, July 1979, pp 18-20. This article is an extract from a lecture delivered by Archer at the Manchester Regional Centre for Science and Technology on 7 May 1976. It is the first in a series of articles published in Design Studies, the aim of which was to establish the theoretical bases for treating design as a coherent discipline of study.

4 Archer (1979b) was referring to the kind of intellectual procedure that distinguishes design, as he stated: “It now seems generally agreed amongst philosophers of science, that the distinctive feature of science is not the subject matter to which the scientist turns his attention, but the kind of intellectual procedure that he brings to bear upon it.”
interpretable knowledge based upon contemplation, criticism, evaluation and discourse, the third area is the collected body of practical knowledge based upon sensibility, invention, validation and implementation.\(^5\) He also argued (Archer, 1981) for a “designerly mode of inquiry”: “[…] there exists a designerly mode of inquiry, comparable with but distinct from, the scientific and scholarly modes of enquiry […]”

Cross (1982, 1999a, 1999b, 2000a, 2000b, 2001) took up Archers’ (1979, 1979b, 1981) arguments for design as a “third area of education” and went on defining the aspects of the “designerly ways of knowing,” as they relate to both design processes and products, as following (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.’”

Therefore, design literature shows that there exists within the international design researchers community a common consensus that design is a discipline distinct from sciences and humanities disciplines; that there exists an approach to knowledge and a manner of knowing distinct from those in the sciences and humanities, it was identified as “the designerly ways of knowing.” By consequence, is “a designerly mode of inquiry” comparable with but distinct from sciences and humanities inquiries possible, necessary and relevant? And, what are the aspects of the “designerly mode of inquiry” as they relate to research processes within master of research and PhD programmes in design?

**A Plurality of Approaches to Design Research**

The nature of design research is among the themes that has been often at the centre of the debates of the international design researchers community.\(^6\) During recent years an important growth in all areas of design research has been taking place (Durling and Friedman, 2000; Findeli and de Coninck, 2002), and many institutions established their first PhD programmes in design. Therefore, the number of conferences and publications dedicated to design research increased notably.\(^7\) The review of these publications revealed that there exists a plurality of approaches to design research.

Several design theoreticians opted for and justified a scientific approach to design research and mainly for the doctoral level. Poggenpohl and Sato (2003), for example, described three different models of research: empirical research, theoretical research and methodological research. According to Poggenpohl and Sato (2003), these models are based on a general theoretical research

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5 Archer (1979a; 1979b) also argued that design activity operates through ‘modelling,’ a medium that is comparable with but distinct from numeracy and literacy, the mediums of sciences and humanities.

6 Mainly because design research is regarded as a young field of inquiry relative to other fields in already established disciplines with long histories in research tradition.

7 The general topic of design research has been a central theme in many research-based design journals, such as *Design Studies and Design Issues*, and in many international design conferences held in the past few years. Among these conferences were: the series of conferences *Doctoral Education in Design* and the *Common Ground* conference held by the Design Research Society; the series of conferences held by the European Academy of Design; the series of conferences held at the University of Art and Design Helsinki, at Loughborough University, and at De Montfort University; the series of conferences entitled *Research into Practice* held at the Hertfordshire University; the conference *Design plus Research* held at the Politecnico di Milano; etc.
framework where the “[…] theoretical perspectives that define the research” are combined with “the additional practical factors that relate to data gathering […]” (Love, 2000a, 2000b, 2000c).

Others argued for the humanities approach to design research. Margolin (1999), for example, argues for design as a social practice where it is fundamental to consider and evaluate the situations in which design occurs. In framing his proposal, he based it on two coinciding issues. The first one was the “indeterminacy” of design, since the subject matter in design is not given, but created through invention and planning. The second issue was the critique of technological rationalism by the philosopher Herbert Marcuse. The acknowledgement of design’s “indeterminacy” and the acceptance of Marcuse’s critical reflection on social practices recognize that design theory is fundamentally a theory of how design functions in society. By consequence, history, theory and criticism become central in doctoral research and should be part of the curriculum of each doctoral programme (Margolin, 1999).

But several other theoreticians worked on the same line of thought of Archer (1979a, 1979b, 1981) and Cross (1982, 1999a, 1999b, 2000a, 2000b, 2001) trying to focus on the nature of design practice and its relationship to design research. Among these: Findeli (1999, 2000, 2001); Findeli and De Coninck (2002); Franz (2000); Glanville (1998, 1999); Glanville and van Schaik (2003); Hummels and Overbeeke (2000); Jonas (2003); Maattanen (2000); Newton and Marshall (2000); Seago and Dunne (1999); Sevaldson (2000); Sheth (2000); Yammiyavar (2000); etc. The contributions of these theoreticians are very different, but they have an underlying assumption in common: the importance of design practice as “a site and medium” for design research, and by consequence, the need of approaches and methods for design research “[…] philosophically and methodologically compatible with a relational and qualitative notion of design.” (Franz, 1998).

A Distinct Approach to Design Research

Different frameworks have been articulated to propose, justify and support an approach to design research distinct from sciences and humanities research approach mainly for the master of research and doctoral levels. Findeli and de Coninck’s (2002) framework constitutes the foundation of the master of research programme Design and Complexity offered at the School of Industrial Design at the University of Montreal. The programme is founded mainly on the principles introduced by Simon (1969) in The Sciences of the Artificial, by Schon (1987) in Educating the reflective Practitioner, by LeMoigne in La

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8 Terence Love quoting Reich (1994) in: “Layered models of research methodologies,” Artificial Intelligence in Engineering Design and Manufacturing, number 8, pp 263-274, argues that the theoretical perspectives that underpin each research project and its conclusions are the combination of the ontological perspective(s), the epistemological perspective(s), theories and the methodological perspective(s). Refer to: “Theoretical perspectives in the Ph.D. thesis: how many?” In: Doctoral Education in Design: Foundations for the Future, La Clusaz, France, 8-12 July 2000, p 283.

9 According to Love, the additional practical factors that relate to data gathering are the research methodology, the research methods and the data gathering and analysis techniques. For the reference, see note number 8.

10 According to Margolin (1999), Marcuse’s concern was for a critical reflection “[…] on the way we create and perpetuate social practices.”
Findeli (2001) and Findeli and de Coninck (2002) argued for the consideration of the complexity of the design process in the development of a framework for both design education and design research as it was stated by Findeli (2001): “If we further accept the fact that the canonical, linear, causal, and instrumental model is no longer adequate to describe the complexity of the design process, we are invited to adopt a new model whose theoretical framework is inspired by systems science, complexity theory, and practical philosophy.”

In framing their research approach, Findeli and de Coninck (2002) found it convenient to complement the “traditional” approach to research by enhancing a specific training, a kind of “complex intelligence.” The principle was to develop an epistemological and methodological training that permits research candidates to capture, describe and model complex design situations and then simulate, take decision, intervene, act and evaluate the results obtained. Therefore, in this research setting, the design project forms the “terrain” of the research, and is supposed to support the theoretical investigation.

Glanville and van Schaik (2003) argued for the use of reflective research as an approach to design research in the doctoral programme “by project through practice” offered at the Royal Melbourne Institute of Technology in Australia. The main concern is to consider design practice as a medium of study “[…], informed by and informing appropriate theory, […]” as it was explicitly stated (ibid.): “At the heart of the RMIT doctoral process is the belief that practice needs to be studied through the practice of (i.e., doing) practice, rather than as some object to be studied ‘independently.’”

This approach is supported, according to Glanville (1999, 2003) and van Schaik (2003), by a “… theory of the involved observer and of the recursions involved in this.” To legitimate and prove the efficiency of this approach to research, the authors referred to contemporary developments in epistemology, to reflective practice as articulated by Schon (1983), to the value of reflective practice (Steier, 1991), and to the theory and practice of second order cybernetics (Glanville, 2002; van Schaik, 2003).

As for the methodology of this research approach, it is framed around the concept of intensifying the researcher’s ability, a kind of “intelligence amplification” as articulated by Ashby (1956). Practice is carried out in the context of theoretical and practical developments that surround the candidate’s own areas of concern. This allows the candidates “[…] not only to connect sensitively into design culture, but also to demonstrate through their…

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knowledge and awareness of that culture the nature of their individual contribution to design knowledge.” (Glanville and van Schaik, 2003)

The emphasis on practice, through the contextualisation of the subject investigated and the use of reflection on the process, to structure an epistemological and methodological framework for design research has been also adopted by the “PhD by project” at the Royal College of Art. Seago and Dunne (1999) argued for action research through the design process as a methodological approach. The researcher in this setting is the critical interpreter of the design processes and their relationship to society and culture. According to the authors (ibid.), what distinguishes the research approach of the “Ph.D. by project” from applied research, where the concern is based on the development of working prototypes, is “[…], the idea of using the process of invention as a mode of ‘discourse,’” in other words, situating the discoveries related to the design projects in a research context.

In the same line of thought, Franz (2000) argued for an “interpretive-contextual framework” that “[…] demands a novel, experiential appreciation of design situations supporting arguments of design as both a site and medium for research.” Franz (2000) based his approach on a philosophical, methodological and substantive understanding of design; Hummels and Overbeeke (2000) proposed a “context-dependent research through design” with a shift from creating products to creating contexts for experience, with a major focus on the aesthetics of interaction;13 Maattanen (2000) considered a pragmatist semiotics framework for design research where the emphasis is on the close analysis of the different aspects of man’s relations to the physical and social environments and the role of design as a mediator of these relations; etc.

**Is a “Designerly Mode of Inquiry” Possible, Necessary and Relevant?**

The three main issues that resulted from the study of the literature about design research are:
- that there is a common consensus among an important number of design theoreticians that design as a discipline is distinct from both sciences and humanities disciplines;
- that there exist “designerly ways of knowing” which are particular aspects that distinguish design thinking, communicating and knowing;
- and that many design theoreticians are trying to propose, justify and support approaches to design research distinct from sciences and humanities research approach mainly for the master of research and doctoral levels.

The need of a further understanding of these issues necessitated the development of two empirical works about design research at the master of research and doctoral levels.14 The first empirical work was the development

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13 The authors (Hummels and Overbeeke, 2000) provide a detailed description of the aspects that compose the aesthetics of interaction.
of a case study of ten PhD programmes in design. The programmes were selected from different geographical-cultural contexts: from North America, Asia, Europe and Australia. Best practices was the criteria for the selection of the programmes. Each case study was divided into three parts: the programme was studied in detail, the coordinator or a supervisor of the programme were interviewed, and a selected PhD thesis was studied. The main results of this empirical work was that there exists three approaches to design research at the master of research and doctoral levels (Saikaly, 2003, 2004):

- **The sciences and humanities approaches to design research**: it is the systematic and methodical approach to research. It is often labelled (Findeli, 1999, 2000; Cross, 1998, 1999a) “academic research.” It was individuated when research was done according to an established plan or procedure, and dominated either by the sciences research culture or by the humanities research culture. In these cases, 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.

- **The practice-centred approach** to design research: in this research approach the development of design project(s) was considered as a form of research. It is the most criticised research approach to the Ph.D. in design, since it has yet to be demonstrated that design practice has the same required characteristics as research. This was sometimes explicitly cited (AHRB, 2003/2004): “The AHRB’s definition of research provides a distinction between research and practice per se. Creative output can be produced, or practice undertaken, as an integral part of a research process […]. Alternatively, creativity or practice may involve no research process at all […].” The characteristics of the practice-centred approach makes it more suitable for a professional doctorate in design rather than a PhD in design (The author, 2003, 2004).

- **The practice-based approach** to design research: this approach to design research was identified in the cases where the development of design projects

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15 A detailed description (the criteria for the selection of the programmes, the methods used, the main findings and the discussion of the results) of this empirical work can be found in the following publications:

16 While in the sciences, understanding is based on observation, measurement, the formulation of hypothesis and testing of theory by further observation or experiment, in the humanities, understanding is based on contemplation, criticism, evaluation and discourse (Archer, 1979b).

17 This approach to design research was entitled “practice-centred approach” with reference to the Art and Design Research Centre from Sheffield Hallam University, a pioneering centre in this approach to design research.

18 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 the term “practice-based.” However, it is important to mention that not all the master of research and PhD programmes that adopted the practice-based approach to research refer to it as it was intended and described here.
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. Action research underpinned and guided the research processes. The ‘action’ took place through the development of design projects. 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. Research processes were iterative, reflective, interpretive and dialectical.

The latter approach to design research was similar to the “project-grounded research” articulated by Findeli and de Conineck (2002), the “integrated conglomerate approach” articulated by Sevaldson (2000), to the research approaches articulated and defined by Franz (2000), Glanville and van Schaik (2003), Newton and Marshall (2000), Sheth (2000), Yammiyavar (2000), etc. The common issue of all of these approaches was their focus and emphasis on design practice as “a site and medium” for design research. Another important issue of the practice-based approach to design research is that the individuated research cases had similarities with what was defined as the aspects of the “designerly ways of knowing” (Cross, 1982) and the “designerly mode of inquiry” (Archer, 1979a, 1979b). Therefore it can be argued that a “designerly mode of inquiry” is:

- **Possible**: from one hand, design theoreticians justified epistemologically and methodologically this approach to research by referring to the particular nature of design and to the development of research paradigms that legitimate this approach to research, i.e. the constructivist and participative research paradigms and to action research and grounded theory methods. From the other hand, the first empirical work revealed that this approach is already practiced in five of the ten PhD programmes studied.

- **Necessary**: what make this distinct approach to design research necessary is, first, its emphasis on design practice as a site and medium of research, which implicates that research in the field of design can be “[…] carried out with the tools of design, i.e. mainly with its most original and specific feature: the project.” (Findeli, 2000b). Second, the idea that the use of design methods

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19 A detailed description of these main aspects of this approach to design research are provided in the following section.

20 Most of the ten interviewed PhD coordinators or research supervisors approved this approach for the master of research and doctoral levels, but with the fundamental condition that the design project(s) undertaken during the research process must not be the objective of the research, but as an integral part of the research process, as it was clearly declared during several interviews. For example Stiny (2003) stated: “I think we should search the general nature of a Ph.D. programme. I think it should be more than an individual design project. Even if the result is an innovative product or a computer programme. I think there should be something more than just an innovative product or a computer programme. You should be able to show how to design a hundred computer programmes like that. So there should be some generality to it. But having said that, there are a lot of ways to learn things, and there are a lot of ways to try.”

21 Several design theoreticians found it necessary for design researchers to use their own tools while doing design research. This issue does not imply the neglect of research tools from other already established disciplines with long histories in research tradition, rather, “we need to draw upon those histories and traditions where appropriate, while building our own intellectual culture, acceptable and defensible in the world on its own terms.” Cross (1981).
within the research process might lead to the definition of design research methods is a quite plausible idea (Sless, 2004a, 2004b; Niedderer, 2004).

The first empirical work also revealed that in the practice-based approach the design projects were used as an integral part of the methodologies of research, i.e. as strategies of research.

- Relevant: this factor depended mainly from the area of research under investigation. In some areas of research, such as artificial intelligence in design, computer support for collaborative design, design cognition, shape representation and synthesis, digital modelling and rendering, etc., a scientific approach to research was best suited. But, in other areas of research, such as modelling product attributes, modelling the integration of professions within the conception process, creative practice, new product development, tangible computing, intelligent environments, etc., a practice-based approach to research was a preferred choice. This did not exclude that in a few areas of research different approaches are all valid.

What are the Aspects of the “Designerly Mode of Inquiry”?  

It was found out through the first empirical work that an approach to design research, similar to the approaches proposed and justified by several design theoreticians, and distinct from sciences and humanities research approaches is already practiced in several master of research and PhD programmes in design. It also resulted that this distinct approach has several similarities with the aspects of the “designerly ways of knowing” and the research approach entitled “designerly mode of inquiry.” A detailed understanding of these aspects and the lack of concrete examples of this approach necessitated the development of a second empirical work: the case studies of research processes including design project(s).

The fourteen cases were selected from different geographical-cultural contexts and from master of research that permitted the inclusion of design project(s) or a practice component within the research process. The method used 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.

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, 1997, 1999, 2004; Oxman et al, 1997; etc.). The main findings about the aspects of this distinct approach to design research are as following:

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22 David Sless (2004a, 2004b) provided examples and references of how specific design research methods can evolve out of design methods: “They may have started life that way, but are now something quite different. I suspect other designers have similar experiences.” (2004a).

23 A detailed description of the method used and the schematic representations developed by the participants can be found in the following publication: Saikaly, F. 2004. Doctoral Research in Design: Towards the Designerly Way. Ph.D. thesis, Politecnico di Milano.

24 For an in-depth study of this argument, refer to the special issues of Design Studies such as volume 16, number 2: Analysing Design Activity; volume 18, number 4: Descriptive Models of Design; volume 19, number 4: Sketching and Drawing in Design.

25 Eleven of fourteen cases were considered practice-based approaches to design research. Two of these cases were considered practice-centred research, since design practice was considered as a form of research. In one of these cases, even though a design project was included in the research process, research was based on the scientific approach.
Dealing with fuzzy research problems

One of the aspects that distinguish this approach to research is the nature of the research problem and the way it was dealt with during the research process. The research problem was not explicitly stated at the beginning of the research process in a question form as it is usually in the sciences and humanities research approaches. Rather defining the research problem necessitated the researchers to undertake several research phases. This was due to the fuzzy nature of the problems,\textsuperscript{26} which were very specific, they depended from the particular research contexts and they did not had right/wrong solutions but preferred situations.

Jacqueson (2003) for example, with a reference to the schematic representation of the phases of his research process (see figure 1), undertook six research phases in order to define the research problem. The phases were: literature search, research of enterprise entry keys, research method, concrete realisation 1, results, conclusions, and then the thesis main problematic definition. In another example, Marchand (2003) also undertook six research phases in order to define the research question. The phases were: field of interest, literature search, preliminary research questions, empirical works, literature search, results and then the research question was defined.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure1.png}
\caption{Schematic representation of the research phases related to the problem definition (Jacqueson, 2003).}
\end{figure}

\textsuperscript{26} the characteristics of these fuzzy problems are similar to what is commonly known as “wicked problems.” According to Rittel and Webber (1973) “wicked problems” were seen: to be unique and context-specific; to offer a host of courses for action; to be without solution, only the opportunity to do better; to rely upon political judgement for resolution.
Ongoing construction of research processes

In the eleven individuated research cases where a practice-based approach to research was adopted, the principles of action research and grounded theory underlied the research processes, where the ‘action’ took place not only through the development of empirical works but also through the development of design projects. Permanent constructions took place between the researchers and the evolving research situations. These constructions were the guiding force of the research processes.\(^{27}\) The phases of the research processes and their sequences were all very different\(^{28}\) as it was described below. This mainly depended from the research contexts or situations which varied from one case to another.

In Marchand’s (2003) and Meroni’s (2003) cases, for example, the research processes were divided in two major parts. The first was the in-depth study of the problematic area, the second was the articulation of the methodology of research, the development of design projects and relative results (see figure 2).

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\(^{27}\) Describing a similar process in management research, Avenier and Nourry (1999) argue: “These processes can then be described as a permanent ‘equilibration’ between ‘assimilation’ and ‘accommodation’ (Piaget, 1967), or as an ‘ends/means dialectic’ (Lacroux, 1996). We call them ‘ongoing’ constructions, based on a continuous to-ing and fro-ing between reflection and action.”

\(^{28}\) On the contrary, in sciences and humanities approaches to research, the research phases and their sequence should be done according to an established plan or procedure, which was described earlier in this paper.
In Leborgne’s (2003) and Bertoluci’s (2003) cases, for example, two parallel research processes were identified. One process was relative to the theoretical context of the research. The other process was relative to the practical context, (see figure 3). The two processes mutually nurtured each other.

In Dominoni’s (2002) and Jacqueson’s (2003) cases the research phases and their sequences had a cyclic nature (see figure 4). The development of design project(s) was combined to all the other major phases of the research. This resulted in cyclic research processes, where each cycle represented a design project or a component of the project and its relative theoretical context. Each cycle introduced more understanding to the general research process.
Figure 4. Schematic representation of the cyclic parts of the research process (Dominoni, 2002).

**Underlying abductive thinking**

As it was reported in the examples above, in the practice-based approach to research, the focus was not on verifying a specific hypothesis or on answering a basic research question. Rather, the focus was on dealing with fuzzy research 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, the researchers tried to discover the nature of the problem by creating different solutions through design projects.

In these research settings the “constructive” kind of thinking is most appropriate as a framework for knowledge generation because of the nature of the research process. It was argued by March (1976, 1984) that “constructive” thinking is related to what Charles S. Peirce called “abductive” reasoning and not to deductive reasoning or inductive reasoning. March (ibid.) also argued that it is the most appropriate for design knowledge generation, because “Deduction proves that something must be; induction shows that something actually is operative; abduction merely suggests that something may be.” (Hartshorne and Weiss, 1998).
The design project as a strategy of research
It was defined earlier in this paper that a methodology of research encompasses the different strategies of research selected by the researcher. In the research cases where a practice-based approach to research was adopted the design projects developed had a methodological role during the research processes. The combinations of different research strategies with design projects formed the methodology of research and contributed to understanding and to the development of the research process (see figures 1, 2, 3 and 4). Therefore, the development of design projects was considered as one of the research strategies. In some cases one project was undertaken, in others a series of projects were developed. These projects were used to translate the requirements derived from particular individual, organisational or social situations and for the embodiments of ‘messages’ into concrete conceptual or working prototypes.

Publishable, local and meta-knowledge
The study of the schematic representations of the research processes shed light on the different kinds of knowledge produced in the practice-based approach. The researcher was not the only person involved in the development of this knowledge, since several interactions took place with different stakeholders. One kind of knowledge was relative to the initial problem addressed, this kind of knowledge, publishable knowledge, resulted in a thesis and publications forms. Another kind of knowledge, local knowledge, was the result of the design projects developed in specific research contexts. A third kind of knowledge was a meta-knowledge constructed over the course of the research process, an ‘actionable’ knowledge destined for further research.

Conclusion
Therefore, it could be argued that the main aspects of the practice-based approach are leading towards the definition of a designerly way of researching which is comparable with but distinct 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 through design practice.
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