1. INTRODUCTION

1.1 Motivation for the research

Many factors such as new professional demands, emerging research streams, new educational challenges, etc. are reshaping the context of design. An important growth in all areas of design research has been taking place (Durling and Friedman, 2000; Findeli and de Coninck, 2002). Recent years have witnessed a rapid development in doctoral education in design worldwide (Durling and Friedman, 2000), and many institutions established their first Ph.D. programmes in design.

Discussions and debates about the Ph.D. in design are a recent phenomenon. The first international debate dedicated exclusively to the Ph.D. in design took place in the autumn of 1998 at the *Doctoral Education in Design* international conference held at the Ohio State University. The intention of its organisers was to initiate a discourse on the doctorates in design (Durling, 2003; Durling and Friedman, 2000). Many other conferences and events followed this 'historical' event and continued the debate.

The central issue discussed during these conferences was the nature of the Ph.D. in design. A coherent picture of the nature of the Ph.D. in design does not exist, but rather different perspectives,[1] and many debates about what is defined as practice-based doctorate[2] in design. A fundamental issue of this debate is whether the Ph.D. in design should be modelled on traditionally established doctorates in other fields, or if it should be shaped in a distinct way.[3] These debates and the need for further understanding of these issues were the motivation for the development of this research.

1.2 Aims of the research

This research is a contribution to the international discourse about doctoral education in design. Two aims were individuated. First, the identification and definition of the different approaches to doctoral research in design, and the description of how they operated and how they related to other forms of doctorates. Second, finding out if it is possible, necessary and relevant for the Ph.D. in design to be modelled on a research approach distinct from traditionally established doctorates in other fields, and how this approach could be articulated.

1.3 Overview of the thesis

Chapter One

Chapter One is the description of the motivation for the research, its aims, and the overview of the thesis chapters.

Chapter Two

Chapter Two is about the problematic area, and the articulation of the research question. It is divided into three parts. The first part is a description of the Ph.D. degree, its background, its nature in the sciences and humanities, and its main objectives. The second part is about the nature of the Ph.D. in design. The research question is framed in the third part.

Chapter Three

Chapter Three is the review of the relevant literature. It is divided in three parts. The first part is a description of design research. The second part is a collection of various

studies about Ph.D. programmes in design. A particular approach to the Ph.D. in design is described in the third part. In the fourth part the prior theoretical finding is articulated.

Chapter Four

In Chapter Four, the methodology of research is reported. The paradigm of research, the different strategies and methods of research are described and evaluated.

Chapter Five

In Chapter Five the results of the empirical works are reported. These are divided into four sections. The first three sections are about the three different approaches to doctoral research in design: the sciences and humanities research approaches, the practice-based approach, and the practice-centred approach. The fourth section reports the characteristics of research through design / practice-based approach, which is considered as a distinct approach to the Ph.D. in design.

Chapter Six

The discussion of the results is reported in Chapter Six. Two main issues are discussed. First, why do different approaches to the Ph.D. in design co-exist? Second, the tendency towards a designerly approach to doctoral research in design, and the discussion of whether the research through design / practice-based approach can be considered designerly research.

Chapter Seven

In Chapter Seven the main contributions of the research, its limitation, and the proposal for further research are presented.

Notes

1. The different perspectives about the nature of the Ph.D. in design were mainly discussed during the following three conferences:
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;

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;

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

The following were among the themes discussed during these conferences: objectives and appropriate nature of advanced studies in design; interdisciplinary initiatives; the need for a more extensive published research base; future directions for design education; philosophies and theories of design; foundations and methods of design research; form and structure for the doctorate in design; the relationship between practice and research in design; best practices.

2. Refer to: United Kingdom Council For Graduate Education. 1997. *Practice-Based Doctorates in the Creative and Performing Arts and Design*. United Kingdom: UK Council for Graduate Education.

3. This issue is articulated in Chapter Two: *Focusing on the Problematic Area: a Distinct Approach to the Ph.D. in Design.*

2. FOCUSING ON THE PROBLEMATIC AREA: A DISTINCT APPROACH TO THE PH.D. IN DESIGN

2.1 The Ph.D. degree

2.1.1 Background of doctoral education

The background of doctoral education is rooted in the medieval Institutions of Higher Education of the thirteenth century (Friedman, 2003a; Greenwood and Levin, 2000; Van Der Lem, 2003; UKCGE, 2002). These institutions were structured into two faculties, the lower faculty and the higher faculty. Lower faculties taught the trivium which involved the study of grammar, rhetoric and logic, and the quadrivium which involved the study of arithmetic, geometry, astronomy and music. Higher faculties taught medicine, law and theology (Friedman, 2003a).

Many characteristics distinguished the lower and the higher faculties. The awarded titles were one of these characteristics. The lower faculty awarded the master degree and the higher faculty awarded the doctor degree. These titles had an equivalent level of competence but they indicated the faculty that awarded them (Friedman, 2003a; Van Der Lem, 2003).

Another characteristic was the relationships that linked these faculties to the public authority of the church and the state. The higher faculty had very strong connections with the church and the state, whereas the lower faculty did not have the same kind of connections, which was the basis of many conflicts[1] that took place between the two faculties.

The first universities with a similar form to today's modern universities were the Prussian universities of the nineteenth century, a result of Wilhelm von Humboldt's university reforms (Friedman, 2003a, Greenwood and Levin, 2000). He restructured the design and articulated the logic of the university. One of many important principles in Humboldt's restructuring was the freedom of thought and inquiry in university life. This meant that research was not to be limited by theological and political constraints (Friedman, 2003a; Greenwood and Levin, 2000). To assure this, the Humboldtian university gave the final decision on what to teach and research to the collegial system, rather than leaving these decisions to the church or political authorities.

Another important principle of the Humboldtian system was the union of research and teaching. University teaching was to be based on research, rather than on untested doctrines. As a result, university faculty and students were to be able to both study and conduct research. This meant that students were trained by the faculty to learn and conduct research (Greenwood and Levin, 2000). It was in this context of the German universities of the beginning of the nineteenth century that the first research doctorate, the doctorate of philosophy,[2] was established (Friedman, 2003a; Greenwood and Levin, 2000; Van Der Lem, 2003; UKCGE, 2002).

This degree spread slowly in the early nineteenth century, and was particularly resisted by many European universities like Oxford, Cambridge, Paris, etc. It took them several decades to recognise it as a legitimate research award (van der Lem, 2003; UKCGE, 2002). However, in the latter half of the twentieth century two major changes took place. The first was a major change in the attitude to university research. Research became the defining characteristic of academics and, in many universities it was

necessary for academics to hold a Ph.D. award. The other change was the growing intellectual demands of a whole range of jobs. These jobs required formal education comparable to that achieved in doctoral study. These changes have led to extensive recruitment of Ph.D. holders in many subject areas (UKCGE, 2002), and more recently this has taken place in the field of design.

2.1.2 Nature of the Ph.D.

The focus of this thesis 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[3] and the Professional Doctorate,[4] were not subject to this inquiry.

2.1.2.1 Training for research

The Ph.D. is defined in various ways by different higher education councils, research councils, universities and Ph.D. guides. The following is among these definitions (UKCGE, 2002):

> […], the PhD is first and foremost a research based qualification. It is based on a protracted period of research, typically around three to four years, during which time a major research project is executed and reported. A dissertation is written to present both the structure of the research project and the results obtained, and the candidate is examined viva voce on the contents of the dissertation.

Since the Ph.D. is primarily a research training exercise (Phillips and Pugh, 2000; UKCGE, 2002), it is opportune to explore the nature of doctoral research and distinguish it from other forms of research. According to Phillips and Pugh (2000), it is fundamental to distinguish research from “intelligence-gathering.” The latter requires

careful definition of terms, unbiased collection of information, meticulous statistical treatment and careful summarizing to get a balanced description of the situation that gives 'a true and fair picture.' Research requires explanations, relationships, comparisons, predictions, testing, generalizations and theories (ibid.).

Three main characteristics distinguish good research. The first one is that research is based on an open system of thought, which means that the researcher does not only search for the right answers, but struggles to articulate the right questions. The second characteristic is that researchers examine data critically, which means they develop systemic, valid and reliable data because their aim is understanding and interpretation. The third characteristic is that researchers aim for generalizations, and specify the limits on their generalizations, which means that they identify where they apply and where they do not apply, and they continually test these limits. Only valid generalizations permit understanding in a variety of appropriate situations (ibid.).

A complete description of research by AHRB (2003/2004) is as follows:

> 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.

2.1.2.2 The Ph.D. in the sciences and the Ph.D. in the humanities

The form and structure of research within a Ph.D. is common to all university disciplines but a major difference exits between the culture of research in the sciences and the culture of research in the humanities. In the sciences approach, the methodology of research is based on observation, measurement, the formulation of hypothesis, the development of empirical works, and the testing of theory by further observation or experiment. Both quantitative and qualitative research methods are used in the sciences approach. In the humanities approach, where the main concern is human culture, the methodology is based on contemplation, criticism, evaluation and discourse. In this latter approach, qualitative research methods are used (AHRB, 2003/2004; Archer, 1979b).

2.1.3 Objectives of the Ph.D.

The PhD award has at its heart the notion of training for research, along with the expectation that the fruits of research will be communicated so as to make an original contribution to knowledge and understanding (AHRB, 2003/2004; Phillips and Pugh, 2000; UKCGE, 1997; UKCGE, 2002; etc.).

2.1.3.1 Becoming a researcher in a field of study

Becoming a researcher in a particular field means that the researcher has a good knowledge of all the developments in the field and a critical and analytical attitude towards them; has the mastery of the methods and techniques of research used in the field of study and knows their limitations; is aware and works within the ethics of his profession; knows how to communicate effectively the results of the research; has the ability to evaluate and re-evaluate his own work; demonstrates the ability to undertake further research without supervision; and carries out all of this in an international context (AHRB, 2003/2004; Phillips and Pugh, 2000; UKCGE, 1997; UKCGE, 2002; etc.).

2.1.3.2 Developing an original contribution to knowledge

The submitted work must make a recognisable original contribution to knowledge and understanding in the field of study concerned. This principle of an original, independent piece of work is enshrined in all PhD regulations (Phillips and Pugh, 2000; UKCGE, 1997; UKCGE, 2002; etc.). Francis (1976) observes eight different ways in which a contribution is considered original. Phillips and Pugh (2000) agrees with only six of these:

Setting down a major piece of new information in writing for the first time;

Continuing a previously original piece of work;

Carrying out original work designed by the supervisor;

Providing a single original technique, observation, or result in an otherwise unoriginal but competent piece of research;

Having many original ideas, methods and interpretations all performed by others under the direction of the postgraduate;

Showing originality in testing somebody else's idea.

Phillips (1992) developed a study[5] to define the concept of originality. The result was nine further definitions of the concept of originality of the Ph.D. contribution. These definitions are:

Carrying out empirical work that hasn't been done before;

Making a synthesis that hasn't been made before;

Using already known material but with a new interpretation;

Trying out something in this country that has previously only been done in other countries;

Taking a particular technique and applying it in a new area;

Bringing new evidence to bear on an old issue;

Being cross-disciplinary and using different methodologies;

Looking at areas that people in the discipline haven't looked at before;

Adding to knowledge in a way that hasn't been done before.

2.2 The Ph.D. in design

2.2.1 Young field of inquiry

New professional demands, emerging research streams, new educational challenges, etc. are reshaping the context of design. An important growth in all areas of design research has been taking place (Durling and Friedman, 2000; Findeli and de Coninck, 2002). Recent years have witnessed a rapid development in doctoral education in design worldwide (Durling and Friedman, 2000), and many institutions have established their first Ph.D. programmes in design. The Ph.D. in design is therefore regarded as a young field of inquiry relative to other Ph.D.s in already established disciplines with long histories of research tradition.

Discussions and debates about the Ph.D. in design are a recent phenomenon. The first international debate on the Ph.D. in design took place in the autumn of 1998 at the international conference *Doctoral Education in Design* held at the Ohio State University. The intention of its organisers,[6] was to initiate a discourse on doctorates in design (Durling, 2003). The discussions covered different subjects, such as the objectives and appropriate nature of advanced studies in design; interdisciplinary initiatives; the need for a more extensive published research base; and future directions for design education.

After the Ohio conference, an e-mail discussion list, *PhD-design,*[7] was established by the Design Research Society to continue the debate about the nature of research in design and the relevance of doctoral education (ibid.). The second international conference was held in 2000 at La Clusaz in France and it was entitled *Doctoral Education in Design: Foundations for the Future*. The conference focused on four central themes: philosophies and theories of design; foundations and methods of design research; form and structure for the doctorate in design; and the relationship between practice and research in design (Durling and Friedman, 2000).

The third conference entitled *Doctoral Education in Design* was held in 2003 in Tsukuba in Japan. The main theme was the practice of research, and the purpose was to share best practice from around the world and the particular application of best practice, with a focus on organising and teaching the doctorate in design (Durling, 2003).

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,

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 held by the European Academy of Design;[8] 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*; the *Common Ground* conference held by the Design Research Society; etc.

2.2.2 Nature of the Ph.D. in design

The nature of doctoral research in design was among the central themes discussed in the conferences cited above. In his keynote address at 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. These questions involved different philosophical, epistemological, methodological and practical aspects of doctoral research in design. Many international design conferences and research-based design journals focused on these aspects and tried to provide more insight into and understanding of these issues.

2.3 Framing the research question

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 and many debates about what is called practice-based doctorate in design do exist. This thesis is a contribution to this international open debate about doctoral research in design, and it addresses the following research question.

2.3.1 Why is a distinct approach to the Ph.D. in design possible, necessary and relevant, and how can it be articulated?

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 thesis. It is important to understand the motivations for a distinct approach, how it could be articulated and justified. To address this question, it is first necessary to articulate an in-depth understanding of the existing approaches to doctoral research in design in different geographical-cultural contexts.

Notes

1. These conflicts were the basis of Emmanuel Kant's book *The Conflict of the Faculties* published in 1795. It was this book that inspired Wilhelm von Humboldt's university reforms. Refer to: Friedman, K., 24 February 2003a, "Re: Professional doctorates and the Ph.D. in ancient and modern universities." *PhD-Design* [online]. Available from: phd-design@jiscmail.ac.uk [Accessed 25 February 2003].

2. The doctorate of philosophy has two abbreviations, the Ph.D. and the D.Phil. The vast majority of universities use Ph.D. as the standard abbreviation.

3. For an in-depth description of this kind of doctorate, refer to: United Kingdom Council for Graduate Education. 1996. *The Award of the Degree of Ph.D. on the Basis of Published Work in the UK*. United Kingdom: UK Council for Graduate Education.

4. For an in-depth description of this kind of doctorate, refer to: United Kingdom Council for Graduate Education. 2002. *Professional Doctorates*. United Kingdom: UK Council for Graduate Education.

5. The study was based on interviewing students, supervisors and examiners. Refer to: Phillips, E. M., 1992. "The PhD: assessing quality at different stages of its development." *In*: O. Zuber-Skerritt, ed. *Starting Research: Supervision and Training*. Brisbane, queensland: tertiary Education Institute, University of Queensland.

6. The organisers were: Richard Buchanan, Dennis Doordan, Lorraine Justice and Victor Margolin.

7. The e-mail discussion list, *PhD- Design*, is accessed on: http://www.jiscmail.ac.uk/phd-design.

8. Refer to: www.europeanacademyofdesign.com, the European Academy of Design web site. The conferences are:
Design Interfaces, 1995, Salford, United Kingdom;
Contextual Design, 1997, Stockholm, Sweden;
Design Cultures, 1999, Sheffield, United Kingdom;
Desire - Designum - Design, 2001, Aveiro, Portugal;
Techné: Design Wisdom, 2003, Barcelona, Spain.

3. THE CULTURAL BACKGROUND TO DESIGN RESEARCH

3.1 Studies on design research

The state of research in any field of inquiry can be judged by 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 on design literature[1] 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.

Almost two decades later, in an article about design research, Cross (1999a) declared:[2]

> 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.

The research-based journals that Cross (1999a) reported as evidence to the previous statement were the following: *Design Studies*, first published in 1979; *Design Issues*, which first appeared in 1984; *Temes de Disseny* in Catalan and Spanish in 1986; the *Journal of Design History* in 1988; *Research in Engineering Design* in 1989; *Revue Sciences et Techniques de la conception* in French in 1992; *Languages of Design* in 1992; *FormDiskurs* in German in 1996.

Cross's (1999a) statement was sustained two years later by Findeli (2001) and Buchanan (2001). Findeli (2001) argued, in an article about design education,[3] that a look at the recent literature in design could be enough to conclude that the general design landscape[4] is safe, quiet and serene. Buchanan (2001) stated, in a brief report on the *Doctoral Education in Design* conference held in October 1998 at Ohio, that "the conference gave me confidence that design has reached a watershed moment in its development as a field of inquiry."

3.1.1 Brief Background of design research[5]

The background of design research can be traced from different perspectives. Two examples are reported below. In the first, the background of design research was described from the German perspective, with reference to the major achievements that have shaped design theory and research in Germany. In the second example, the background of design research was described from the perspective of design methods and the scientific approach, with reference to the major design publications and conferences.

Bauhaus, Ulm, post-modern movement and empirical research

The background of design research, as traced by Burdek (2003), was influenced by four major achievements: the Bauhaus, the Ulm design school, the post-modern movement and empirical research. Although Burdek (2003) referred particularly to the German context, many other geographical-cultural contexts had the same historical background as design research and were influenced by the same achievements.

According to Burdek (2003) the main idea of the Bauhaus from 1919 until 1933 at Weimar, Dessau and Berlin, was to integrate art and technology in order to develop new forms of living; design research focused on the social needs of the user; new forms of products were intended to generate new democratic forms of living; the Bauhaus was considered as a political movement as well as an art and design school (ibid.).

At the Ulm design school, from 1953 to 1968, the focus of research was on design methodology whose aim was to bring the status of design in industry to the same level as engineering and technology (ibid.); knowledge from engineering, the social and cultural sciences, literature and art were all integrated into design education and the development of products; concepts such as "Good Design" and "Bel Design" had a leading role in German industries; Ulm design school supported democratic movements in post-war Germany and was considered as a cultural institution (ibid.).

The post-modern movement was initiated at the beginning of the 1980s by the Italian group called Memphis. It brought the functional movement of the Bauhaus and Ulm to an end (ibid); "product language" and "product semantics" became the main concern in design research; the design focus shifted from the product to the context; the "semantic turn" concentrated on the connotation of products, and the added values became more important then the product themselves (ibid.).

In the 1990s it became necessary for designers to develop their own 'body of knowledge' for interdisciplinary demands. Research in design shifted towards empirical research (ibid.). Several topics became central to design research, such as environmental factors and social 'milieu' for new product development; product clinic,

i.e. testing the images, desired life styles, semantic values, aesthetic qualities, etc. before products are launched on the market; usability and interface concepts since design projects are becoming more immaterial; etc. (ibid.).

First-generation, second-generation design methods and scientific research

The following section reports the background of design research traced from the design methods and scientific approach perspective, mainly referring to publications and conferences about design research.

According to Jerrard et al (1999), due to technological developments and the implications of mass production during the 1960s, designers' interests shifted from hardware and form to the consideration of human needs. This required a new consideration of design methods. These were particularly influenced by systems analysis and systems theory, which formed the background for the foundation of the "systematic design methods" (Bayazit, 2004). These were later called "first generation design methods" by Rittel (1972).

The following are among the major publications and events[6] that marked the period of the first-generation design methods: *Introduction to Design* by Asimov (1962); *Community and Privacy* by Chermayeff and Alexander (1963); *Systematic Methods for Designers* by Archer (1965); *Notes on the Synthesis of Form*[7] by Alexander (1965); *The Sciences of the Artificial* by Simon (1968).

The *Conference on Design Methods*, held in London in 1962 and organised by Jones and Thornley,[8] marked the launch of the design methods movement and design

methodology as a field of inquiry (Cross, 2000a); the *Design Methods Group (DMG) Newsletter* was first published in 1967 by Sage Publications when the Design Methods Group was established at the University of California, Berkley; A series of conferences followed, among which: the *Design Methods Group First Annual International Conference*, organized at the Massachusetts Institute of Technology in 1968, the *Design Activity International Conference*, held in London in 1973, the *Portsmouth Changing Design Conference*, held in 1976, the *California-Berkley Design Methods in Action Conference*, held in 1977.

About these publications and events, Bayazit (2004) argues:

> Design methods people were looking at rational methods of incorporating scientific techniques and knowledge into the design process to make rational decisions to adapt to the prevailing values, something that was not always easy to achieve. They were attempting to work out the rational criteria of decision making, and trying to optimize the decisions.

During the 1970s, two of the pioneers of the design methods movement, Christopher Alexander and John Christopher Jones, announced a manifesto against design methodology, whose methods they regarded as too simplistic to meet the requirements of complex, real-world problems. The Operation Research model and systems theory were applied to design problems in a very abstract way for every problem (ibid.).

It was Rittel who proposed new argumentative methods as the second-generation design methods (Bayazit, 2004; de Vries et al, 1993). The main characteristic of the second-generation design methods was the user's involvement in design decisions. *The design*

Participation Conference was held in Manchester in 1971 and it was organised by Nigel Cross. About user's participation, Bayazit (1978, 1979) argues that it is:

> […] a very wide and comprehensive subject, with its political, ideological, psychological, managerial, administrative, legal and economical aspects in relation to various countries. The concept of user participation is a wide and variable as that of democracy.

Meanwhile, the Design Research Society (DRS) was founded in London in 1967. Together with the Design Methods Group, they started to publish the *DMG – DRS Journal* instead of the *DMG Newsletter*, until 1979, when *Design Studies* was published by IPC in cooperation with the Design Research Society, and has been edited since then by Nigel Cross. In 1980 the *Design: Science: Method. The Design Research Society Conference* was held at Portsmouth. Design research was among the major themes discussed in that conference, during which Archer (1981) posited the following question: "What is design research that it is different from other forms of research?"

Many achievements during the 1980s contributed to a new era of design research and to the significant growth that took place in all areas of design research during the 1990s (Bayazit, 2004). Among these achievements were the following:[9] *The Design Policy Conference* organised in 1982 at the Royal College of Art; the *Design Process Newsletter* by the Institute of Design at the Illinois Institute of Technology; Donald Schon's book the *Reflective Practitioner* published in 1983, which opened the way to a new paradigm for design research.

This important growth in all areas of design research culminated in the launch of an increasing number of Ph.D. programmes in design worldwide. In 1998 the first

Doctoral Education in Design conference was held in Ohio. It was followed by two other conferences: *Doctoral Education in Design: Foundations for the Future* held in 2000 at La Clusaz in France, and *Doctoral Education in Design* held at Tsukuba in Japan in 2003.

3.1.2 Nature of design research

A review of the relevant literature about design research reveals that there are no common definitions of design and design research among design researchers[10] (Buchanan, 2001; Friedman, 2000a; Margolin, 1999; Owen, 2000; etc.). According to Simon (1982), to design is to "[devise] courses of action aimed at changing existing situations into preferred ones." Friedman (2000a) defines design as "[…] an interdisciplinary and integrative process constituting a professional field and an intellectual discipline." Sato (2000) argues that "one general way of defining design is as a knowledge transformation process." For Sevaldson (2000), "design is a phenomenon that includes design as a quality of objects, design as a profession, design as method, design as cultural expression, design as marketing strategy and so on." For Buchanan (2001), "design is the human power of conceiving, planning and making products that serve human beings in the accomplishment of their individual and collective purposes."

As for the definition of design research, Archer (1981) provides the following definition: "[…] design research is systematic enquiry whose goal is knowledge of, or in, the combined embodiment of configuration, composition, structure, purpose, value and meaning in man-made things and systems." Narvaez provides another definition (2000): "design research is, therefore, basically directed to establishing an organized

conceptual structure of design's own knowledge, whereas its foundations will rest on the immediate interpretation of material culture and the mediation between the material production of society and its diverse scientific and technological phenomena."

While there seem to be different definitions of design and design research, the consideration of design as a distinct discipline became a very common and accepted issue (Archer, 1979b, 1981; Cross, 1982, 1999a, 2000b; Jones, 1998; Owen, 1998). What is agreed on is that design belongs to a third area of human knowledge "[…] concerned with the making and doing aspects of human activity […]."[11] distinct from the sciences and 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 justifying the existence of this area of knowledge distinct from both the sciences and humanities, Archer (ibid.) argues for the existence of a different approach to knowledge and of a different manner of knowing, 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 interpretive knowledge based upon contemplation, criticism, evaluation and discourse, the third are is the collected body of practical knowledge based upon sensibility, invention, validation and implementation.

Archer's interpretation of the relationships between the three areas of human knowledge is represented in the diagram below (figure 1), 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 (ibid.):

> […] 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.

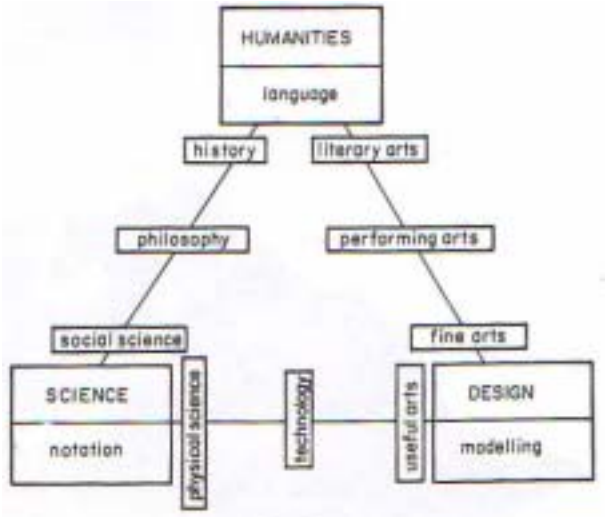

Fig.1 The relationships between the three areas of human knowledge (Archer, 1979b).

These distinctions between design, sciences and the humanities were also discussed by many other authors 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."

Archer (1981) was the first to distinguish between design research and "designerly mode of inquiry," where the latter is comparable with but distinct from research in the sciences and humanities:

> 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. Design research, on the other hand is not equitable with scientific research. It is designerly enquiry, not design research that is equitable with scientific research.

3.1.3 Fields of design research

Different approaches have been used for the articulation of the fields of design research, as reported in the following examples. One of these approaches was the consideration of design knowledge as the goal of design research, and by consequence an attempt to articulate the fields of design research by individuating where this knowledge resides (Archer, 1979b, 1981; Cross, 1999a, 2000b). Cross (1999a; 2000b) argues that design knowledge is found in people, in design processes and in products. Therefore his taxonomy of the field of design research is: Design epistemology, which means the "study of designerly ways of knowing;" Design praxiology, which is the "study of the

practices and processes of design;" Design phenomenology, which is the "study of the form and configuration of artefacts."

Sources of design knowledge	People	Processes	Products
Fields of design research	**Epistemology**	**Praxiology**	**Phenomenology**

Table 1. Fields of design research (Cross, 1999a , 2000b).

Archer (1981), who used the same approach, divided design research into a different taxonomy: Design phenomenology, in which he included design history, design taxonomy and design technology; Design praxiology, in which he included design modelling and design metrology; Design philosophy, in which he included design axiology, design epistemology and design pedagogy.[12]

Design phenomenology	**Design praxiology**	**Design philosophy**
Design history Design taxonomy Design technology	Design modelling Design metrology	Design axiology Design epistemology Design pedagogy

Table 2. Fields of design research (Archer, 1981).

Friedman (2000a) argues that "the nature of design as an integrative discipline places it at the intersection of several large fields," fields of thinking and pure research and fields of practice and applied research. The fields of theoretical study are the natural sciences, the humanities and liberal arts, and the social and behavioural sciences. The fields of practice and application are human professions and services, creative and applied arts, and technology and engineering. He identifies four areas of design research drawing on Kristensen's (1999) work,[13] which raised the question of design research by addressing the notion of a progressive research programme. As a result, according to Friedman

(2000a), there are four areas of design research: Philosophy and theory of design, research methods and research practices, design education and design practice.

Philosophy and theory of design
Research methods and research practices
Design education
Design practice

Table 3. Fields of design research (Friedman, 2000).

3.1.4 Kinds of design research

Different approaches and perspectives have been adopted in the articulation of the kinds of design research, as is reported in the following examples. Depending on the type of problem addressed, Buchanan (2001) divides design research into clinical, applied and basic research.[14]

Clinical research is directed towards an individual case. It is practiced to solve particular and individual design problems, just as "in a field such as medicine, clinical research is the investigation of the effects and consequences of a particular course of treatment", and as "in business clinical research often emerges in case studies where an investigator attempts to observe and record all of the relevant events that have shaped a course of action or a business decision." (Buchanan, 2001). So clinical research is regarded as an information gathering and understanding process relevant to the solution of a particular design problem.

Kind of design research	Type of problem addressed
Clinical research	Directed towards an individual case.
Applied research	Directed towards principles that account for a class of phenomena.
Basic research	Directed towards fundamental problems in understanding the principles which govern and explain phenomena.

Table 4. Kinds of design research (Buchanan, 2001).

In applied research, according to Buchanan (ibid.), the focus is shifted from the particular, individual problem "[…] towards problems that are discovered in a general class of products or situations." So the goal is shifted towards principles "[…] that account for a class of phenomena." In applied research the goal is to formulate from many individual cases a hypothesis or several hypotheses for explanation.

The third kind of research is basic research. The focus here is directed towards "[…] fundamental problems in understanding the principles – and sometimes the *first* principles – which govern and explain phenomena." According to Buchanan (ibid.), this kind of research is associated with design theory, and suggests bridges to other disciplines.

Roth (1999) individuated three categories of inquiry in design very similar to Buchanan's classification but different in terminology.[15] Her approach was based on the nature of the research topic rather than on the problem. When the topic is defined by a "specific situation," the research is concrete / specific. The topic can extend beyond a specific instance to an "entire class of situations," in which case the research is conceptual. When the topic examines "design practice and its artefacts in a broader context," the research is theoretical / philosophical.

Kind of design research	Nature of the research topic
Concrete/specific research	Defined by a specific situation.
Conceptual research	Extends beyond a specific instance to an entire class of situations.
Theoretical/philosophical research	Examines design practice and its artefacts in a broader context.

Table 5. Kinds of design research (Roth, 1999).

The first two approaches to identify the different kinds of design research focus on design research in general. The first approach was based on the problem to be addressed, the second approach was based on the nature of the research topic. In the following example the focus shifts from design research in general to the scientific approach in design research. The use of a scientific approach in design research generates three categories[16] (Gero, 1999, 2000): empirically-based design research, axiom-based design research and conjecture-based design research.[17]

Empirically-based design research	Based on the experimental paradigm.
Axiom-based design research	Based on the identification of a set of axioms and their logical consequences.
Conjecture-based design research	Based on the identification of an analogy with other processes.

Table 6. The scientific approaches to design research (Gero, 1999, 2000).

According to Gero (1999, 2000), empirically-based design research uses the experimental paradigm. During the research process, experiments are set up, the data is collected and then analysed to produce a set of results. The results are used to either develop a hypothesis about design or to confirm an existing one. This kind of design research is very similar to cognitive science research.

Axiom-based design research is based on the identification of a set of axioms and their logical consequences, the objective is to produce models of design. The research process involves: the specification of relevant axioms, the derivation of logical consequences of the axioms, and the mapping of the axioms and their consequences onto a particular domain to derive new results. This kind of design research resembles mathematical / logical research.

Conjecture-based design research is based on the identification of an analogy with other processes. It starts with either a human process or a computational process,[18] and develops it as a specific model of a designing process. This kind of research is similar to some theoretical engineering research.

3.1.5 Design knowledge

The study of knowledge, including the definition of knowledge, the nature of knowledge, the kinds of knowledge, the knowledge creation process, the validity of knowledge, etc., has a long and robust history in philosophy. The New Oxford Dictionary of English (1998) defines knowledge as:

> 1 Facts, information, and skills acquired by a person through experience or education; the theoretical or practical understanding of a subject.
>
> What is known in a particular field or in total; facts and information.
>
> Philosophy: true, justified belief; certain understanding, as opposed to opinion.
>
> 2 Awareness or familiarity gained by experience of a fact or situation.

The following knowledge definitions were quoted by authors[19] who have contributed, among others, to the articulation of design knowledge. Wiig (1990) defines knowledge as, “Truths, approaches, judgements and methodologies that are available to handle

specific situations. Knowledge is used to interpret 'information' about a particular circumstance or case." Drucker (1990) argues that "knowledge is information that changes something or somebody – either by becoming grounds for action, or by making an individual (or an institution) capable of different and more effective action." Davenport and Prusak (1998) developed the following definition: "knowledge is a fluid mix of framed experiences, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers. In organizations, it often becomes embedded not only in documents or repositories but also in organizational routines, processes, practices, and norms."

The issue of design knowledge is a central field of inquiry for design research, since knowledge is the goal of research (Archer, 1981; Bonsiepe, 2000; Cross 1999a, 2000b; Narvaez, 2000; Owen, 1998) and since design research is a relatively young field of inquiry (Byrne, 2001; Friedman, 2000b, 2003b; Krippendorff, 1999; Owen, 1998; Roth, 1998; etc.). Many authors have attempted to approach design knowledge from different perspectives, as is shown in the next two sections.

3.1.5.1 Kinds of design knowledge[20]

Ever since ancient times, knowledge has been divided into different kinds. Quoting Narvaez (2000), who was referring to Ferrater (1971):

> […] Aristotle distinguished three classes of knowledge: theoretical knowledge, *praxical* knowledge, and poietic knowledge. The object of the first class is knowledge; the object of the second one is wisdom with respect to moral action (politics), and the third has productive action as its object.

According to Downton (2000), epistemologists frequently divided knowledge into practical knowledge, "the knowledge of how to do things;" factual or propositional knowledge, "(knowledge that), which is the area of normal concern in philosophical accounts;"[21] and knowledge by acquaintance or "knowledge of."[22]

Narvaez (2000) argues that design activities generate two kinds of knowledge, the *noesis*[23] of design and the *poiesis*[24] of design. She defines the *noesis* of design as "the science of thinking about design." It includes "[…] the theory, critique, and history of design activity, as well as the results of designers' professional activities." The *poiesis* of design is defined as designing, since *poiesis*, "[…], the process of achieving an idea, is comparatively similar to the design process. Designing thus is a *poietic* act."

The basic categories of design knowledge, according to Narvaez (ibid.), are the object, the project and the conceptual meta-structure of design. The object is "[…] the tangible materialization of the *poietic* act of design […]." It is considered as an "object of knowledge," and may involve the analysis of the object as physical element, the interpretation of the object as a social and historical entity, the object as a social transformer, etc. The project is not only intended as "planning, arranging, or projecting," but also as "[…] the action of projecting oneself, and acting as a project in itself." The conceptual meta-structure of design covers all the studies and reflections concerning "[…] the global and holistic conceptualization of the actions of design in culture." This category encompasses studies such as the social and institutional role of design, the social changes produced by design, the reliance of design on technical thought, etc.

Cross (1999a, 2000b, 2001) argues that the development, articulation and communication of design knowledge has to be the concern in design research. He identifies three sources for design knowledge: people, processes and objects. Firstly, design knowledge resides in people, and especially designers. He argues that "designing is a natural human ability" and that research should investigate this human ability. Secondly, design knowledge resides in design processes, in the "tactics and strategies of designing." Thirdly, design knowledge resides in products, "the forms and materials and finishes which embody design attributes."

Bayazit (1993) focuses on the kind of knowledge held by designers. She defines it as the following:

> Design knowledge is the knowledge utilized by the designer during the design process, and it is related to the perception of the information, the organization of the knowledge in the memory, the evolution process of the new knowledge for the specific design situation.

She divides designers' knowledge into two main groups, procedural knowledge and declarative knowledge. Procedural knowledge is concerned with "[…], the study of the process of designing." Bayazit (ibid.), quoting Heath (1984), argues that craft knowledge is an "operative knowledge." Craft knowledge belongs to the procedural knowledge and is "[…] the accumulation of various skills which are gained throughout the professional practice."

The second group of designers' knowledge is the declarative knowledge. It is composed of positive knowledge, concrete knowledge, and design discourse. "Positive knowledge theory in design is an attempt to explain the accumulation of facts about the world." It is

related to the relationship between human beings and their environment. This kind of knowledge is concerned with studies such as ecological psychology, environmental psychology, ergonomics, etc. Concrete knowledge, identified also as substantive or scientific knowledge, is "[…] concerned with the description and explanation of the physical nature of the products and the built environment – its material, space and structure." Design discourse is what design practices, design studies and design theories deal with, discursive rules and formations. Bayazit (ibid.) argues that "the subject of the design discourse is the objects, structure of the objects and the mechanisms of the discourse itself, the formations of the discourse as a network of relations as indicated by Teymur (1982)."

Bayazit (ibid.) identifies two other patterns of design knowledge. The first is normative knowledge which "[…] relates to preferences, values, tastes, attitudes of designers." The second is collaborative design knowledge. It is related to the collaborate design work, which is a different methodological approach from individual design work.

3.1.5.2 Knowledge using and knowledge building

Knowledge using and building in design have been articulated in various approaches by reference to scientific and scholarly models for guidance (Bayazit, 1993; Narvaez, 2000; Owen, 1998; Roth, 1999; Strickler, 1999). Some of the approaches have been developed in particular fields of design research, as shown in the first two examples.

Strickler (1999) articulated a model of research[25] in three principle domains, the substantive, the conceptual and the methodological. The first "concerns content that is of interest." The second "concerns ideas that give meanings to content," and the third

"concerns procedures for studying content." This model was particularly appropriate to visual communication research.

Bayazit (1993) articulated three main functions in the development of knowledge acquisition.[26] These functions are: knowledge elicitation, knowledge interpretation and knowledge structuring. The approach was developed for the exploration of the methods used by expert designers, and referred to the approach developed for the purpose of building expert systems in various fields.

Narvaez (2000) argues that there is an important relationship between design research and the theories of social action of John Dewey and Jurgen Habermas, and that "their philosophical concepts are a free and comprehensive contribution for a conceptual framework of design." She structures a model of design knowledge referring to Habermas's (1993) categories in science research: the empirical-analytical sciences, the hermeneutical-historical sciences, and the sociocritical sciences (Table 7).

Approaches	**Empirical-Analytical** Prediction and control	**Hermeneutical-Historical** Location and direction	**Sociocritical** Liberation
Focus and attitude	Observation Positivism	Analysis of historical events Hermeneutics	Social imbalance Critical
Logical procedure	Analytically breaks down systems to reconstruct them by means of relations and transformations.	Reconstructs isolated pieces of facts into a meaningful whole.	Discloses alienating situation or power manipulation in work and language. Supplies theoretical models for social action.
Purpose	Analyse, explain, and predict. Control over nature.	Understanding and interpreting phenomena of all types, especially those of a social nature.	Transformation and liberation through critical anlysis. Knowledge of reality to change it.
Method	Analytical	Synethic	Transformational
Cognitive interest	Theoretical Techno-scientific	Praxis Meaningful	Emancipation or liberating

Table 7. Comparative table for the classification of sciences (Habermas, 1993).

The empirical-analytical research approach "[…] have had an influence on design especially when attempting to understand the processes related to the physical and biological constitution of the human being, as well as to the technical and technological aspects of the production of design objects." The hermeneutical-historical approach can be the model for the development of the historical knowledge of design. In this case, knowledge using and building "[…] consists in the holistic reconstruction of isolated pieces of facts, where history is the axis and its moment are interpreted." The sociocritical approach is the reference, in using and building knowledge in design, when research focuses on an "attitude of change," on a "high sense of transforming reality," on "improving the human condition" and using Narvaez's (2000) statement, when "its sense is thus transformational, and its interest is emancipating."

Owen (1998) articulated a knowledge using and knowledge building model for design "especially suited to the way design is studied and practiced." The guiding reference for the model was not based on the scientific and scholarly models, but on systems of conventions and rules under which design operates. These systems of conventions and rules, entitled 'channels,' "embody the measures and values that have been empirically developed as 'ways of knowing' as the discipline has matured."

According to Owen (1998) the general model of using and building knowledge is asking questions, developing answers and making decisions. These are different in nature from discipline to discipline, and depend on the measure and value systems of the discipline, as reported in a comparison of disciplines in table 8. The questions, answers and decisions that contribute to knowledge using and building also differ within the discipline. In design, for example, between design inquiry and design application.

Domain	Discipline	Measures	Source of values
Science	Mathematics	True / False Correct / Incorrect Complete / Incomplete	Reason logic
	Chemistry	True / False Correct / Incorrect Right / Wrong Works / Doesn't work	Physical world
Technology	Mechanical Engineering	Right / Wrong Better / Worse Works / Doesn't work	Physical world Artificial world
Law	Statutory Law	Just / Unjust Lawful / Unlawful Right / Wrong	Social contract
Arts	Painting	Beautiful / Ugly Skilful / Unskilful Though provoking / Banal	Culture
Design	Product Design	Better / Worse Beautiful / Ugly Fits / Doesn't fit Works / Doesn't work	Culture Artificial world

Table 8. Differences in measures and values (Owen, 1998).

Knowledge using and knowledge building as articulated by Owen (1998) is a process "[…] expressed as concatenations of question / answer and question / decision mediated through the channel appropriate to the process." The channels differ in the two realms of design, design inquiry and design application.

3.2 Studies on the Ph.D. in design

3.2.1 Introduction

Design research is mostly practiced in two different contexts: professional practice and the academic environment. In the academic environment design research takes place within graduate programmes, research programmes, units of research, laboratories, etc. Among research programmes, Ph.D. programmes in design are exclusively dedicated to design research.

In recent years a rapid development of Ph.D. programmes in design has been noticed (Durling, 2003; Durling and Friedman, 2000; Friedman, 2000b). The key issues surrounding this rapid development were discussed during the first Doctoral Education in Design international conference,[27] held at the Ohio State University in 1998. It was the intention of its organizers to initiate an international discourse on doctoral education in design (ibid.)

A series of events resulted from this historical conference. These events had one common objective: the continuation of the debate about this emerging field of inquiry. Among these events, two other *Doctoral Education in Design* international conferences took place. The first was in the year 2000 in La Clusaz, in France,[28] the second in 2003, in Tsukuba, Japan.[29]

The second Doctoral Education in Design conference focused on four main themes: philosophies and theories of design; foundations and methods of design research; form and structure for the doctorate in design; and the relationship between research and practice. The main theme in the third Doctoral Education in Design conference was "[…], the professionality in research education in design."[30]

The proceedings of the three Doctoral Education in Design conferences constitute an important literature reference about Ph.D. programmes in design. Special issues of design journals[31] were also dedicated to this topic. Various issues concerning doctoral education in design were discussed in these publications. These issues were divided into three distinct sections as articulated below.

The first section reassembled issues concerning the philosophical and theoretical foundations of doctoral research in design.[32] The second section included issues about current Ph.D. programmes in design,[33] such as their different forms, structures, contents, methods, intentions, etc. The third section grouped issues about new proposals for doctoral education in design,[34] such as new approaches, new models of research, new academic structures, etc.

3.2.2 Ph.D. programmes in design

3.2.2.1 Philosophical foundations

Different ontological, epistemological and methodological frameworks have been articulated as foundations for design research in general and for doctoral education in particular. Among these are the following examples.

Krippendorf (1999, 2000) argues for a new paradigm in design due to a shift in design thinking. He refers to the pioneering works of Simon[35] (1969) and those of Schon[36] (1983, 1987). About Simon's works he argues:

> Although his proposal was informed largely by engineering, committed to an old positivism, and marred by a celebration of the kind of cognitivism that derived from his earlier work in artificial intelligence, it does contain the seeds of a new approach to design. It outlines a new logic of the design process.[37]

Schon (1987) addressed, as in Simon's (1969) proposal, issues of design quite generally, "[…] but unlike Simon's, It was no longer positivist and is modelled less on engineering decisions than on that of practical designers […]."[38] Krippendorff (ibid.) also argued that this paradigm shift needs to enter design discourse, which he defined as "[…] the designerly way of languaging […]." He opposed design discourse to natural

science discourse, and argued that it would be a grave mistake to model the Ph.D. in design on scientific research, since " science inquires into what is, design into what could be." He declared:

> […], I contend that designers allow their discourse to become colonized by the commercialism of marketing, the conservatism of science, the individualism of art, and the mechanism of engineering.

He noticed a gradual increase of human / social considerations in design thinking, and proposed a human-centred philosophy for design where "meaning" is at the centre of design discourse, and this latter is the domain of the Ph.D. scholarship in design.

Margolin (1999) argues that whereas undergraduate programmes are practice-oriented, even though they often contain some research components, the doctorate level "[…] is more likely to set the parameters for the social understanding of design because of its emphasis on research." (ibid.). He considered the advent of doctoral programmes in design as an important motivation to frame a deeper debate on the nature of design activity that could lead to a better understanding of the valuable types of design research. He found no problem in 'swamping' design research with other research cultures, instead he recognized and valued "[…] the plurality of research methods and goals […]."(ibid.).

He argues for design as a social practice where it is fundamental to consider and evaluate the situations in which design occurs, and that history, theory and criticism should have a central role within design research and should be part of the curriculum of each doctoral programme. 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.[39] The second issue was the critique

of technological rationalism by the philosopher Herbert Marcuse. Marcuse's concern was for a critical reflection "[…] on the way we create and perpetuate social practices." (Margolin, 1999).

Therefore Margolin (ibid.) argues that 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 training in design.

Cross (2000) argues for the "intellectual independence" of design as a discipline,[40] "[…] whilst seeking to emulate other disciplines in standards of rigour in scholarship and research."[41] Design should not be turned into an imitation of science, or treated as a kind of art. He also argues that we are in the phase of building the appropriate paradigm for design research. The basic theory for this paradigm is what he articulated as "designerly ways of knowing" (Cross, 1982). These are "[…] forms of knowledge special to the competencies and abilities of a designer" (Cross, 2000b). In fact, in recent years, throughout the field of design research, "[…] there has been a growing awareness of the intrinsic strengths and appropriateness of design thinking within its own context, of the validity of a form of 'design intelligence.'" (Cross, 1999b).

The examples reported below show a variety of frameworks articulated as philosophical foundations for doctoral research in design. These are only a part of a long list: many other authors have argued for a scientific approach to doctoral research in design (Gero, 2000; Love, 2000a, 2000b, 2000c; Poggenpohl, 2000; Poggenpohl and Sato, 2003; Sato,

2000); Maattanen (2000) considered a pragmatist semiotics framework; 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."[42]

Franz's (2000) interpretive and contextual framework focuses on the importance of design practice as "a site and medium" for design research. Many other authors share this view and argue for the importance of grounding design research, and specifically doctoral research, in design practice (Dominoni and Trabucco, 2000; Findeli, 1999, 2001, Findeli and De Coninck, 2002; Hummels and Overbeeke, 2000; Newton and Marshall, 2000; Seago and Dunne, 1999; Sevaldson, 2000; Sheth, 2000; Yammiyavar, 2000; etc.). This challenging framework is reported, later in this chapter, in the section entitled "research through design."

3.2.2.2 Examples of current Ph.D. programmes in design

While the first part of the studies of Ph.D. programmes in design focused on the diversity of the philosophical foundations underpinning these programmes, in the following part concrete examples are reported in order to illustrate the rich variety of doctoral education in design.

Illinois Institute of Technology, Chicago

The Ph.D. programme, entitled Ph.D. in Design, offered at the Institute of Design at the Illinois Institute of Technology of Chicago is based on the scientific approach to doctoral research in design (Poggenpohl, 2000; Poggenpohl and Sato, 2003; Sato, 2000). Three different models of research are articulated (Poggenpohl and Sato, 2003):

empirical research based on experiment or case study, theoretical research and methodological research. All these models are based on a general theoretical research framework where the "[…] theoretical perspectives that define the research"[43] are combined with "the additional practical factors that relate to data gathering […]."[44] (Love, 1998, 2000a, 2000b, 2000c).

Another characteristic of this Ph.D. programme is the question-based approach to Ph.D. research (Meyer, 1995; Poggenpohl, 2000). The development of specific research questions and the examination of the alternative approaches to the questions provide two benefits. Firstly, a social agreement on the importance of the question, and secondly, the selection of appropriate research methods (Poggenpohl, 2000; Poggenpohl and Sato, 2003).

Sheffield Hallam University, Great Britain

At the Art and Design Research Centre at Sheffield Hallam University in Great Britain, it is possible to undertake a practice-centred Ph.D. programme in Art and Design. The centre is recognized for its pioneering work in the definition and articulation of the practice-centred methodologies for doctoral research. In this new approach, the primacy of practice is considered as a fundamental tool of research. Practice skills and implicit knowledge of design are considered vital for their research culture.[45]

The main issue in the practice-centred research in design, as articulated by Rust and Whiteley (1998), Rust et al (2000) and by Rust and Wilson (2001), is that research is "[…] conducted largely through an investigative, experimental use of practical design activities."[46] These design activities were guided by "creative reasoning," a process of

iterative cycles of drawing and / or making and evaluation. The result of this kind of research is a great number of drawings and three-dimensional objects which, according to Rust and Wilson (2001), represent and make explicit the processes that have been followed, and the objective is to stimulate practical developments in the field concerned.

Since this approach is a recent one, major problems were faced in the discussion of the work and the development of the thesis (Rust and Wilson, 2001). This was due to the lack of suitable examples appropriate to the research situation. The authors (ibid.) proposed and articulated the notion of a "visual thesis in design:"

> The approach agreed was to construct a series of composite images, comparable to sections of an exhibition. Each of these would bring together the objects and drawings relevant to a specific issue or event in the research. From there, we hoped to move forward by adding text as appropriate.

The first two examples of Ph.D. programmes in design present a polarity between the nature of research, the processes, the objectives, etc. While in the first one the emphasis is on theoretical contributions, in the second one, the emphasis is on the developments in design practice. In the following examples of doctoral programmes, both the theoretical and the practical are combined in the research approaches.

Royal Melbourne Institute of Technology, Australia

At the Royal Melbourne Institute of Technology in Australia a doctoral programme "by project through practice" is offered. The basic premise underpinning the programme is the use of reflective research as an approach to doctoral research in design (Glanville and Van Schaik, 2003). The 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 refer 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). Therefore, the approach of this doctoral programme is to consider design practice as a medium of study "[…], informed by and informing appropriate theory, […]." (Glanville and Van Schaik, 2003):

> 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.'

The emphasis on practice, through the contextualisation of the subject investigated and the use of reflection on the process, to structure a methodological framework for doctoral research in design has been adopted by other universities in different geographical-cultural contexts. Among these doctoral programmes are: the one offered at James Cook University in Townsville in Australia[47] (Davis, 2003); the doctoral programme offered at the School of Design at Curtin University of Technology in Australia (Swann, 1999); a similar approach, mainly based on the concept of the "making disciplines," is adopted by the doctoral programme at the Oslo School of Architecture (Dunin-Woyseth and Nielson, 2003).

Royal College of Art, London

At the Royal College of Art in London, a particular approach is adopted for all the master and doctoral programmes offered in their different departments. At the doctoral level, it is possible to choose between a Ph.D. by thesis or a Ph.D. by project. The methodologies of research in the Ph.D. by thesis and in the Ph.D. by project are different. The Ph.D. by thesis consists of a major theoretical work reported in a conventional thesis of 80,000 words (Seago and Dunne, 1999). The Ph.D. by project "[…] consists of a major element of practical research supported by a minor element of related text of between 25,000 and 40,000 words." (ibid.).

According to the authors (ibid.), what distinguishes 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. Action research through the design process is the methodology used where the researcher is the critical interpreter of the design processes and their relationship to culture and society. The Ph.D. by project as offered at the Royal College of Art and in other doctoral programmes, as reported above, concentrates on the important role of design practice within the research process. An in-depth study of this argument is developed later in this chapter, in the section entitled "research through design."

3.2.2.3 Examples of new proposals for doctoral education

Most Ph.D. programmes in design were launched during the 1990s, as reported earlier in this chapter. New proposals for doctoral education in design (Bruder, 2000; Chen, 2000; Ehn and Svenstedt, 2000; Kroelinger and Giard, 2000) are still taking place in

different geographical-cultural contexts. The motivations for these new proposals, the underpinning principles, the structure and the objectives of these new doctoral programmes vary from one context to another. Some examples are reported below in order to view the latest developments in doctoral education in design.

National Cheng Kung University, Taiwan

In Taiwan for example, the first Ph.D. programme in design was launched during the year 2000 at the National Cheng Kung University, which was the first school to offer a bachelor and master degree in design in 1973 and 1991 respectively (Chen, 2000). The motivations for the creation of this doctoral programme were: the new orientation of the department of industrial design towards the theoretical realm of design; the important growth in the number of design programmes in the country, which had reached a critical point that required qualitative changes to be developed through the doctoral programme; the need for local design scholars familiar with national cultural, social, economical and industrial affairs and activities (ibid.).

University of Essen, Germany

It is possible to develop a Ph.D. thesis in design in only a few universities in Germany. This is due to the German educational system. The fact is that design education is mostly found in applied universities, where the emphasis is on practice and where it is not possible to get a doctoral degree (Bruder, 2000). The University of Essen, the faculty of Design and Arts Education, is one of these few universities where it is possible to develop a doctoral thesis in design.[48] In order to intensify doctoral education in design, since only a small number of theses were produced, the faculty planned and developed structural changes in design education.

The following actions were among the planned and developed changes: cooperation with other faculties of the university in the supervision of doctoral students through the development of common research projects, and cooperation with university and non-university organisations to promote the transfer of research findings; the establishment of the Institute for the Sciences of Art and Design to strengthen the theoretical aspects of design education; the development of the faculty's existing areas of research and their organisation into different fields of specialisation, which were considered as the starting point for further doctoral research; finally, a change in the rules for graduation, so that doctoral candidates were allowed to develop a doctoral thesis in the sciences of design and not only in the sciences of art (ibid).

Malmo University, Sweden

In the School of Arts and Communication at Malmo University, a doctoral programme was launched during the year 2000. The orientation of the programme was towards a design doctorate, rather than a traditional Ph.D. in design. The epistemological foundation for this orientation "[…] may well be found in rethinking the intellectual virtues Aristotle named *techne* and *phronesis*." (Ehn and Svenstedt, 2000).

About *techne*, Ehn (ibid.) argues:

> In *techne* art and technology are not yet separated. *Techne* does not separate methods and theories for science and technology, and creativity and freedom for art, but focus on pragmatic, concrete context dependent means-end knowledge oriented towards production.

Techne as an epistemological basis implies that studies are developed as shared projects in an interdisciplinary studio-based research environment. There are two main characteristics to this environment. Firstly, the learning by doing approach, where

students learn to reflect on their own theories-in-action through patterns of phenomena of practice. Secondly, coaching rather than teaching, through what Schon (1987) called "reflective practicum."

Ehn (ibid.) also argues that "in *phronesis* wisdom and artistry as well as art and politics are one." So it is about the competence of developing judgements in particular cases. Considering *phronesis* as the second epistemological basis meant that:

> No one is seen as a naïve neutral technician, […], but as designers with a humanistic stance recognizing the collective and political character of the design process in real cases […].

In brief, this new doctoral programme in Design and Digital Media "[…] has aesthetic-technical-critical foundation and is based on the idea of a design-oriented synthesis of constructive action and critical reflection." (ibid). The thesis may take the form of a portfolio of works and a reflective summary, or a multimedia production.

3.2.3 Comments

The study of the literature on doctoral education in design in different geographical-cultural contexts shows a rich variety of doctoral programmes. There are different motivations that lead to the development of these programmes in each university context. The programmes are characterised by different underpinning foundations, by different research processes and by different orientations and objectives. These programmes emphasise different kinds of learning, and different kinds of doctoral theses are developed.

The doctoral programmes are described in different manners, some authors focus on the epistemological foundations, others on the methodology of research, the objectives, etc. Therefore, it is impossible to compare these programmes using the same criteria and to frame a classification or a categorisation of these programmes.[49] Also, it is impossible to individuate and articulate all the interrelated factors that shape these different doctoral programmes. All these reasons motivate the first empirical work, a case studies of Ph.D. programmes in design.

3.3 Research through design

3.3.1 Introduction

Approaching design research often sheds light on the nature of design and its relationships to design research (Archer, 1979, 1981; Cross, 1982, 1999a; Findeli, 1999; Findeli and De Coninck, 2002; Franz, 2000; Narvaez 2000; Newton and Marshall, 2000; Press 1995; Seago and Dunne, 1999; Sevaldson, 2000; Sheth, 2000; Yammiyavar, 2000; etc.). Frayling (1993/1994) proposed distinguishing three types of design research: research into design, research for design and research through design. This terminology has had a very wide acceptance within the design research community since it is quoted by many authors such as Bayazit (2004), Branco et al (2000), Findeli (1999) Findeli and De Coninck (2002), Press (1995), Redmond (2000), Swann (1999) etc., but it had different interpretations.

One of the most convincing interpretations of Frayling's categories was the one provided by Findeli (1999, 2000b). He argued that research in design or about design covers the kind of research that is academically recognized. It is carried out by the epistemological

and methodological tools of already established academic disciplines, such as sociology, semiotics, psychology, history, etc., "[…], and as such foreign to design."

Research for design was interpreted (1999, 2000b) as what is known as R&D, Research and Development. According to Findeli (ibid.), it has no scientific recognition "[…], 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 simply not its goal)."

Research through design is research "[…] carried out with the tools of design, i.e. mainly with its most original and specific feature: the project." (ibid.). The main objective of research through design is not to carry out a design project, but to use it as a terrain of research.

3.3.2 Foundations of research through design

Different frameworks have been articulated to propose, justify and support the approach of doing design research through the design project or through design practice, and mostly for the master and doctoral levels. The main idea is to ground design research in practice, where practice is considered as a medium of study "[…], informed by and informing appropriate theory, […]." (Glanville and Van Schaik, 2003). This idea is supported "[…] by a theory of the involved observer and the recursions involved in this." (Van Schaik 2003; Glanville, 2003).

Many of these frameworks that support and argue for the approach of research through design are based on the nature of design as a point of departure (Franz, 2000; Glanville,

1998, 1999, 2003; Newton and Marshall, 2000; Sevaldson, 2000; Sheth, 2000; Yammiyavar, 2000; etc.). For example, in describing the position of the "doctoral programme by project through practice" offered at the Royal Melbourne Institute of Technology, Van Schaik and Glanville (2003) argue:

> We are convinced that studies of practice as an object miss the point. Design is an activity, and designers, in order to study the activity, need less to study the outcome of the activity (the process, design-as-verb) and more to study the activity itself.

In another example, Franz (2000) also considers the nature of design in proposing an "interpretive-contextual framework" for design research. He argues for approaches and methods for design research "[…] philosophically and methodologically compatible with a relational and qualitative notion of design." (Franz, 1998). In the same line of thought, Hummels and Overbeeke (2000) propose 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.

Another framework for research through design is the one articulated by Findeli and De Coninck (2002). The framework constitutes the foundation of the master of research programme *Design and Complexity* offered since the year 2001 at the School of Industrial Design at the University of Montreal. The programme is founded on the principles introduced by Simon (1969) in *The Sciences of the Artificial*,[50] by Schon (1987) in *Educating the reflective Practitioner*,[51] by LeMoigne in *La Théorie du système general*[52] (1990) and by Boutinet (1996) in *Anthropologie du Project*.[53]

Findeli (2001) argues for the consideration of the complexity of the design process in the development of a framework for both design education and design research:

> 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.

He distinguishes between methodological complexity, product complexity, problematic complexity and impact complexity (ibid.). Specific training is considered necessary to deal with this complexity. In framing the research approach, Findeli and De Coninck (2002) found it convenient to complement the 'traditional' approach to research by enhancing a "complex intelligence." The principle was to develop an epistemological and methodological training that permits research candidates to model complex design situations and act within these situations. Therefore, the design project is considered as the terrain of the research, and is supposed to support the theoretical investigation.

3.3.3 Methodology of research through design

Since research through design is a relatively new approach, the methodological framework is still unclear. In fact, only a few contributions about doctoral research in design focus on the methodological approach of research through design.[54] Two examples are reported below. The first was from the Royal College of Art in London, a "Ph.D. by project" in interaction design, the second from the Royal Melbourne Institute of Technology in Australia, the Ph.D. "by project through practice."

Seago and Dunne (1999), argue for action research by project as a methodological approach for the "Ph.D. by project." One of the greatest challenges of this

methodological approach "[…] involves the coherent linkage of the written and studio aspects of the project within the research context." (ibid.) The key methodological factor is to use the process of developing prototypes, considered as a process of invention, as a mode of 'discourse.'

In other words, the methodology of research is "[…] interpreted as 'conceptual modelling' involving a critique of existing approaches to production / consumption communicated through highly considered artefacts." (ibid.). The researcher in this setting is seen as a critical interpreter of design processes and their relationship to the natural, artificial, human, social and cultural worlds.

According to Van Schaik and Glanville (2003), the methodology of research of the doctoral programme at the Royal Melbourne Institute of Technology 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. The intention is to generate explicit and demonstrable changes in the candidate's work.

The researchers identify a research "gap" and frame their project(s) around it. "The process involves abstraction of themes, testing and re-abstracting – a distillation." (Van Schaik, 2003). Van Schaik and Glanville (2003) argue:

> […] the practice is married to theory and exists within a developing theoretical framework based in the practice of design re-enforced by an awareness of current developments and the context; and also the theoretical exploration of circular causality, (second order) cybernetics.

The methodology of research is based on the study of how studying practice can develop theory that informs practice the same way practice informs theory (ibid.).

3.3.4 Comments

Many authors have contributed to the theoretical articulation of research through design. The lack of concrete examples of doctoral research suggests the need for further understanding of two of its underpinning principles. The first is how the design project(s) contribute to theory building in concrete examples of doctoral research. The second is concerned with the methodological role of the design project(s) within the research process. A second empirical work is developed in order to contribute to an in-depth study of these issues.

3.4 Prior theoretical finding

3.4.1 Towards design's own research paradigm

Many authors propose, justify and try to articulate, although in different ways, the approach of research through design. Seago and Dunne (1999) name it "action-research by project;" Findeli (1999) names it "project-grounded research;" Sevaldson (2000) defines it as a "integrated conglomerate approach;" Dominoni and Trabucco (2000) entitle it "*ricerca progettuale*;" Glanville and Van Schaik (2003) name it "doctoral programme by project through practice;" etc.

None of these authors, or others, exclude the importance of other co-existing approaches to doctoral research in design, approaches modelled on research in the sciences or humanities. They agree for a plurality of approaches to doctoral research in design, and

that the approach of research through design will probably lead towards a design's own research paradigm, as described by Archer (1981):

> Design, then, like science, is not so much a discipline as a range of disciplines united by a common intellectual approach, a common language system and a common procedure. 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.

3.4.2 Epistemological and methodological foundations

Many recent developments and references can form the terrain and legitimate the approach of research through design. In epistemology, the constructivist paradigm in particular, have led to the reconsideration of 'field' research methods, and to the questioning of the role of the researcher and his / her place in this kind of setting (Avenier and Nourry, 1999). The idea of the researcher as a neutral and objective subject is highly contested for two reasons. The first is that their values, beliefs and goals influence the representations they construct from the phenomenon under inquiry. The second is that the presence of the observer in the field and the interaction between observer and observed can influence the evolution of the phenomenon (ibid.). Rather than considering these issues as a problem to knowledge, Berry (1986) argues that "[…], it should be considered the opposite, as a means of knowledge and perhaps the only means."

Other recent contributions that sustain the approach of research through design are the ones related to fieldwork methods of research, such as action research and grounded theory methods. These methods considered as 'transformative' fieldwork methods, as

opposed to ‘contemplative methods,’ have demonstrated their potential fertility for the researcher and other persons involved in the research setting (Avenier and Nourry, 1999). These methods considered as soft sciences methods have demonstrated their adequacy for enquiry into complex areas (Sevaldson, 2000).

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 abstract indexes. He referred mostly to publications in English of the period 1970-1980. See: 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. The article "Design research: a disciplined conversation" was published in a special issue of *Design Issues*, which was dedicated to design research, volume 15, number 2, pp 5-10.

3. The article entitled "Rethinking design education for the 21st century: theoretical, methodological, and ethical discussion" was published in *Design Issues*, volume 17, number 1, pp 5-17.

4. The author meant by design landscape: design education, design practice and design research, as he specified later in the same paragraph, p 5.

5. This section is not intended as a complete historical review of design research, rather it reports briefly and from two different perspectives the important periods and developments that influenced the current state of design research.

6. The list of publications and events were selected from Bayazit's article: Bayazit, N., 2004. "Investigating design: a review of forty years of design research." *Design Issues*, volume 20, number 1, pp 16-29.

7. This book was Christopher Alexander's Ph.D. thesis. It was the first Ph.D. thesis about design methods. It was published by Harvard University Press.

8. The proceedings were published a year later in 1963 by Oxford University Press.

9. The list of publications and achievements is too long, only a few examples are reported. To view the complete list, refer to: Bayazit, N., 2004. "Investigating design: a review of forty years of design research." *Design Issues*, volume 20, number 1, pp 16-29.

10. This fact was discussed by Richard Buchanan in his paper "Design research and the new learning" published in *Design Issues*, volume 17, number 4, autumn 2001. He argues that the literature is full of contrasting and sometimes contradictory definitions of design. He also discusses the different kinds of definitions. He identifies, for the purposes of his paper, two kinds of definitions, the descriptive definition and the formal one, pp 3-23.

11. 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.

12. A detailed description of each field is provided in his article "A view of the nature of design research" presented at the Design Research Society conference *Design: Science: Method* held in 1980 in Guilford, UK, pp 30-47.

13. In his article " Research on design in business," presented at the conference *Useful and Critical: Research in Design*, held at the University of Art and Design, Helsinki, Tore Kristensen raised an important question for design research in addressing the notion of a progressive research programme.

14. In his paper "Design research and the new learning" published on *Design Issues*, volume 17, number 4, pp 3-23. Buchanan refers to a distinction employed by universities, corporate and governmental funding agencies to articulate the kinds of design research, based on the type of problem addressed.

15. In her paper "The state of design research," published in *Design Issues*, volume 15, number 2, summer 1999, pp18-26.

16. The identification of three different scientific approaches to design research was based on different projects in the area of design computing and cognition. It is an area of design research that leads to the construction of either cognitive or computational models of designing.

17. This categorisation of design research was based on a series of projects supported by a number of grants from the Australian Research Council, as Gero (2000) declares in his paper "Research methods for design science research" published in the proceedings of the conference *Doctoral Education in Design: Foundations for the Future*, organised by the Design Research Society in La Clusaz in France on July 2000, pp 153-161.

18. In the same paper Gero (2000) argues that not only does the development of models of designing rely on cognitive studies of designers, but also that there is a potential to identify analogies with computational processes and then apply them to a design domain. When the analogy is with computational processes, the research borrows heavily from computational fields such as artificial intelligence. It produces specific computational models of design, for example evolutionary systems (genetic engineering and co-evolution) and neural networks (emergence models).

19. These authors were selected in order to offer different perspectives in the articulation of design knowledge.
Wiig was quoted by Nigan Bayazit in her article "Designing: design knowledge: design research: related sciences." *In*: M. de Vries, N. Cross and D. Grant, eds. *Design Methodology and Relationships with Sciences*. Dordrecht: Kluwer, 1993, pp 121-136. In this article, Bayazit focused mainly on designers' own knowledge.

Drucker was quoted by Ken Friedman in his article "Creating design knowledge: from research into practice." *In*: *Idater 2000. Loughborough, United Kingdom, September 2000.* United Kingdom: Department of Design and Technology, Loughborough

University. Friedman articulated the differences between information and knowledge, and reflected on what philosophers call "the problem of knowledge."

Davenport and Prusak were quoted by Gui Bonsiepe in his article "Design as cognitive tool: the role of design in the socialization of knowledge." *In*: S. Pizzocaro, A. Arruda and D. De Moraes, eds. *Design Plus Research, Milano, Italy, 18-20 May 2000.* Bonsiepe discussed the process of transformation of data in information, information into knowledge, and then the distribution of knowledge. He articulated the role of design as a cognitive tool in this transformation process and offered an explicit example.

20. Many authors have tried to identify the categories of design knowledge. The examples reported here were selected because the authors identified fields of knowledge pertaining to design and which could constitute possible fields of research.

21. On the 'knowledge-of how' and the 'knowledge-that,' Downton was referring to Gilbert Ryle, 1949 in *The Concept of Mind*, London, Hutchinson, Chapter Two.

22. On the 'knowledge-of', Downton was referring to Bertrand Russell, 1912 in *The Problems of Philosophy*, Oxford University Press.

23. According to Narvaez, *noesis* is a Greek verb. It means "discerning seeing." Greek philosophers used it to designate an 'intangible seeing' or 'thinking seeing.' In "Design's own knowledge," *Design Issues*, volume 16, number 1, p 40.

24. According to Narvaez, quoting Ferrater (1971) in *Diccionario de Filosofia*, volume2, Buenos Aires: Editorial Sudamericana, the infinitive form of the verb *poiesis* means make, form, produce. It is used to define all the disciplines that are directed at making or producing. *Poiesis* is the origin of the world 'poetry' and is related to creating or representing something. In "Design's own knowledge," *Design Issues*, volume 16, number 1, p 41.

25. According to a model of research described by David Brinberg and Joseph E. McGrath in: *Validity and Reliability in the Research Process*, 1985, Beverly Hills, California: Sage Publications, p 13.

26. According to Bayazit (1993), Knowledge acquisition is a "process which involves eliciting, analyzing, and interpreting the knowledge that a human expert uses when solving a particular problem and transforming this knowledge into a suitable machine representation." In "Designing: design knowledge: design research: related sciences." M. de Vries, N. Cross and D. Grant, eds. *Design Methodology and Relationships with Sciences*. Dordrecht: Kluwer, 1993, p 128.

27. The conference was held on the 8-11 of October 1998. The organizers were Richard Buchanan, Dennis Doordan and Lorraine Justice. The conference proceedings were published in Pittsburgh by the School of Design, Carnegie Mellon University.

28. The conference was held at La Clusaz in France on the 8-12 of July 2000. It was entitled *Doctoral Education in Design: Foundations for the Future*. The conference

proceedings were edited by David Durling and Ken Friedman, and were published in Stoke-on-Trent by the Staffordshire University Press.
29. The third conference was held at Tsukuba in Japan on 14-17 of October 2003 and was part of the *6th Asian Design Conference*. The editors of the conference proceedings were David Durling and Kazuo Sugiyama, and they were published in Tsukuba by the University of Tsukuba.

30. As reported by David Durling in the *Design Research News*, the Design Research Society Digital Newsletter, volume 8, number 12, December 2003.

31. Many design journals have dedicated special issues to the theme of design research. Among these, two journals focused on Ph.D. research in design. These journals are: the *International Journal on Design Sciences and Technology*, volume 10, number 2, ISSN 1630 – 7267, and the *Art, Design & Communication in Higher Education*, volume 1, number 3, ISSN 1474 – 273X.

32. There is a wide range of approaches concerning the philosophical and theoretical foundations for doctoral research in design. In this section, the intention was not to report all or most of these different approaches, but to identify the most significant ones (those quoted frequently) and those which do not focus on a particular area of doctoral research in design.

33. Most contributions about doctoral education in design focus on current examples of Ph.D. programmes, where the authors described particular aspects of their own programmes. The most significant ones are reported in this section.

34. A considerable number of contributions about doctoral education in design concerned new proposals, such as the rationale for new Ph.D. programmes arising in different countries, new models of research, etc. These are reported in this section.

35. Here he referred to *The Sciences of the Artificial*. The first edition was published in 1969 at Cambridge, Massachusetts by the MIT Press. Other important contributions by Simon were the series of *Compton Lectures* at the Massachusetts Institute of Technology.

36. He was referring to *The Reflective Practitioner: How Professionals Think in Action*, first published in 1983. Another important contribution by Schon was *Educating the Reflective Practitioner*, published in 1987.

37. Here the reference is to Klaus Krippendorff's paper, "A field for growing doctorates in design," presented at the first *Doctoral Education in Design, Ohio, 8-11 October 1998*. R. Buchanan, D. Doordan, and L. Justice were the organizers and the editors of the proceedings, published in Pittsburgh by The School of Design, Carnegie Mellon University.

38. Refer to note number 37.

39. Here Margolin refers in his paper to Buchanan's statement: "However, the subject matter of design is not given. It is created through the activities of invention and

planning, or through whatever other methodology or procedures a designer finds helpful in characterising his own work."

40. Many theoreticians have discussed whether design is a field, a discipline, a science or otherwise. For Cross, by design as a discipline he means "[…] design studied on its own terms, within its own rigorous culture. I mean a 'science of design' based on the 'reflective practice' of design." This definition was articulated in his paper entitled "Design as a discipline." 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, p 96.

41. In his paper entitled "Design as a discipline." 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 93. In most of his contributions about design research, Cross insists on the nature of valid design research. The characteristics of good research , according to Cross, are: purposive, inquisitive, informed, methodical and communicable.

42. In his paper "An interpretive-contextual framework for research in and through deign." It was published in the proceedings of the conference *Doctoral Education in Design: Foundations for the Future, La Clusaz, France, 8-12 July 2000*, p 71.

43. 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.

44. 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 43.

45. With reference to the Art and Design Research Centre web site: http://www.shu.ac.uk/schools/cs/cri/adrc/research2/index.html, accessed on January 2004.

46. In Rust, C., and Wilson, A., 2001. "A visual thesis? Techniques for reporting practice-led research." In: *Desire Designum Design: 4th European Academy of Design Conference, Aveiro, Portugal 10-12 April 2001*.

47. The doctoral programme is in visual arts, music, literature, film, theatre and theatrical design.

48. In the German educational system, getting a Ph.D. degree requires independent and individual supervised research work. The Ph.D. programmes are not structured programmes with course components and credit requirements.

49. The classification or categorization might be seen as introducing more dogmatism in the field. But According to Findeli, they can be used and considered as a rhetorical and pedagogical tools where the originality and articulation of future research in design will be described and stressed. In: Findeli, A., 2000b. 28 November 2000, Re: Frayling's "categories." *PhD-Design* [online]. Available from: phd-design@jiscmail.ac.uk [Accessed 15 September 2002].

50. Simon, H., 1969. *The Sciences of the Artificial.* Cambridge, Massachusetts: MIT Press.

51. Schon, D., 1987. *Educating The Reflective Practitioner.* San Francisco, California: Jossey-bass Inc.

52. Le Moigne, J. L., 1990. *La Théorie du Système Général*. 3rd ed. Paris, France: Presses Universitaires de France.

53. Boutinet, J.-P., 1996. 3rd ed. *Anthropologie du Project*. Paris : PUF.

54. There are very few examples of doctoral research through design. Only three examples from the Royal College of Art were found. These were reported in the paper: Seago, A., and Dunne, A., 1999. "New methodologies in art and design research," *Design Issues*, volume 15, number 2, pp 11-17.

4. METHODOLOGICAL APPROACH

4.1 Theoretical framework

The main issue addressed in the research problematic area was whether the Ph.D. in design should be modelled like Ph.D.s in the sciences and the humanities, or if it should have a distinct approach to doctoral research. The review of relevant literature on the current state of design research and the Ph.D. in design highlighted critical issues[1] and introduced the first theoretical finding.[2] Both the critical issues and the first theoretical finding necessitated further empirical explorations. The combination of the 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.

4.1.1 Paradigm of research

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):

> 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.

Among the major research paradigms,[3] constructivism which underlies this research, adopts a relativist ontology which means local and specific constructed realities; a transactional epistemology and a hermeneutical, dialectical methodology. This implies,

from a practical point of view, that the orientation of the inquiry is towards the production of reconstructed understandings; the nature of knowledge is individual reconstructions coalescing around consensus; and that trustworthiness and authenticity are the criteria of validity (ibid.).

4.1.2 An empirical basis from selected case studies

Two different strategies of inquiry have been adopted for the empirical part. The first one is the comparison of case studies of Ph.D. programmes in design selected from different geographical-cultural contexts. The second one is the comparison of case studies of research cases including design projects. The selection of the case study as a strategy of inquiry was, firstly, "[…] because it draws attention to the question of what specially can be learned from the single case." (Stake, 2000). Secondly, because an instrumental interest in the case can be used to "[…] provide insight into an issue or to redraw a generalization." (ibid.).

4.2 Case studies of Ph.D. programmes in design

The review of literature on the current state of Ph.D. programmes in design introduced a rich panorama of doctoral programmes with different underpinning philosophies, different natures, different structures and contents, different aims, etc. It was impossible to compare and classify[4] these programmes since they were described in different ways. It was also obvious that interrelated factors shaped and contributed to this variety of programmes (Durling, 2003; Findeli and de Coninck, 2002). In order to get a deep understanding of all these critical issues the first empirical work was developed.

4.2.1 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[5] were taken into consideration: northern America, Asia, Australia and Europe. The selected countries for the study were:

In northern America: Canada and the United States of America;

In Asia: Japan;

Australia;

In Europe: France, Germany, Great Britain and Italy.

The number of selected universities in a particular country depended on the average number of Ph.D. programmes in design offered in that country.[6] Where in Canada, France, Germany and Italy the number of Ph.D. programmes in design did not exceed five, in the United States of America, Japan and Australia the number was approximately between five and ten programmes. Great Britain was the country[7] with the number of doctoral programmes in design considerably more than ten. Therefore, one university was selected from each country, and three from Great Britain.

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

Table 9. The approximate number (n) of Ph.D. programmes in design.

Another criterion for the selection of the programmes was the consideration of the best practices[8] in doctoral education in design.

The selected 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*.

4.2.2 Structure of the case study

Each case study was divided into three parts. The first part was the study of the Ph.D. programme. The second part was the study of a selected Ph.D. thesis. The third part was the development of an interview with the coordinator of the Ph.D. programme or with one of the doctoral supervisors.

4.2.3 Study of the Ph.D. programme

The study of the Ph.D. programme was structured into four parts. The first part was about general information related to the entry requirements and the period of study. The second part was dedicated to doctoral research: the areas of research, groups / units of research and the research phases.[9] The curriculum was studied in the third part where particular attention was paid to the philosophy underpinning the programme, its intention, the content and the sequence of study. Finally, the fourth part of the study focused on people involved in the doctoral programme such as the faculty members, the Ph.D. candidates and the Ph.D. graduates. The format of the programme study report is reported in appendix A.1.

4.2.4 Study of a selected Ph.D. thesis

After the examination of the Ph.D. theses developed within each programme, one representative thesis was selected for a further in-depth study. This criterion of selection was applied to six cases.[10] In four cases[11] the contacted coordinator or supervisor of the doctoral programme selected the representative thesis for the study. The principal issues reported in the study of the theses were: the motivation for the study, the aims, the methodology of research, the results developed and the principal contributions. The structure of the thesis and the abstract were also reported. The format of the thesis study report is reported in appendix A.2.

The selected Ph.D. theses were:

- Burns, Ausra, 2002. *Social Issues in Design Practice: Learning from a Community-based Project in Sackville, New Brunswick*. Ph.D. thesis, University of Alberta;

- Colakoglu, Birgul M., 2000. *Design by Grammar: Algorithmic Design in an Architectural Context*. Ph.D. thesis, Massachusetts Institute of Technology;

- Ishikawa, Shigetou, 2003. *Formative Process of the "Fat Face" Types and the Background for their Emergences.* Ph.D. thesis, Chiba University;

- Tang, Hsien-Hui, 2002. *Exploring the Roles of Sketches and Knowledge in the Interlinked and Multimode Design Process Using Protocol Analysis*. Ph.D. thesis, University of Sydney;

- Jacqueson, Loic, 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;

- Lango, Clemens, 2002. *Visuos. A Visuospatial Operating Software for Knowledge Work*. Ph.D. thesis, University of Wuppertal;

- Eckert, Claudia, 1997. *Intelligent Support for Knitwear Design*. Ph.D. thesis, Open University;

- Dunne, Anthony, 1999. *Hertzian Tales. Electronic Products, Aesthetic Experience and Critical Design.* Ph.D. thesis, Royal College of Art;

- Whiteley, Graham Paul, 2000. *An Articulated Skeletal Analogy of the Human Upper-Limb*. Ph.D. thesis, Sheffield Hallam University;

- Meroni, Anna, 2000. *Il Cibo Disegnato. Un Nuovo Ambito Disciplinare per il Disegno Industriale*. Ph.D. thesis, Politecnico di Milano.

4.2.5 Interview with the Ph.D. coordinator or supervisor

The final part of each case study was the development of an interview with the coordinator of the doctoral programme or with a supervisor. The interview was conducted with a doctoral supervisor when the Ph.D. programme did not have the role

of the coordinator. The unstructured open interview was adopted in all cases, since it "[…] can provide a greater breadth of data than the other types, given its qualitative nature." (Fontana and Fray, 2000). The format of the interview report is reported in appendix A.3.

The interviewed professors were:

Prof. Jorge Frascara from the University of Alberta;

Prof. George Stiny from the Massachusetts Institute of Technology;

Prof. Michio Miyazaki from Chiba University;

Prof. John Gero from the University of Sydney;

Prof. Robert Duchamp from the *Ecole Nationale Supérieure des Arts et Métier Paris* ;

Prof. Mihai Nadin from the University of Wuppertal;

Prof. Nigel Cross from the Open University;

Prof. Irene McAra-McWilliam from the Royal College of Art;

Prof. Chris Rust from Sheffield Hallam University;

Prof. Ezio Manzini from the *Politecnico di Milano.*

4.2.6 Data collection and evaluation

The research materials gathered and generated in the ten case studies were considered as principal data sources for the dissertation subjects. Multiple information sources and methods were used for data gathering, among which: the web sites of the doctoral programmes; the Ph.D. handbooks; correspondence with faculty members, doctoral candidates and graduates; publications of faculty members, doctoral candidates and doctoral graduates; Ph.D. theses; interviews; visits to universities and meetings with the coordinators or supervisors.

The process of data gathering was both iterative and idiographic. Each developed case raised new concerns because during the gathering stage a partially theoretical construction was made, which meant that data gathering process moved from one case to another through a winding approach. Both cross-sectional[12] and longitudinal[13] data were gathered for all cases. The Multiple information sources and methods used for data gathering permitted further triangulation,[14] which increased the validity and reliability of the findings.

4.3 Case studies of research processes including design project(s)

Another issue that emerged from the review of literature, and necessitated further investigation was the approach of research through design, intended as research through the project or through design practice. There exists within the design community a common consensus that this approach to research might lead towards the definition and articulation of design's own research paradigm that is different from other existing research approaches in the sciences and humanities.

However, the lack of concrete examples of research through design necessitated further understanding of two of its underpinning principles. The first one, an epistemological principle, concerned the relationship and contribution of the design project(s) to theory building.[15] The second one, a methodological principle, focused on the role of the design project(s) during the research process. This led to the development of the second empirical work.

4.3.1 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, i.e. northern America, Asia, Australia and Europe, and were considered for the same reason.[16] 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.[17]

The selected programmes were:

- From northern America: In Canada, the University of Montreal, the master of research programme in *Design and Complexity*;
- From Europe: In France, the *Ecole Nationale Supérieure des Arts et Métiers Paris*, the doctoral programme in *Conception de Produits Nouveaux*; In Great Britain, the Royal College of Art, the programme in *Interaction Design*; and Sheffield Hallam University, the doctoral programme in *Art and Design*; In Italy, the *Politecnico di Milano*, the doctoral programme in *Industrial Design and Multimedia Communication*.

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, 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.

Therefore, many cases were found at the *Ecole Nationale Supérieure des Arts et Métiers Paris*, among these five of the most recently developed were chosen; in addition, one case was selected from the master of research programme at the University of Montreal; two cases from the Royal College of art; one case from Sheffield Hallam University; five cases from the *Politecnico di Milano*.

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;
- Higgins, J. 2003. *Multi-Sensory Memorabilia: New Ways for Visually Impaired People to Save and Share Personal Memories* [online]. London: Royal College of Art.

- 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.

4.3.2 Description of the method

As reported above, the main concern in the second empirical work was to develop an in-depth understanding of the design project relationship with and contribution to theory building and its role during the research process. Research methods such as the interview and the study and interpretation of the theses were considered insufficient. Many critical issues about the research processes could have remained unclear and thus unarticulated. The following were among these issues: the various phases of the research process; how they were articulated; how the design project(s) were collocated with the whole research process.

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. The use of visual representations as a method of research has a very long tradition in research into design thinking[18] (Cross, 1999b; Dorner, 1998, 1999; Lawson, 1979, 1980; Oxman, 1994, 1997, 1999, 2004; Oxman et al, 1997; 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 (1997) and Oxman et al (1997) refer to the theories of "creative cognition"[19] (Finke, Ward and Smith, 1992) and the theory of "representation-redescription"[20] (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 (ibid.).

All the participants were asked to construct a schematic representation of their research processes using the blocks shown below in figure 2. The square blocks indicated different phases of research. They were divided into three groups. The first group represented the principal phases of a 'traditional' research process. The second group was related to the design project(s) included as a part of the research process. The third group was untitled square blocks to be used if participants wanted to add particular research phases. The material sent to the participants is reported in appendix C.

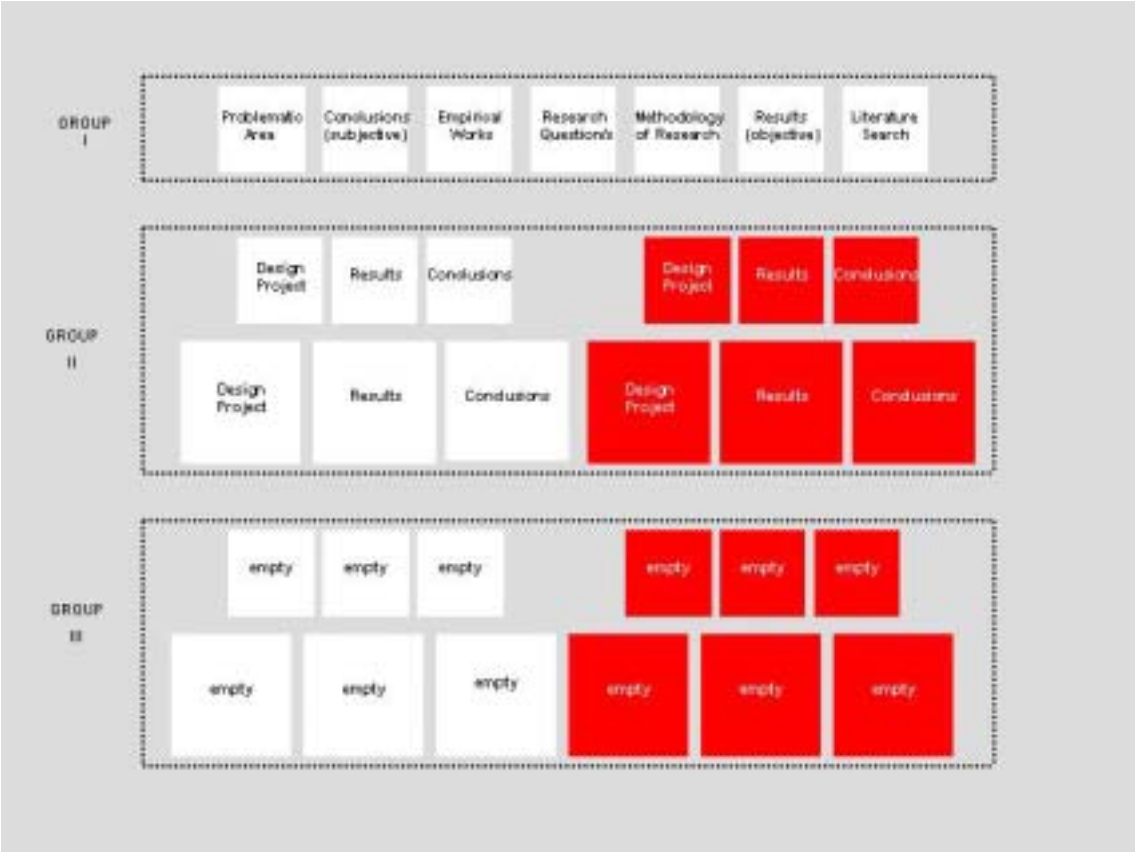

Figure 2. The blocks to be used for the schematic representation of the research process.

4.3.3 Data collection and evaluation

The research materials gathered and generated in the fourteen case studies were considered as principal data sources for the dissertation subjects. But in this empirical work the study of only a few individual 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; Frankenberger, 1997; 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, whether of the whole process or of a particular part of it, which were found similar in more than one case were taken into consideration for further understanding and generalizations.

1. Briefly, about critical issues:
Firstly, Ph.D. programmes in design were described in different ways. It was impossible to compare them and classify them. It was also impossible to individuate and articulate all the interrelated factors that shaped them differently. All these motivations necessitated further empirical investigation.
Secondly, many authors have contributed to the theoretical articulation of a research approach founded on design practice. The lack of concrete examples of this approach to research indicated a need for further understanding of its underpinning and guiding principles. These were the motivations for another empirical investigation.

2. Many authors have proposed, justified and tried to articulate, in different ways, the approach of research through design. None of these authors, or others, has excluded the importance of other co-existing approaches to doctoral research in design, approaches modelled like research in the sciences or in the humanities. They agreed on a plurality of approaches for doctoral research in design, and that the approach to research through design will probably lead towards a design's own research paradigm.

3. According to Denzin and Lincoln "[…] the major paradigms and perspectives that now structure and organize qualitative research: positivism, postpositivism, constructivism and participatory action frameworks. Alongside these paradigms are the perspectives of feminism (in its multiple forms), critical race theory, queer theory, and cultural studies." Refer to Denzin, N. K., and Lincoln, Y. S. eds. 2000. *Handbook of Qualitative Research*. 2nd ed. Thousand Oaks, California: Sage Publications, p 157.

4. Classifications and taxonomies might be seen as introducing more dogmatism into the field. On this issue, Langrish (1993) argues that "putting words to things that people have been vaguely aware of helps communication, teaching, etc. and gives the power of prediction via assignment to a particular class, having several things in common." In his article "Case studies as a biological research process." Published in *Design Studies*, volume 14, number 4, pp 357-364.

5. 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.

6. 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.

7. What distinguished the British context was the high number of universities that offered Ph.D. programmes in design and the rich variety of approaches adopted by these programmes. According to Archer (2000) and Durling (2000), this was the result of the different reforms in the structure of Higher Education that took place in Britain first, in 1965 (local and regional colleges were to amalgamate to form polytechnics), then in 1992 (polytechnics became self-governing universities) and later in 1997 (the Council for Graduate Education published its report "Practice-based doctorates in the creative

and performing arts and design." For an in-depth study, refer to Archer's (2000) and Durling's (2000) papers published 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 257-260 and 317-327.

8. Langrish (1993) argues that best practice is one of the six basic types of case study selection. These are: the comparative, the representative, the best practice, the ones next door, the 'cor, look at that' and the taxonomic. For an in-depth study, refer to the article "Case studies as a biological research process" published in *Design Studies*, volume 14, number 4, pp357-364.

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. It is intended by research phases, in some doctoral programmes, the sequence of research phases. In others, it is referred to the description of all the programmes' phases from the beginning of the study until receiving the Ph.D. award.

10. The cases were: the Massachusetts Institute of Technology (case 02); the University of Sydney (case 04); the *Ecole Nationale Supérieure des Arts et Métier Paris* (case 05); the Open University (case 07); the Royal College of Art (case 08); the *Politecnico di Milano* (case 10).

11. The cases were: the University of Alberta (case 01); Chiba University (case 03); the University of Wuppertal (case 06); Sheffield Hallam University (case 09).

12. Cross-sectional data is developed when comparing the cases on the selected issues.

13. Longitudinal data is developed when comparing the changes between the cases on the selected issues.

14. According to Robert E. Stake, in qualitative casework, "triangulation has been generally considered a process of using multiple perceptions to clarify meaning, verifying the repeatability of an observation or interpretation." He adds that "[…], triangulation serves also to clarify meaning by identifying different ways the phenomenon is being see." Refer to Stake, E. R., 2000. "Case studies." *In*: N. K. Denzin, and Y. S. Lincoln, eds. 2000. *Handbook of Qualitative Research.* 2nd ed. Thousand Oaks, California: Sage Publications, p 443.

15. While answering the question: "what is, or indeed should be, the role of theory in practice?" Findeli (1999) replied: "The traditional answer is that design practice is applied theory, a model inherited from the nineteenth century. This idealistic model,

widely propagated in design education, is contradicted every single day by both concrete design practice and research. It should therefore be abandoned and replaced by a more sophisticated, complex, model where practice and theory mutually nurture and validate themselves." In the introduction of the special issue of *Design Issues*, dedicated to design research, volume 15, number 2, p 2.

16. 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.

17. Only one of the selected cases was a master programme: the master in *Design and Complexity* offered at the University of Montreal in Canada. The motivation for its selection was that this particular master programme is a research programme explicitly based on the approach of research through the project.

18. 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*.

19. Oxman (1999) was referring to: Finke, R. A., Ward, T. B., and Smith, S. M., 1992. *Creative Cognition, Theory Research and Applications*. Cambridge, Massachusetts: MIT Press. In the article, "Educating the designerly thinker" published on *Design Studies*, volume 20, number 2, p 107.

20. Oxman (1999) was referring to: Karmiloff-Smith, A., 1995. *Beyond Modularity*. Cambridge, Massachusetts: MIT Press. In the article, "Educating the designerly thinker" published on *Design Studies*, volume 20, number 2, p 107.

5. AN OUTLINE OF RESULTS FROM CASE STUDIES ANALYSIS

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 for 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."

5.1 Sciences and humanities research approaches to the Ph.D. in design

By the sciences and humanities approaches for doctoral research in design, the systematic and methodical approach to research is intended. 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, 1979b). In humanities, understanding is based on contemplation, criticism, evaluation and discourse (ibid.).

This approach to design research, often labelled (Findeli, 1999, 2000b; Cross, 1998, 1999a) 'academic research' have the following characteristics (Cross, 1998, 1999a, 2000a, 2000b):

- purposive, based on identification of an issue or problem worthy and capable of investigation;
- inquisitive, seeking to acquire new knowledge;
- informed, conducted from an awareness of previous, related research;
- methodical, planned and carried out in a disciplined manner;
- communicable, generating and reporting results which are testable and accessible by others.

In all the ten cases of doctoral programmes, it was possible to undertake this approach to research. In five of these programmes it was the only accepted approach to doctoral research (refer to table 10). These programmes were: In Canada, the University of Alberta, the doctoral programme in *Art and Design* (appendix B.1); In the United States of America, the Massachusetts Institute of Technology, the doctoral programme in *Design and Computation* (appendix B.2); In Japan, Chiba University, the doctoral programme in *Science of Design and Architecture* (appendix B.3); In Australia, the University of Sydney, the doctoral programme in *Design Computing and Cognition* (appendix B.4); and In Great Britain, the Open University, the doctoral programme in *Design and Innovation* (appendix B.7).

	Sciences and Humanities Approaches[1]	**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 10. Research approaches adopted by the selected Ph.D. programmes in design.[2]

5.1.1 Processes, methodologies and methods

In five of the ten studied Ph.D. cases,[3] research was based on the sciences or the humanities approach to inquiry. In these cases, the research process was 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 (appendix B.1 and B.2), the historical approach (appendix B.3), protocol analysis (appendix B.4) and ethnography (appendix B.7). A variety of methods was used in each strategy of research. In case studies the main methods or tools used were:[4] photographic images, video recording, interviews and recording of observations. The historical approach involved the use of historical documents and written records of the past, including letters, newspapers and other popular culture documents. In protocol analysis the main tools used were protocol, sketches and videotape recording. In ethnography the methods used were participant observations and interviews.

5.1.2 Common form of theses

The studied cases of doctoral theses, developed on the basis of a sciences or humanities approach to inquiry, were structured like common 'academic' Ph.D. theses. These theses, independent of the contents, have the same structure in all fields of academic research. These five theses included the following main chapters: a general introduction where the main problem or issue, the motivations, aims and an overview of the thesis were described; a review of relevant literature; the articulation and description of the methodology; the results; the discussion of these results; the conclusion, where contributions of the research and future work were described. (Refer to appendixes B.1, B.2, B.3, B.4 and B.7.)

5.1.3 A training in 'academic' research

It was argued, in Chapter Two,[5] that a Ph.D. is a research training process the aim of which, to become a professional researcher in a field of concern and to develop an original contribution to knowledge. In the studied cases these issues varied from one

context to another. In the sciences and humanities approach to research, the training mainly emphasized the research methodology. The concern was for the early articulation of a research problem, the identification of a research site, selection of research strategies and relative methods for collecting and analysing data. All of these research phases were laid out in a thesis form.

5.2 Practice-based approach[6] to the Ph.D. in design

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.

This approach was adopted in five[7] of the ten cases of Ph.D. programmes (refer to table 10). But, in two doctoral programmes: *Conception de Produits Nouveaux* from the *Ecole Nationale Supérieure des Arts et Métier Paris* (appendix B.5) and the *Interaction Design* from the Royal College of Art (appendix B.8), it is the preferred research approach.[8]

This approach to research was similar to the "project-grounded research" articulated by Findeli (1999, 2000b, 2001), the "integrated conglomerate approach" articulated by Sevaldson (2000), to the research approaches articulated and defined by Franz (2000), Glanville (1998, 1999, 2003), 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. They were represented in the review of literature under the title “research through design.”

5.2.1 Action research through design practice

In the studied practice-based cases,[9] action research underpinned and guided the research processes. The ‘action’ took place through the development of design projects[10] 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. An in-depth description of these research processes is reported later in this chapter in section 5.4 entitled “Characteristics of research through design / practice-based approach.”

5.2.2 Different forms of theses

The theses developed under the practice-based approach for doctoral research in design were structured in different ways.[11] They were divided into different sequences of chapters, which in some cases were grouped into several parts, with different titles given to the parts and the chapters. The number of chapters ranged from four to eight (refer to appendixes B.5, B.8 and B.10.).

Although it was not possible to identify a common form to these theses, the sequence of contents was very similar.[12] The sequence of contents was the following: the introduction; the in-depth study of the context of the research, both the situation and its theoretical implications; the methodology of the research; the project(s) developed with relative phases of development; and the conclusions.

The project(s) developed were reported in a few cases at the end of the theses, in the last chapter or in the annexes, however, in most cases, they were reported where they took place during the research process in a chronological order of research development. Visual material relative to the projects and their phases of development constituted an integral part of the theses.

5.2.3 A training in 'situated' research

The main emphasis of the practice-based approach was the coherent linkage of the theoretical and studio aspects of a particular area of design within a research context. Candidates learned how to articulate and situate different kinds of findings in a research context. They dealt with fuzzy problems by integrating deliberate reflections, challenging interpretations and iterative actions through the development of design project(s).

The research situations demanded responsiveness during the research development in order to produce intentional change. Candidates often faced participative situations that required delicate negotiations, interactions, procedures and processes. The development of design project(s) during the research processes enhanced the candidates' abilities in

particular areas of design practice. All of these different aspects of the research process, reported above, were used as a mode of discourse in writing the thesis.

5.3 Practice-centred approach[13] to the Ph.D. in design

Three of the ten cases of Ph.D. programmes in design adopted a practice-centred approach as well as the sciences, humanities and practice-based ones. These programmes were: In Germany, the University of Wuppertal, the doctoral programme in *Computational Design* (appendix B.6); In Great Britain, Sheffield Hallam University, the doctoral programme in *Art and Design*[14] (appendixes B.9 and D.9); and in Italy, the *Politecnico di Milano*, the doctoral programme in *Industrial Design and Multimedia Communication* (appendix D.11).

In this recent approach[15] to doctoral research in design, the development of design project(s) was considered as a form of research. About the problems related to this approach, Findeli (2000b) 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.[16]

5.3.1 Product development processes and methods

In the practice-centred approach different design projects were developed: a visuospatial operating software for knowledge work, an anatomically analogous skeletal model hand and arm, and tools for the International Space Station (refer respectively to appendixes

B.6, B.9, D.9 and D.11). The development of these advanced design projects was considered as a form of doctoral research in design. 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. In one of the cases, software development methods were used (refer to appendix B.6). In another case, methods ranged from craft methods and design-by-drawing methods guided by creative reasoning to analogies and mathematical analysis (refer to appendixes B.9 and D.9). Fast prototyping and virtual reality methods and tools were also used (refer to appendix D.11).

5.3.2 Thesis problem

The emphasis in the practice-centred approach to doctoral research in design was on the development of advanced design projects. The phases of development of the projects and resulting prototypes were reported in the theses. A great number of two-dimensional visual material and three-dimensional objects represented the different practices developed and the results. They were all represented in the theses.

This was problematic since there were no reference models in other disciplines suitable to this kind of doctoral thesis. Various thesis structures were developed. Contents were articulated in different ways in order to represent and make explicit the procedures which had been followed and the results reached (refer to appendixes B.6 and B.9).

5.3.3 A training in 'professional practice' research

In the practice-centred approach to doctoral research in design, design practice was considered as a form of research. Design practice was studied through practice. Candidates conducted practical design activities in a reflective, interpretive, investigative and experimental way. Creative processes of discovery, invention and innovation were undertaken. The emphasis on practice permitted the candidates not only to improve their own practices, but also to regenerate their own work.

5.4 Characteristics of research through design / practice-based approach

5.4.1 Introductory elements

The research approach where the emphasis was on design practice, considered as both a site and medium for research, was first reported in the review of literature.[17] Different names were given to this approach for design research such as: the "interpretive-contextual framework" (Franz, 2000), "action-research by project" (Seago and Dunne, 1999), "project-grounded research" (Findeli, 1999), etc. They were all grouped and identified, in the review of literature, under the title "research through design."[18]

The first empirical work revealed that this approach to design research was already practiced at the doctoral level. It was given different names, such as "Ph.D. by project" at the Royal College of Art, "*recherche-projet*" at the University of Montreal, etc. The

different terms assigned to this doctoral approach for design research were grouped in the first part of the results under the title "practice-based approach."[19]

The second empirical work focused on cases of doctoral research in design that included a practice component.[20] Fourteen cases were selected. Two of these cases were considered practice-centred research, since design practice was considered as a form of research (refer to appendixes D.9 and D.11). In a third case, even though a design project was included in the research, the latter was based on the scientific approach. In this latter case, the design project was considered as a site for the application of the research results (refer to appendix D.14).

The study of the eleven other cases contributed to a better understanding of some of the fundamental principles of research through design (refer to appendixes D.1, D.2., D.3, D.4, D.5, D.6, D.7, D.8, D.10, D.12, and D.13). Among these principles were the following: the nature of the research problem addressed in this kind of research and its relative articulation phases; the nature of the research process and the role of the design projects within the process; the contribution of the design project to knowledge and the kinds of knowledge produced.

5.4.2 Fuzzy research problems

The study of the doctoral research processes as represented by the candidates revealed that the problematic areas and the research questions were not represented, as in the cases that adopted the sciences or humanities approach for design research, at the beginning of the research processes. Their definition involved undertaking several research phases.

This was due to the fuzzy nature of the problems concerned. These problems were very specific, and depended on particular research contexts. Their definition necessitated the development of different 'actions.' In the figures reported below, the definition of the research problem was represented as a long process articulated in different research phases. This problem definition was carried out for approximately half of the research processes (see figures 3 and 4).

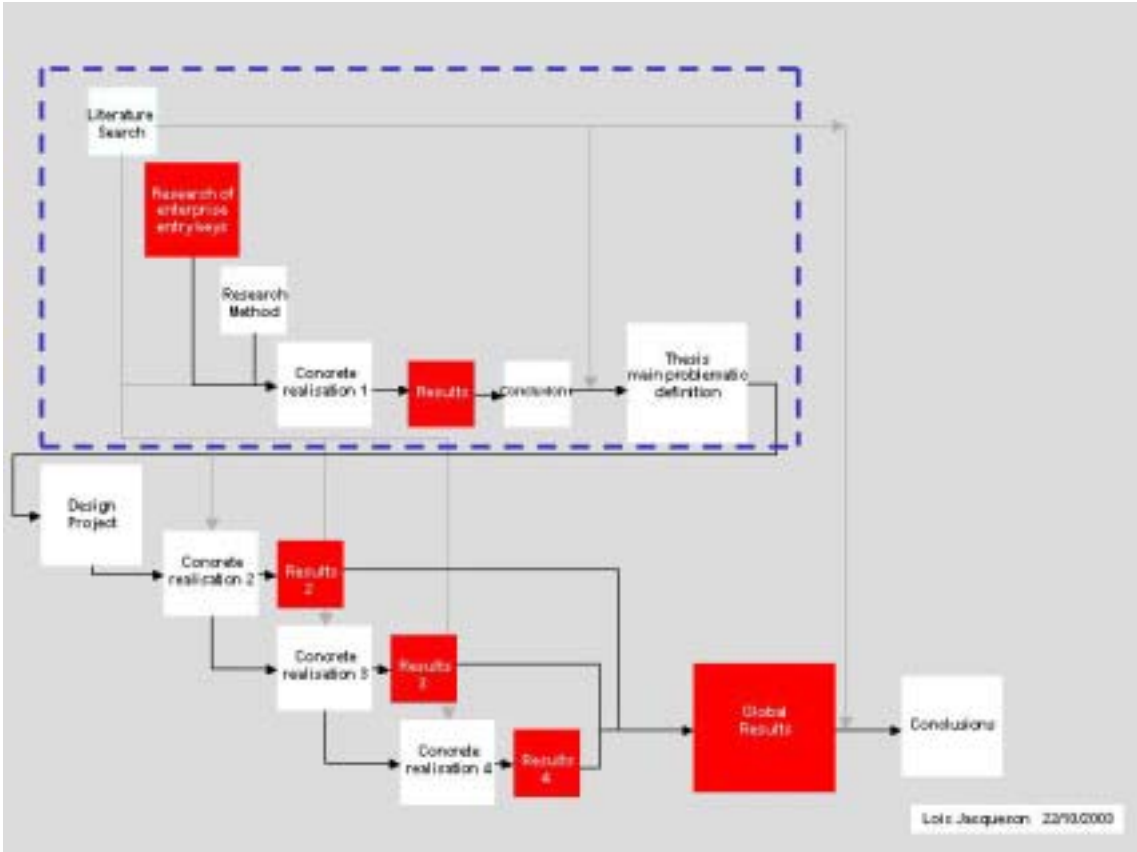

Figure 3. Schematic representation of the research phases related to the problem definition (Jacqueson, 2003).

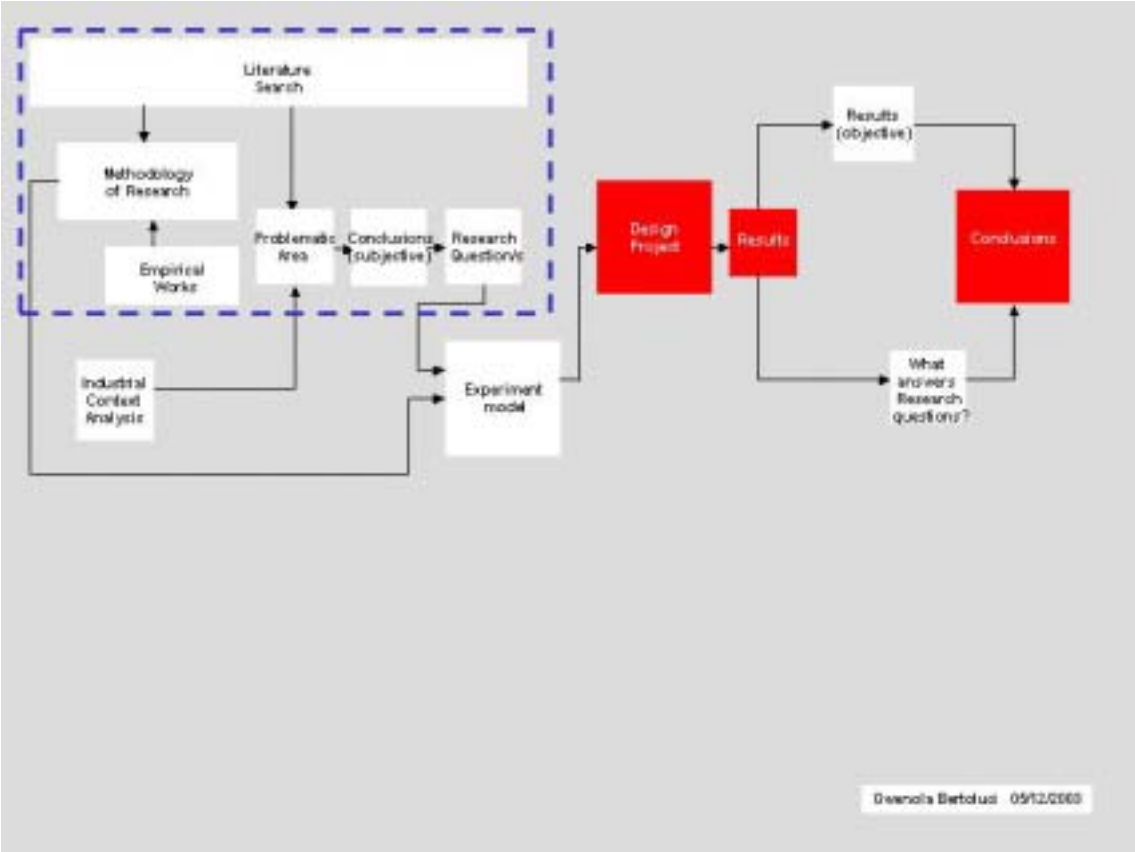

Figure 4. Schematic representation of the research phases related to the question definition (Bertoluci, 2003).

5.4.3 Ongoing construction of research processes

Action research underpinned the research processes. Unlike action research as developed in qualitative research settings, in the studied cases the 'action' took place through design practice. The development of design projects was considered as a site and medium for the research and not as an end of the research. These projects contributed to understanding and to the development of the research.

The phases of the research processes were a combination of different research phases and design project(s). 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).

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.

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.

Linear research processes

In linear research processes, two major research phases were identified. 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. In the some of the cases, the combination of the design project, empirical works and literature search formed the methodology of research, as shown in figure 5. In other cases the development of several design projects contributed to the refinement of the methodology of research as shown in figure 6.

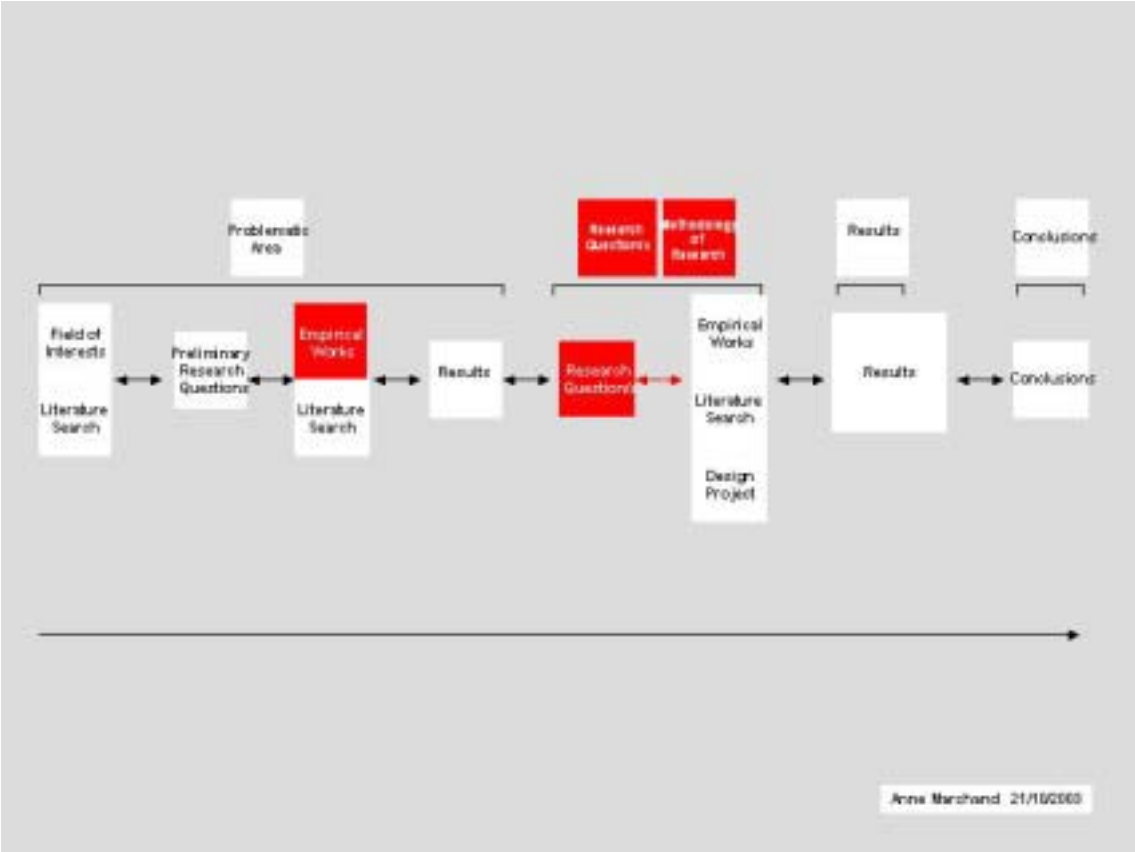

Figure 5. Schematic representation of a linear research process (Marchand, 2003).

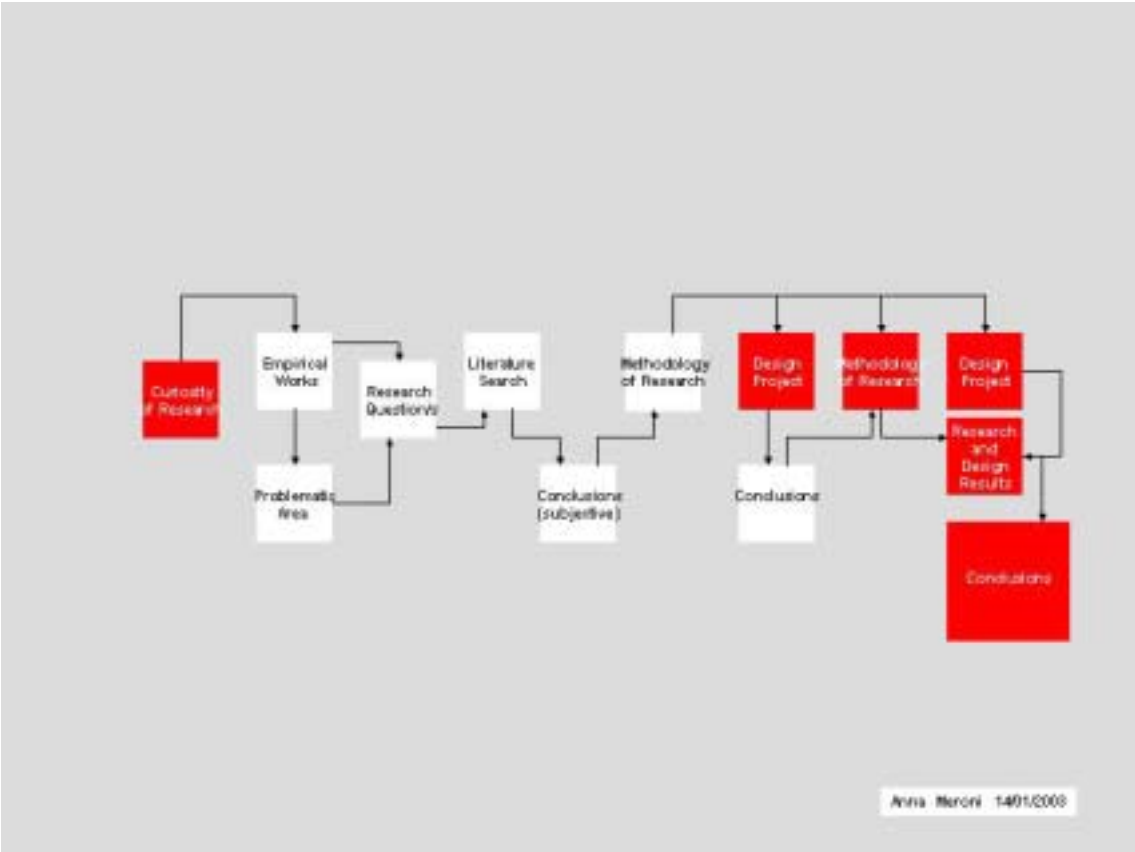

Figure 6. Schematic representation of a linear research process (Meroni, 2003).

Parallel research processes

In other cases, 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 figures 7 and 8. The two processes mutually nurtured each other, as it was represented in the example below: the participant represented first her research process in the structural schema in figure 8. When she was asked to represent the relations between the research phases, she developed the schema reported in figure 9.

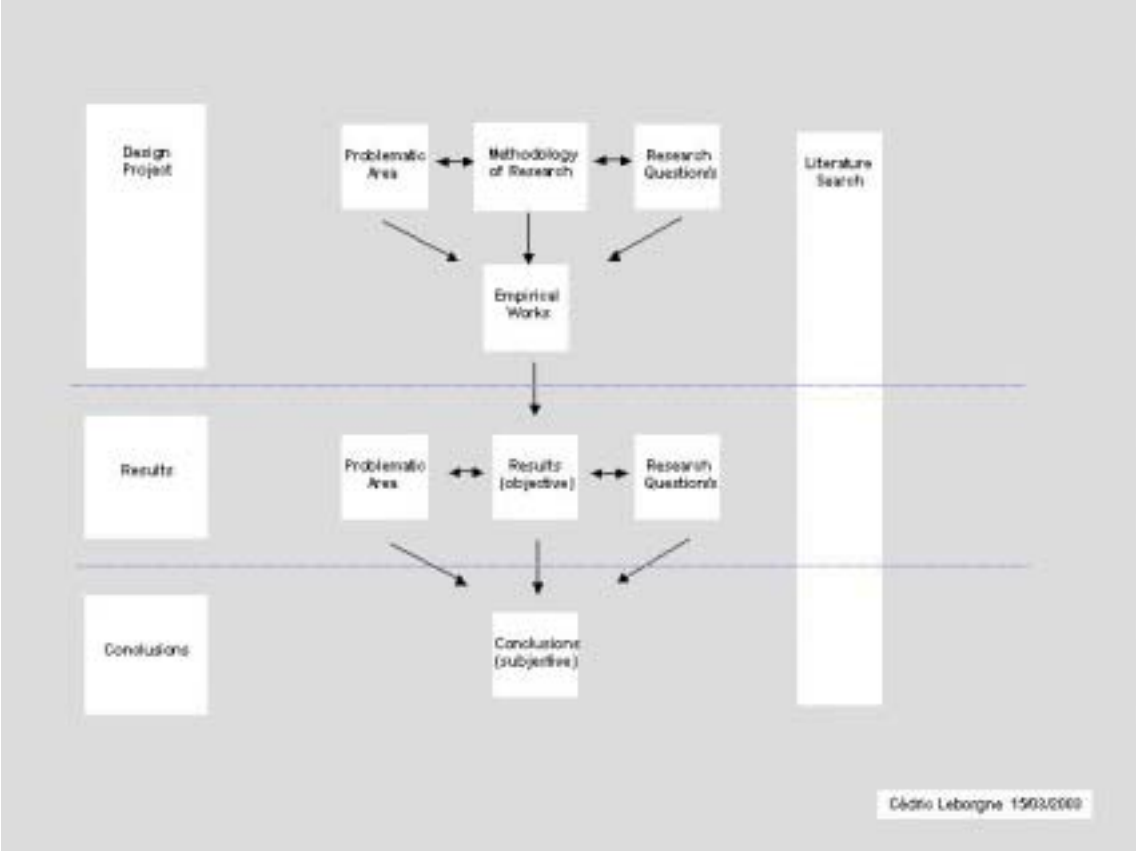

Figure 7. Schematic representation of a parallel research process (Leborgne, 2003).

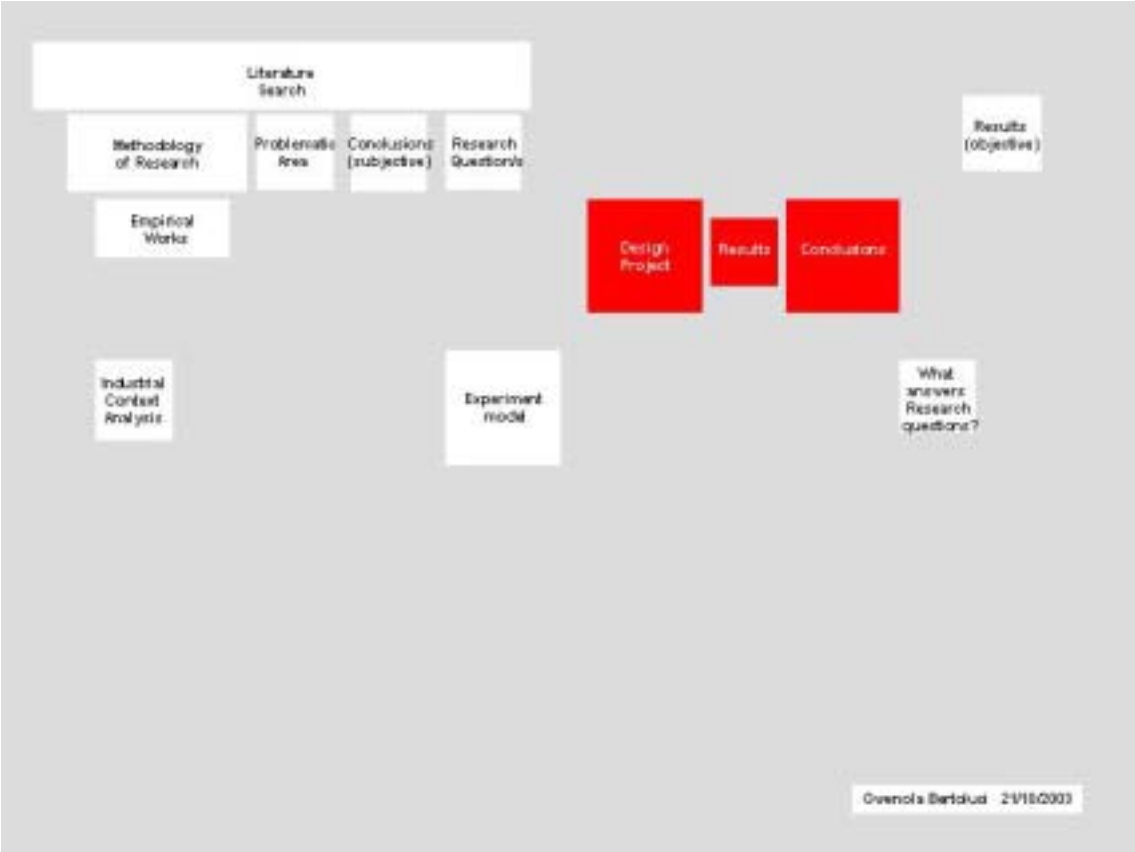

Figure 8. Schematic representation of a parallel research process (Bertoluci, 2003).

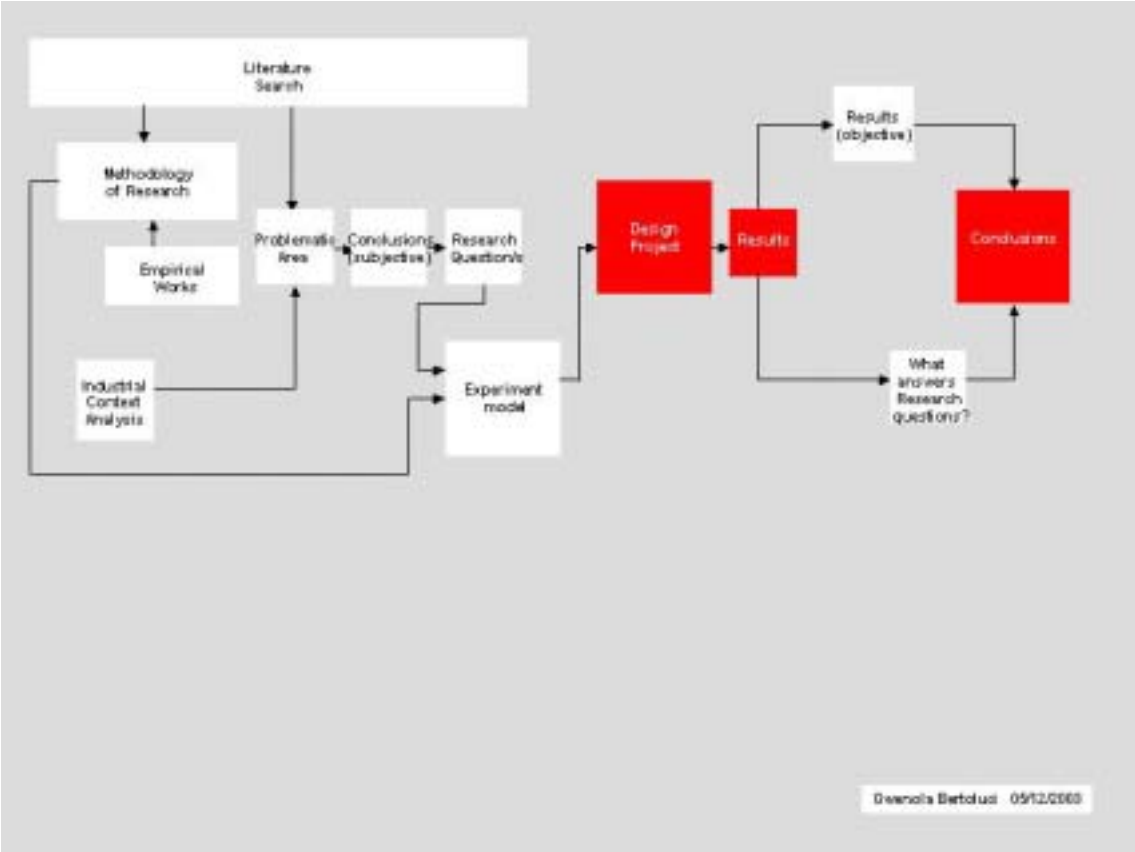

Figure 9. Schematic representation of the relations between the phases in a parallel research process (Bertoluci, 2003).

Cyclic research processes

In other cases the combination of design projects with the other phases of the research resulted in cyclic processes. Each cycle represented a design project or a component of the project and its relative theoretical context. Each cycle produced more understanding and contributed to the refinement of the methodology of research. See the figures 10 and 11.

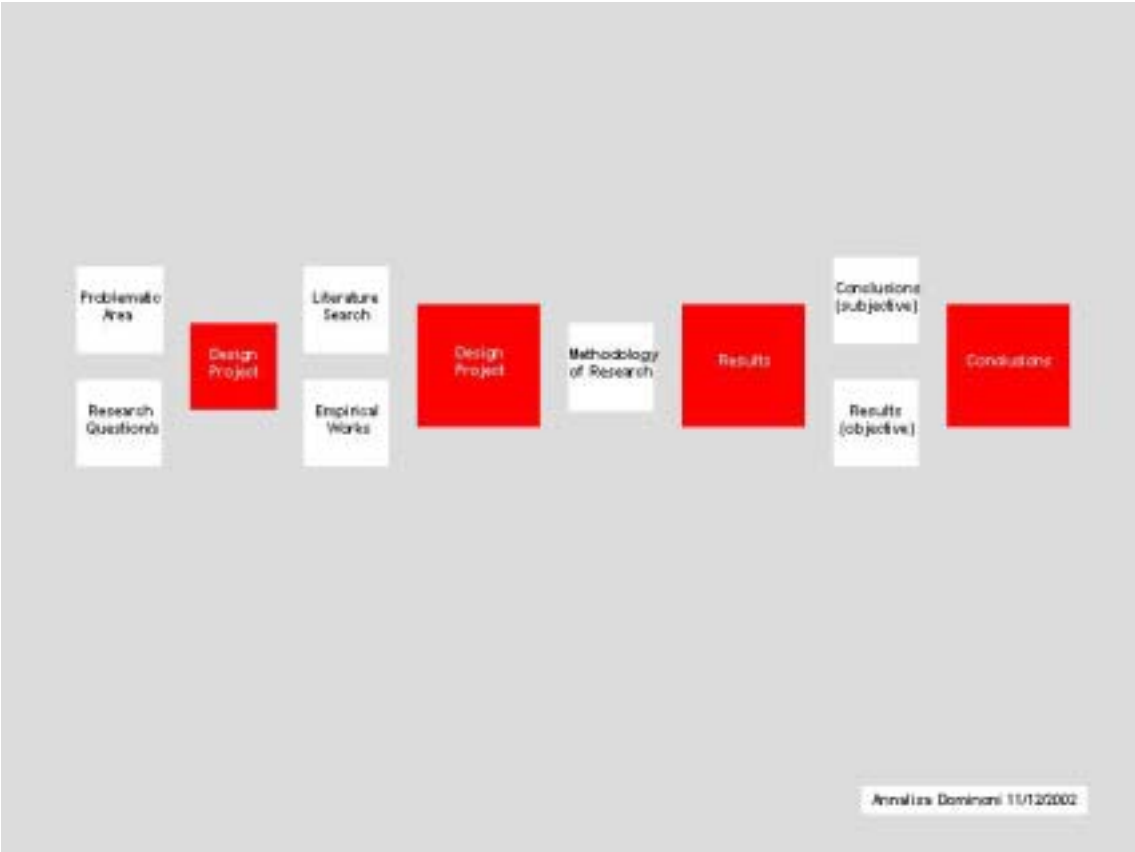

Figure 10. Schematic representation of a cyclic research process (Dominoni, 2002).

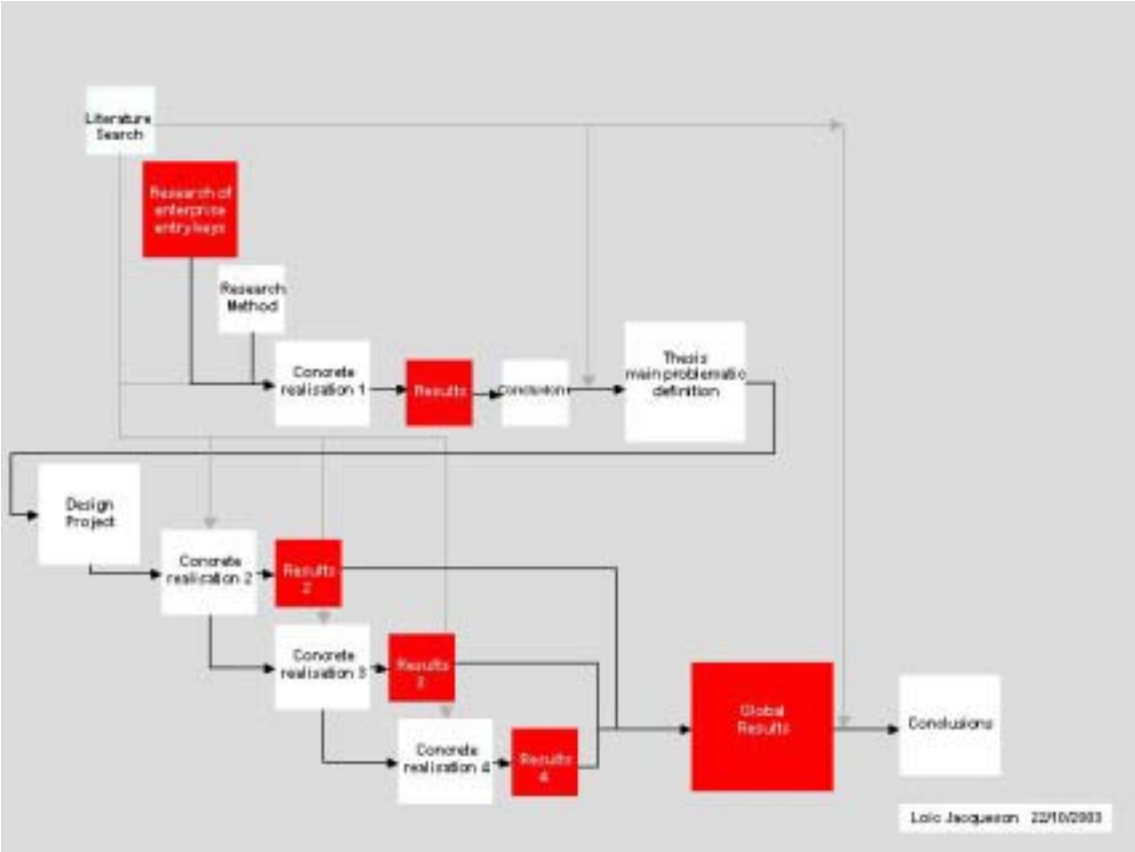

Figure 11. Schematic representation of a cyclic research process (Jacqueson, 2003).

5.4.4 Categories of knowledge produced

The study of the schematic representations of the research processes shed light on the different kinds of knowledge produced in the research through a design / 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. Another kind of knowledge was the result of the design project(s) developed. A third kind of knowledge was a 'meta-knowledge' constructed over the course of the research process, an "actionable" knowledge destined for further research.

These different kinds of knowledge produced were evidenced in different ways. For example in one case two kinds of results were reported at the end of the process as shown in figure 12: research results and design results. In another case three kinds of results were reported in the schema. The first was relative to the theoretical context of the research. The second was relative to the industrial context and the third was relative to the design projects developed, as it was represented in figure 13. These different kinds of knowledge were interwoven.

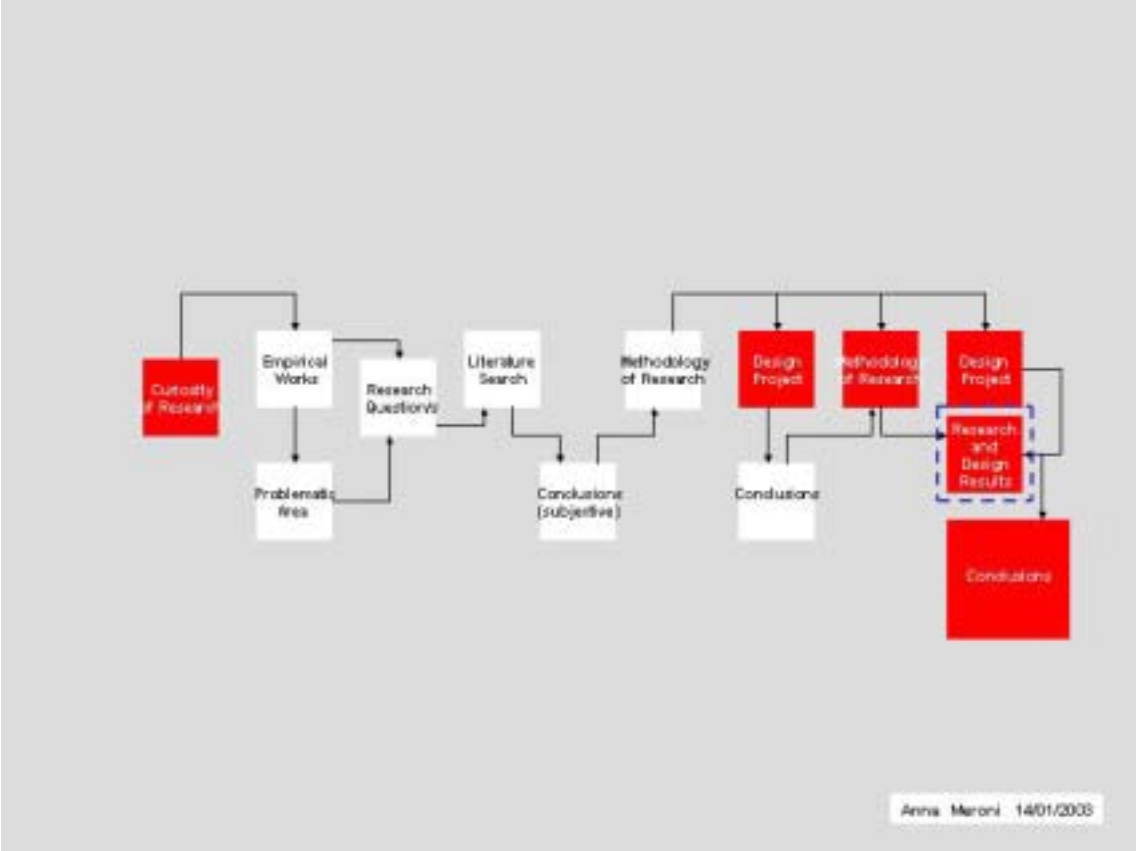

Figure 12. Schematic representation of two kinds of results (Meroni, 2003).

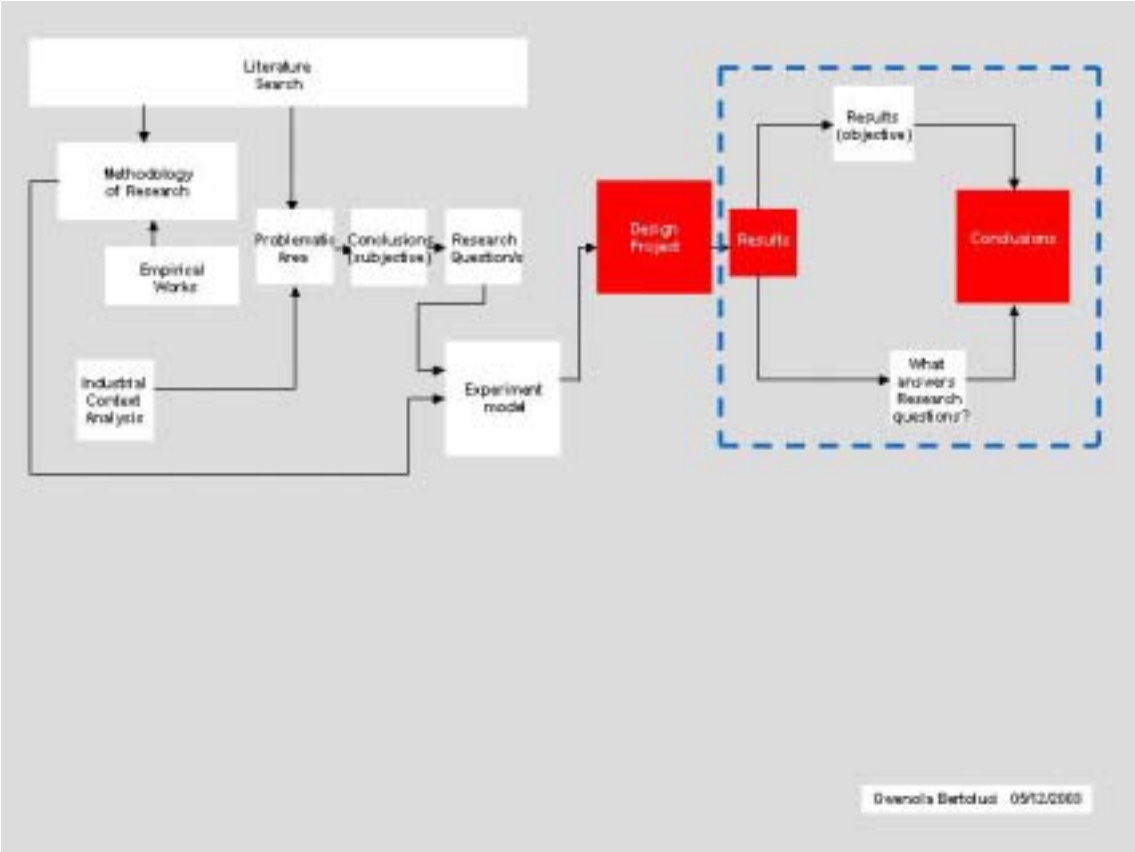

Figure 13. Schematic representation of three kinds of results (Bertoluci, 2003).

5.4.5 Autonomy versus non-autonomy principles

The research through design / practice-based approach to doctoral research in design was underpinned either by the principle of autonomy or by the principle of non-autonomy. When autonomy was the underpinning principle, the researchers constructed their research and design projects. They developed different negotiations, interactions, and interventions. They chose the kind of design projects to be developed, they selected different stakeholders, and they were responsible for the management and development of the design projects. Refer to appendixes B.8, B.10, D.1, D.8, D.10 and D.13.

When the non-autonomy principle underpinned the research process, the researcher worked within an organisation. Many phases of the design projects required the participation of different actors from within the organisation. These projects were co-managed and co-designed. Refer to annexes B.5, D.2, D.3, D.4, D.5, D.6. and D.7.

According to Branzi (2002) the principle of autonomy is fundamental to design research. He argues that the autonomy principle permits researchers to articulate research problems and develop design projects that do not end up in concrete realizations, but in the consideration of these projects as a medium of inquiry and thinking. The importance of the autonomy principle lies in the kind of knowledge it produces. It is not an immediate knowledge that results in a project form. It is a long term knowledge that is directed toward other disciplines. In the autonomy research settings, design projects are considered as tools to address socio-cultural problems (ibid.)

1. All of these programmes adopted the scientific approach for the Ph.D., but not all of them also adopted the humanities approach.

2. This table is the result of the analysis of the reports of the Ph.D. programmes, the selected Ph.D. theses and the interviews with the Ph.D. supervisors. Refer to annex B.

3. The four following theses were based on the scientific approach for research:
- Burns, Ausra, 2002. *Social Issues in Design Practice: Learning from a Community-based Project in Sackville, New Brunswick*. Ph.D. thesis, University of Alberta;
- Colakoglu, Birgul M., 2000. *Design by Grammar: Algorithmic Design in an Architectural Context*. Ph.D. thesis, Massachusetts Institute of Technology;
- Tang, Hsien-Hui, 2002. *Exploring the Roles of Sketches and Knowledge in the Interlinked and Multimode Design Process Using Protocol Analysis*. Ph.D. thesis, University of Sydney;
- Eckert, Claudia, 1997. *Intelligent Support for Knitwear Design*. Ph.D. thesis, Open University.

The following thesis was based on the humanities approach for research:
- Ishikawa, Shigetou, 2003. *Formative Process of the "Fat Face" Types and the Background for their Emergences.* Ph.D. thesis, Chiba University;

4. In the Ph.D. thesis selected from MIT, the case study was the methodological approach to research, and the method used was not inspired by qualitative research methods. It was a design method entitled "shape grammar," a rule-based design method used for the analysis and generation of forms and design styles. For a detailed description of the thesis refer to appendix B.2.

5. In Chapter Two, the nature and objectives of the Ph.D. were articulated with reference to documents and reports by research councils, higher education councils, university handbooks and Ph.D. guides.

6. 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 thesis.

7. These Ph.D. programmes are:
- In France, the *Ecole Nationale Supérieure des Arts et Métier Paris*, the doctoral programme *Conception de Produits Nouveaux* (appendix B.5);
- In Germany, the University of Wuppertal, the doctoral programme in *Computational Design* (appendix B.6);
In Great Britain, the Royal College of Art, the doctoral programme in *Interaction Design* (appendix B.8) and Sheffield Hallam University, the doctoral programme in *Art and Design* (appendix B.9);
- In Italy, the *Politecnico di Milano*, the doctoral programme in *Industrial Design and Multimedia Communication* (appendix B.10).

8. This was explicitly revealed by the head of the doctoral programmes during the interviews. Refer to the interviews in appendixes B.5 and B.8.

9. The cases were:
- Marchand, A., 2003. *Bionique en Design: Approche Revisitée et Perspectives Nouvelles*. M.Sc. thesis. University of Montreal (appendix D.1);
- Bertoluci, G., 2001. *Proposition d'une Méthode d'Amélioration de la Cohérence des Processus Industriels.* Ph.D. thesis, ENSAM Paris (appendix D.2);
- 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 (appendix D.3);
- 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(appendix D.4);
- 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 (appendix D.5);
- Ollendorff, C., 1999. *Construction d'un Diagnostic Complexe d'une Bibliothèque Académique*. Ph.D. thesis, ENSAM Paris (appendix D.6);
- Higgins, J. 2003. *Multi-Sensory Memorabilia: New Ways for Visually Impaired People to Save and Share Personal Memories* [online]. London: Royal College of Art. Available from: http://www.hhrc.rca.ac.uk/programmes/ra/2003/jac.html [accessed 12 March 2004]. (appendix D.7);
- Swinford, R., 2004. Personal Communication Devices. Realising the Extensions of Man. M.Phil. thesis, Royal College of Art (appendix D.8);
- Dominoni, Annalisa, 2001. *Disegno Industriale per la Progettazione Spaziale.* Ph.D. thesis, Politecnico di Milano (appendix D.10);
- 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 (appendix D.12);
- Meroni, Anna, 2000. *Il Cibo Disegnato. Un Nuovo Ambito Disciplinare per il Disegno Iindustriale*. Ph.D. thesis, Politecnico di Milano (appendix D.13).

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

11. with the exception of the doctoral programme of the *ENSAM Paris*, where the theses had the same structure.

12. With the exception of the following thesis: Dunne, A., 1999. *Hertzian Tales. Electronic Products, Aesthetic Experience and Critical Design.* Ph.D. thesis, Royal College of Art.

13. This approach to design research is entitled in this thesis "practice-centred approach" with reference to the *Art and Design Research Centre* from Sheffield Hallam University, a pioneering centre in this approach.

14. This centre was pioneering in the development of the "practice-centred approach" for doctoral research in design.
15. Only a few theses have recently been developed in each doctoral programme. One of these theses was submitted in the year 2000. The other two were submitted during the year 2003.

16. Periodical debates about this approach for doctoral research in design have taken place, for example, in the *PhD-Design* on-line discussion list, available at: http://www.jiscmail.ac.uk/lists/PHD-DESIGN.html.

17. Mainly in Chapter Three, section 3.3 entitled *Research through design*.

18. The use of the term *research through design* was motivated by the fact that it has been quoted by many authors in the design research community.

19. As it was reported earlier, this kind of doctoral research was given various names by different 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 title in this thesis.

20. By practice component, it was intended the development of conceptual prototypes, working prototypes, design methods, or design tools.

6. DISCUSSION: TOWARDS A DESIGNERLY APPROACH TO RESEARCH

The existence of different approaches to design research and doctoral research in design was first articulated in the review of literature developed in Chapter Three. Another important issue of the review of literature was the common consensus that design as a discipline has a status of its own, distinct from other disciplines.[1] It was agreed that design belongs to a third area of human knowledge[2] concerned with the making and doing aspects of human activities.[3] These issues required and justified a design's own research paradigm, identified in the review of literature as "research through design." Nevertheless, other co-existing approaches were also considered valid and important.

The two empirical studies that focused on doctoral research in design brought more understanding about these issues. Three categories of design research, based on three different approaches to research,[4] were identified and described. It was also found that "research through design," as first described in the review of literature and considered as a distinct approach to design research,[5] was already practiced in a few doctoral programmes. The empirical works also contributed to a better understanding of this distinct approach to design research.

However, to offer a complete view of the picture of doctoral research in design and argue for a designerly approach to research, it was considered important to articulate two further issues. Firstly, why different research approaches to the Ph.D. in design co-exist. Secondly, whether the research through design / practice-based approach to doctoral research can be considered as designerly research. These issues are articulated in the following two sections.

6.1 Why are there different approaches to the Ph.D. in design?

The identification of three different approaches to doctoral research in design was interpreted as the result of the interplay of many different factors, divided into external factors and internal factors. The distinction between external and internal factors was borrowed from a model of the history of sciences, concerned with the study of the evolution of scientific paradigms and theories. Concerning this model, Findeli and De Coninck (2002) argue that internal factors depend mainly on the internal logic of the science under consideration. External factors depend on economic, social, cultural, political, etc. factors.[6] Following this model, the factors that implicated the co-existence of different approaches to doctoral research in design are reported below.

6.1.1 External factors

Higher education reforms

Higher education reforms, such as changes in the structure of higher education, in the status of higher education institutions or in the nature of doctoral education, were among the several external factors that shaped doctoral research in design. For example, in the Australian (Davis, 2003) and the British context (Archer 2000; Durling 2000) these changes due to higher education reforms were more evident than in other contexts studied. In both contexts the higher education reforms contributed to the current state of their doctoral education in design.

In Britain for example, in 1965, local and regional colleges that taught art and design considered as 'vocational' subjects amalgamated to form polytechnics. As a consequence, a first degree in design was offered.[7] In 1992, Polytechnics became self-governing universities. Doctoral degrees in practitioner disciplines such as design were

introduced. Then, in 1997, the UK Council for Graduate Education published its famous report "Practice-based doctorates in the creative and performing arts and design."[8] This event marked the launch of doctoral programmes in design in Britain. Several universities extended "[…] the requirements for the award of their Ph.D. degrees, allowing the submission of practical work as part of the candidate's independent and original contribution to knowledge."[9] In particular, the latter reform contributed to the variety of approaches to doctoral research in design that exist in Britain.

Decision makers stances

Another factor that contributed to the existence of different approaches to doctoral research in design was the knowledge stances of academic decision makers. In the studied Ph.D. cases, decisions concerning the Ph.D. programmes were mainly made by the heads / coordinators of Ph.D. programmes.[10] The heads of departments and the Ph.D. supervisors were also involved in these decisions making.

In most of the cases the choice of the doctoral research approach was significantly influenced by the educational backgrounds of the decision makers. Most of the interviewed professors holding a Ph.D. degree opted for a scientific approach for doctoral research in design. They explicitly referred to their personal experiences while they were doing their own Ph.D. as a satisfying and valid experience. Most of the professors with a rich professional background opted for practice-based and practice-centred approaches.

Programmes' contexts

The programmes' different contexts were also considered as a factor that influenced the existence of different approaches to doctoral research in design. In some cases, doctoral programmes belonged to a kind of 'scientific' context. The surrounding environment, such as the different departments, conferences, initiatives and activities, etc., were mainly characterized by scientific 'attitudes.' In these cases, a scientific approach to doctoral programmes was adopted. This, for example, was noticed during the visits to the doctoral programmes *Design and Computation* at the Massachusetts Institute of Technology and *Design and Innovation* at the Open University.

In other cases, doctoral programmes belonged to an 'art and design' context. In these contexts design practice was a dominant activity. This was very evident in two cases, the doctoral programme in *Art and Design* from Sheffield Hallam University and the doctoral programme in *Industrial Design and Multimedia Communication* from the *Politecnico di Milano*. In both contexts, Sheffield and Milan, design is considered as a driving force for regional regeneration and industrial competitiveness. In these doctoral programmes, the practice-based and practice-centred approaches were adopted as well as the sciences and humanities approaches to doctoral research.

Challenges and orientations of academic research

The last external factor is the different challenges that face all the areas of academic research, with design research no exception. Among these challenges (*Centre National de la Recherche Scientifique*, 2002; Jonas, 2003) is the classical distinction between "fundamental research" and "finalized research." The tendency is towards seeing research as an integrated space of different activities. Another challenge is the classical

distinction between “theoretical priorities” of knowledge and “research tools.” The tendency is towards renewing methodologies and research problems by opening the way to new possibilities. The distinction between distinct disciplines, with each discipline assigned its specific camps and methods, is another challenge. The tendency is towards interdisciplinary research. Finally, “complexity” challenges and the need to face this challenge with new ‘thinking tools’ must be considered (ibid.).

All these challenges are orienting research within organisations towards multidisciplinary, interdisciplinary and transdisciplinary[11] practices and thinking; towards the redefinition of the evaluation and consideration modes of the “social demand;”[12] and towards reinforcing systematically, within each institution, a collective practice of scientific auto-reflectivity based on the existence of permanent places for exchanging ideas and debates (ibid.).

6.1.2 Internal factors

Young field of inquiry

The existence of different research approaches to the Ph.D. in design could be explained and justified by the fact that it is a relatively new field of inquiry.[13] In fact the study of the launch and evolution of doctoral programmes in already established disciplines,[14] with a long research history and tradition, has shown that the co-existence of and the struggles between alternative approaches to inquiry was a common and important phase of development (Byrne, 2001; Friedman, 2003b; Krippendorff, 1999).

Concerning the co-existence of different approaches to research in emerging disciplines, Byrne (2001) makes a comparison with anthropology:

> Anthropological inquiry has thrived on conflicts between different epistemological and theoretical traditions for over a century. The discipline grew because the conflicts offered tremendous opportunities to improve our knowledge about contested topics. The struggles spur anthropologists as a collective to discover more about our species, history, socio-cultural systems and options. […]. I suspect that designers who demand a single epistemological basis in the emerging discipline will get nowhere. By admitting multiple epistemological programmes, the entire profession might focus research and get beyond current quandaries.

'Nature' of design in various contexts

Another factor that contributed to the co-existence of different approaches to doctoral research in design was the 'nature' of design in different contexts. The 'nature' of design varied from one doctoral programme to another, and as a consequence the approach to design research also varied. This change in the 'nature' of design depended mostly on the curriculum of the doctoral programmes and their relative intentions.

The 'nature' of design and its dependence on the curriculum and the intentions of doctoral programmes can be better understood through the following example. In describing the curriculum of design education within the Bauhaus tradition, Findeli (2001) developed the archetypical model represented in figure 14. A three-part structure, art / science / technology, was developed. The structure was enclosed in a general purpose for design.

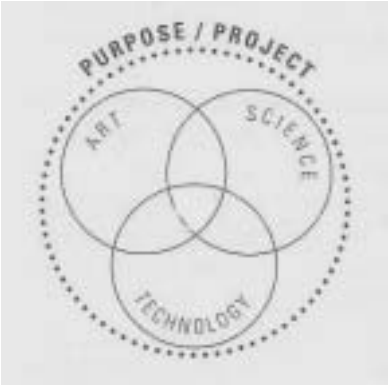

Figure 14. An archetype of design curriculum (Findeli, 2001).

In changing the articulation between the components of the curriculum, the relative weight of the three dimensions and the general intention, the nature of design varied as shown in figure 15. This was similar in the case of the doctoral programmes studied, where the 'nature' of design depended mostly on the curriculum and the intention of the doctoral programme. These curricula consisted of different embodiments. Embodiments were given different degrees of importance and were articulated in different ways, and had different overall purposes. This was one of the factors that contributed to the adoption of different approaches to doctoral research in design.

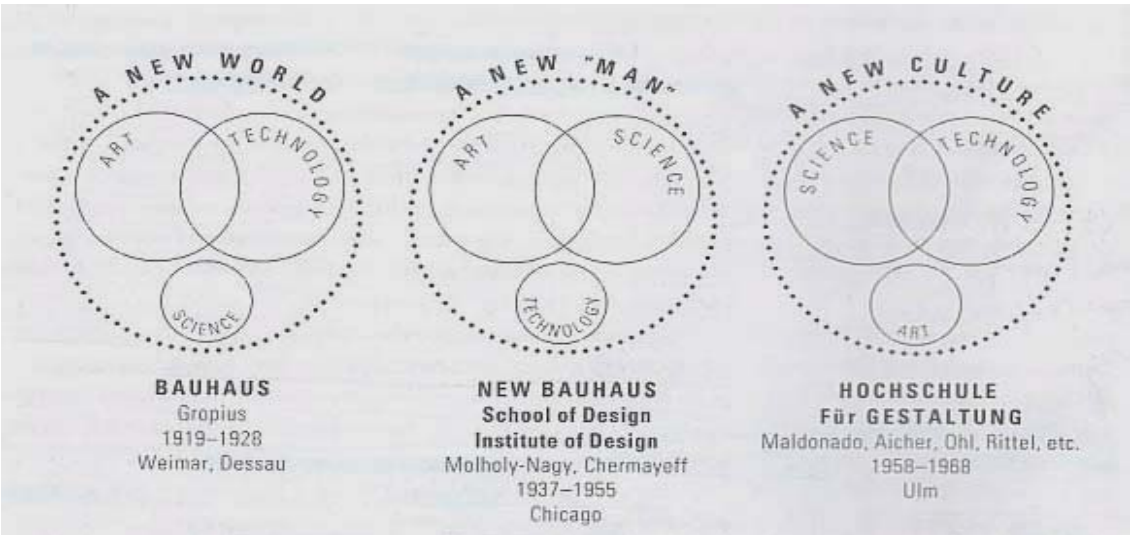

Figure 15. Three historical embodiments of the archetype (Findeli, 2001).

Areas of research

The areas of research were among the internal factors that contributed to the existence of different approaches to doctoral research in design. In each doctoral programme several areas of research were identified. 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.

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., practice-based and practice-centred approaches to research were a preferred choice. This did not exclude that in a few areas of research the three approaches were valid.

Growing design complexity

Among the internal factors that have contributed to the current state of design research, the notion of complexity can be considered as a fundamental issue. It is undeniable that the practice of design has been facing, during the last few years, a growing complexity (Duchamp, 1999; Findeli, 2001; Findeli and De Coninck, 2002; Jonas, 2003; Manzini, 2003; Pizzocaro, 2000a; 2000b).

Duchamp (1999) identifies three levels of design complexity: the intrinsic products complexity, the managerial complexity and the complexity of implementation processes. Findeli (2001) and Findeli and De Coninck (2002) articulate four areas of design complexity: methodological complexity, products complexity, problematics[15]

complexity and impact complexity. Pizzocaro (2000a; 2000b) argues for a complex design environment.

For a comprehension of such complex and evolutive design environments, it was found necessary to complement, but not replace, 'traditional' research training with a kind of "complex intelligence" (Findeli, 2001; Findeli and De Coninck, 2002; Le Moigne, 2003, 2004), i.e. the acquisition of methods that permit the perception, description and modelling of complex design situations in order to simulate them, make decisions, intervene, act and then evaluate results.

As a consequence, research should be carried out within, rather than applied to, these systems (Findeli, 2001; Findeli and De Coninck, 2002; Jonas, 2003; Le Moigne, 2003, 2004). The 'project' in these research settings gains a much stronger 'theoretical' status and becomes the terrain of design research, the design project as a support for the theoretical investigation. A new research approach has emerged,[16] whose theoretical framework was inspired by systems science, complexity theory and practical philosophy (ibid.).

6.2 Towards a designerly approach to doctoral research in design?

The main issue addressed in this thesis is whether it is possible, necessary and relevant for the Ph.D. in design to be modelled on a research approach distinct from the research approaches in the sciences and humanities.[17] While addressing this issue the other existing research approaches were not considered less important or irrelevant to design research. On the contrary, (Cross, 2001):

> […] they have much stronger histories of inquiry, scholarship, and research than we have in design. 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.

It has emerged, from the study of the current state of design research and the Ph.D. in design that: there exists a consensus that design as a discipline has a status of its own; design belongs to a third area of human knowledge, concerned with the making and doing aspects of human activities; design practice has a fundamental role to play in design research; and a kind of design's own research paradigm, where the emphasis is on design practice, is a possible, necessary and relevant distinct approach to design research.[18]

The empirical works, which focused on doctoral research in design, brought more understanding to all the above issues. It was found that a plurality of research approaches co-exist; and that a distinct approach to doctoral research in design is already practiced. This distinct approach has been given various names by different authors and within different doctoral programmes. It has been referred to in this thesis by two terms "research through design" and "practice-based approach." More understanding of its underlying principles and main characteristics has been reached. But, whether this distinct approach can be considered as designerly research is still missing from this discourse. This issue is discussed in the following section.

6.2.1 Designerly ways of knowing

It was Archer (1979a, 1979b, 1981) who first introduced the word 'designerly' while arguing for "a third area in education."[19] The first two areas were, obviously, science and humanities education. The third area was entitled design. The word design was "[…] used in a sense which goes far beyond the day-to-day meaning which architects, engineers and other professional designers would assign to it." (Archer, 1979b). The word design was articulated as (ibid.):

> […] the collected experience of the material culture, and the collected body of experience, skill and understanding embodied in the arts of planning, inventing, making and doing.

Archer (1979a, 1979b, 1981) referred to a "designerly way of thinking and communicating" as different from both scientific and scholarly ways of thinking and communicating:

> 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.[20]

According to Archer (1979b), the intellectual procedure, the distinctive feature of design, is modelling. Models and representations are employed to capture, analyse, explore and transmit ideas through 'doing and making.' This relates, particularly, but not exclusively to "[…] configuration, composition, meaning, value and purpose in man-made phenomena." (ibid.). Design activity operates through the modelling medium, while science operates through notation, and humanities through language. In science, understanding is based on observation, measurement, the formulation of hypothesis and testing of theory by further observation or experiment; In humanities,

understanding is based on contemplation, criticism, evaluation and discourse; In design, understanding is based on sensibility, invention, validation and implementation (ibid.).

Cross (1982, 1999a, 1999b, 2000a, 2000b, 2001) took up Archer's (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.'

So, both Archer (1979a, 1979b, 1981) and Cross (1982, 1999a, 1999b, 2000a, 2000b, 2001) were among the first to argue "that there are things to know, ways of knowing them, and ways of finding out about them that are specific to the design area." (Cross, 1982). Actually, this issue is very common and widely accepted within the community of design researchers.

6.2.2 Designerly mode of inquiry

Archer (1981) was also among the first to argue for a "designerly mode of inquiry" and distinguish it from research in the sciences and the humanities:

> 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.

Archer (ibid.) also distinguished between designerly inquiry and design research as different approaches to research in design:

> It is designerly inquiry, not design research, that is equitable with scientific research. Design research can, and does, employ the methods of scientific research and scholarly inquiry in its pursuits, as well as, more rarely, the methods of designerly inquiry itself.

Many other authors have argued for building a design's own intellectual research culture[21] (Cross, 1982, 1999a, 1999b, 2000a, 2000b, 2001; Dunne and Raby, 2001; Findeli, 2000b, 2001; Jonas, 2003; Jones, 1998; Nelson and Stolterman, 2003a; etc.). They have also found in design practice the 'ground' for this research culture, as reported, for example, by Cross (2001):

> Following Schon and others, many researchers in the design world have realized that design practice does indeed have its own strong and appropriate intellectual culture […].

6.2.3 Can Research through design / practice-based approach be considered designerly research?

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.). This approach has been identified by various terms, which are grouped in this thesis under the term "research through design."

The empirical works revealed that "research through design" is already an approach applied in several Ph.D. programmes. It was often identified as "practice-based approach." The empirical works contributed to a better understanding of the underlying principles and characteristics of research through design / practice-based approach. These had many similarities with the main aspects of "the designerly ways of knowing," and the "designerly mode of inquiry" as they were articulated by Archer (1979b, 1981) and by Cross (1982, 1999a, 1999b, 2000a, 2000b, 2001). 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 research through design / practice-based approach for doctoral research in design, involved dealing with 'fuzzy' research problems.[22] 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."[23]

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.

All these problem characteristics were identified in the problems addressed in the research through design / practice-based approach to doctoral research in design.

“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 research through design / 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.[24] 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 are also characterised by a ‘constructive’ mode of thinking. In the research through design / practice-based approach action research underpinned and guided the research processes. ‘Action’ took place through the development of different kinds of design projects,[25] 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.[26] 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[27] according to Cross (1982), who referred to March (1976).

"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, 1979b, 1982; Alexander, 1964, 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[28] (Cross, 1982; Hillier and Leaman, 1976) that enables designers to translate individual, organisational and social needs into physical artefacts. Archer (1979b, 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 research through design / 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.[29] 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 main characteristics of research through design / 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 though design practice.

Notes

1. Refer to Chapter Three, section 3.1.2 entitled *Nature of design research*.

2. The first two areas are the sciences and the humanities.

3. Among the several contributions that focused on this issue, see the following:
Archer, B., 1979. "The Three Rs." *Design Studies*, volume 1, number 1, pp 18-20;
Cross, N., 1982. "Designerly ways of knowing." *Design Studies*, volume 3, number 4, pp 221-227.

4. Refer to Chapter Five: *An Outline of Results from Case Analysis*.

5. This distinct approach for design research was entitled in various ways by different authors and within different Ph.D. programmes in design. In this thesis it was referred to it, mainly, as "research through design" and "practice-based approach." For an in-depth description, refer to Chapter Five: *An Outline of Results from Case Analysis*.

6. Refer to Alain Findeli and Pierre De Coninck's paper: 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.

7. Before this date a vocational award was assigned. It was known as the National Diploma in Design (NDD). Then a more academically based award was established, the Diploma in Art and Design (DipAD). Then came the transition to undergraduate degree. For an in-depth study, refer to David Durling's paper: "Design in the UK: some reflections on the emerging Ph.D." *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 317-327.

8. United Kingdom Council For Graduate Education. 1997. *Practice-Based Doctorates in the Creative and Performing Arts and Design*. United Kingdom: UK Council for Graduate Education.

9. For an in-depth study , refer to Bruce Archer's paper: "A background to doctoral awards." *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 257-260.

10. In six of the ten studied cases, the post of head / coordinator of the doctoral programme existed. During the interview, they explicitly expressed their choices of research approaches adopted within the programmes and their relative motivations. Refer to appendixes B.2, B.4, B.5, B.6, B.8 and B.10, to the interviews sections. In four of the cases the interviews took place with Ph.D. supervisors. Refer to appendixes B.1, B.3, B.7 and B.9.

11. For a detailed descriptions of each practice refer to: *Centre National de la Recherche Scientifique*, 2002. "*Extraits du schéma stratégique du CNRS 2002.*" [online]. Available from: http://ns3833.ovh.net/~mcxapc/docs/ateliers/lemoign4.pdf [Accessed 28 July 2002].

12. Social demand is expressed by various actors such as local and public authorities, professional groups, enterprises, financial institutions, editors, media, justice, consumer associations, nongovernmental organisations, etc.

13. Most Ph.D. programmes in design were launched during the 1990s. For more details refer to Chapter Two: *Focusing on the Problematic Area: a Distinct Approach for the Ph.D. in Design*, to section 2.2 *The Ph.D. in design*.

14. Comparisons were developed with disciplines such as physics (Friedman, 2003b), anthropology (Byrne, 2001) and communication (Krippendorff, 1999).

15. According to Findeli in: Findeli, A., 2001. "Rethinking design education for the 21st century: theoretical, methodological, and ethical discussion." *Design Issues*, volume 17, number 1, p 12: "the French word 'problématique' is an important concept of Foucault's archaeology. In design it is the result of the complexification of mere product-centred problems in terms of social, economic, symbolic, political, etc. issues."

16. In this case, the research through design / practice-based approach for doctoral research in design.

17. For an in-depth study, refer to Chapter Two: *Focusing on the Problematic Area: a Distinct Approach for the Ph.D. in Design.*

18. Refer to Chapter Three: *The Cultural Background to Design Research.*

19. "Design in general education" was a research project developed at the Royal College of Art. The principal outcome of the project "[…] was the restatement of a belief in a missing 'third area' of education." (Cross, 1982). This area was entitled "Design with a capital D." Refer to: Royal College of Art, 1979. *Design in General Education*. London, Great Britain: Royal College of Art; and to Cross, 1982. Designerly ways of knowing. *Design Studies*, volume 3, number 4, p 221.

20. See the paper: Archer, B., 1979b. "The Three Rs." *Design Studies*, volume 1, number 1, pp 18-20. This paper was the second in a series of papers, published in *Design Studies*, which aimed to establish the theoretical bases for treating design as a coherent discipline of study in its own right.

21. Refer to Chapter Three, section 3.3 entitled: *Research through design.*

22. Refer to appendixes B.5, B.8 and B.10 to the theses reports and to appendixes D.1, D.2, D.3, D.4, D.8 and D.13.

23. 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.

24. Refer to appendixes B.5, B.8 and B.10 to the theses reports.

25. Refer to appendixes B.5, B.8 and B.10 to the theses reports and to appendixes D.1, D.2, D.3, D.4, D.5, D.7, D.8, D.10 and D.13.

26. Refer to appendixes B.5, B.8 and B.10 to the theses reports.

27. It was argued by March (1976) and quoted by Cross (1982), 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.

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

29. Refer to appendixes B.5, B.8 and B.10 to the theses reports and to appendixes D.1, D.2, D.3, D.4, D.5, D.7, D.8, D.10 and D.13.

7. CONCLUSION

Three arguments are articulated in this final chapter: the main contributions of this research, the limitation of the research and the proposal of further work.

7.1 Main contributions

7.1.1 Approaches to doctoral research in design

An important growth in the number of Ph.D. programmes in design, in different geographical-cultural contexts, has taken place in recent years[1] (Durling, 2003; Durling and Friedman, 2000; Friedman, 2000b). These programmes, with different underlying philosophies, different natures, structures, contents, aims, etc. offer a very rich panorama of doctoral research in design.[2]

A series of events has taken place as a result of this important growth, the most of which is a series of conferences about doctoral research in design organized in different parts of the world.[3] The aim of these conferences was to initiate and maintain an international open debate about this emerging field of inquiry. These conferences focused mainly on: key issues surrounding this rapid development; philosophies and theories of design; foundations and methods of design research; form and structure for the doctorate in design; the relationship between research and practice; best practices in doctoral education; etc.

This thesis was developed in order to contribute to this international open debate about the emerging field of doctoral research in design. The main issue addressed here has been whether it is possible, necessary and relevant for the Ph.D. in design to be

modelled on a research approach distinct from the scientific and humanities approaches to 'academic' research. Before addressing this issue, it was considered fundamental to articulate a better understanding of the existing approaches of the Ph.D. programmes in design.[4]

Through the combination of a review of literature and empirical works and the movement back and forth between the theoretical analyses and the empirical ones, it was possible to identify, classify and describe three different approaches to doctoral research in design: a research approach modelled on Ph.D. research in the sciences and humanities, a practice-based approach and a practice-centred approach. While the first was the most common, the second was a relatively new approach and the last the most criticised one.

Sciences and humanities approaches

One of the approaches to the Ph.D. in design is modelled on already existing research approaches in the sciences and humanities. This is the systematic and methodical approach to doctoral research in design, and is research done according to an established plan articulated in 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.

In the scientific approach, the methodology of research is based on observation, measurement, the formulation of hypothesis, development of empirical works, and

testing of theory by further observation or experiment. Both quantitative and qualitative research methods are used in the scientific approach. In the humanities approach, the methodology is based on contemplation, criticism, evaluation and discourse. In this latter approach qualitative research methods are used.

The theses developed according to the scientific and humanities approaches to the Ph.D. in design had the following structure: a general introduction; a review of relevant literature; the articulation and description of the methodology; the results; the discussion of these results; and the conclusion where contributions of the research and future work are stressed.

In these Ph.D. settings, the research training emphasis was mainly on the methodology of research. The concern was to learn the methodology of 'academic' research, i.e. the early articulation of a research problem, the identification of a research site, selection of research strategies and relative methods for collecting and analysing data, and the reporting of all these research phases in a thesis form.

Research through design / Practice-based approach[5]

In the research through design / practice-based approach to doctoral research in design, design practice constitutes an integral part of the research process. The development of design projects is considered as 'a site and medium' for research. Action research underpins and guides the research process. The 'action' takes place through the development of design projects that result in conceptual or working prototypes. These projects are considered as a terrain or source that informs understanding and guides the research.

This approach was adopted in situated research settings requiring flexibility, intentionality, responsiveness, interventions and participation, in order to deal with fuzzy research questions. The research process is iterative, reflective, interpretive, and dialectical. It is articulated in most of the cases in the following phases: in-depth study of the context of the research, both the situation and its theoretical implications; the methodology of the research; the project(s) developed with relative phases of development; the conclusions.

In this research setting, there is no common form to the theses, which were structured in very different ways. The emphasis in this research training is on the coherent linkage of the theoretical and studio aspects of a particular area of design within a research context. It is a kind of training in 'situated' research that requires dealing with fuzzy research problems by integrating deliberate reflections, challenging interpretations and performing iterative actions through the development of design project(s).

Practice-centred approach

This is a recent approach to doctoral research in design. The emphasis in this approach is on the development of advanced design projects. The development of design project(s) is considered as a form of research. It is the most criticised approach to doctoral research in design, since it has no 'discourse' attached to it; it has no intention of generalizability except technological; and it is not accumulative in the theoretical realm.

In this approach the product(s) development phases constitute the research process, which is often articulated in the following phases: the analysis phase, the synthesis phase, the concept, the development, and the evaluation. Methods used are relative to the involved areas of design practice.

A great number of two-dimensional visual material and three-dimensional objects represented the different practices developed and the results. Reporting this material in a thesis form was found problematic, since there were no reference models in other disciplines. Different invented solutions were adopted. The theses were structured in different ways in order to represent and make explicit the procedures which had been followed and the results reached.

This approach to doctoral research in design is a training in 'professional practice' research. Design practice is studied through practice. It permits the candidates to improve their own practices and to regenerate their own work.

7.1.2 Towards the designerly approach to doctoral research in design

The main issue addressed in this thesis was whether it was possible, necessary and relevant for the Ph.D. in design to be modelled on a research approach distinct from scientific and humanities approaches for 'academic' research. The review of literature revealed that many design theoreticians have already started defining and articulating such an approach, which is described as a kind of "research through design." The empirical works revealed that such an approach is already practiced in several Ph.D. programmes in design. It is often referred to as a "practice-based approach."

What distinguishes the research through design / practice-based approach is the built-in flexibility of the research process, which is a kind of path of discovery through design practice to seek new understanding. The development of design projects is considered as an integral part of the research process, i.e. a site and medium for research. The main characteristics of this research approach are the following:

Firstly, the fuzzy nature of the research problems, which are 'unique' because they depend on specific contexts. These problems are better approached through action, because they do not have an ideal solution but only better or 'plausible' possibilities.

Secondly, the constructive nature of the research process. Permanent constructions occurred between the researcher and the evolving situations. These research processes are a mix of deliberate reflections, challenging interpretations and iterative actions through the development of design project(s). These processes are subject to ongoing constructions that require flexibility, intentionality, responsiveness, interventions and participation.

Thirdly, different categories of knowledge are produced in these research settings: the knowledge relative to the design project(s) developed, which is a kind of 'local knowledge;' the knowledge constructed over the course of the research process, which is a kind of meta-knowledge; and the findings relative to the whole research with its theoretical and practical contexts, which is mainly a 'publishable'[6] knowledge. Constructivist epistemology underlies and justifies these kinds of knowledge that do not have a status of truth, but the status of 'plausible hypothesis.'

The main characteristics cited above were found very similar to the characteristics of what was defined and described as "designerly ways of knowing" and "designerly mode of inquiry."[7] In fact, the distinctive feature of the research through design / practice-based approach is its underlying intellectual procedure. Within the research process, ideas were captured, analysed, explored and transmitted through modelling, i.e. through models and representations. Modelling was used as medium of research, while sciences research operates through notation, and humanities through language.

Therefore, the research through design / practice-based approach has been retained as an approach which characteristics are leading towards the definition of the designerly way of researching, based on design practice as a medium of research and justified by constructive epistemology, action research and grounded theory. A designerly approach to research can be applied "[…] 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."[8]

7.2 Limitation of the research

The second empirical work was developed through the development of fourteen case studies of research processes including design project(s). The study of a few individual cases in order to develop generalizations presented a limitation to the research. A strategy was framed to reveal what was specific to one individual case and what was not. The strategy relied on the repetition of issues. Only issues found similar in several cases were taken into consideration for further understanding and generalizations.

7.3 Further work

This research has been among the first academic studies to focus on doctoral education in design through the combination of theoretical and empirical works. The main issues arising from this research are the in-depth study and classification of the different existing research approaches to the Ph.D. in design, and an argument for a possible, necessary and relevant designerly approach to the Ph.D. in design, distinct from scientific and humanities approaches to research. This study raises many research questions concerning doctoral research in design.

7.3.1 Towards the designerly way of researching

The research process

It is argued in this thesis that the main characteristics of research through design / practice-based approach are leading towards the definition of a designerly way of researching. In these research settings, constructivist epistemology and the concepts of action research and grounded theory underpin and guide the research process. Researchers are confronted with concrete situations where they must develop suitable negotiations, interactions, and interventions, with reference to certain theoretical frameworks and with the intention of producing knowledge. The epistemological basis, the use of 'transformative' research methods[9] and the procedures of negotiation, interaction and intervention within the research process necessitate further studies.

The systemic basis

The main emphasis in the designerly approach to research is on design practice, considered as a site and medium for research. In recent years design practice has been facing a growing complexity (Duchamp, 1999; Findeli, 2001, 2002; Jonas, 2003;

Manzini, 2003; Pizzocaro, 2000a; 2000b). In these settings, where design practice is an integral part of the research, researchers need to perceive, describe and model complex design situations in order to simulate them, take decisions, intervene, act and then evaluate the results.

For a comprehension of such complex and evolutive design research environments, it was found necessary to complement, but not replace, 'traditional' research training with a kind of "complex intelligence" (Findeli, 2001, 2002; Le Moigne, 2003, 2004), i.e. the acquisition of methods that permit the perception, description and modelling of complex design situations in order to simulate them, make decisions, intervene, act and then evaluate results.

Theoreticians (Findeli, 2001, 2002; Jonas, 2003; Le Moigne, 2003, 2004) argue that the theoretical framework for these methods and tools should be inspired by systems science, and practical philosophy. A further study of the systemic basis for designerly research and its relative methods and tools is needed.

The Ph.D. thesis

The Ph.D. theses have a common form independent of the content and the field of knowledge. The Ph.D. theses developed under the designerly approach for research were articulated in various ways. In many cases the structure did not reflect neither the research process nor the sequence of knowledge construction. A further study could focus on the form of the Ph.D. thesis as it should be structured in the designerly approach for research.

7.3.2 The practice-centred approach

In the practice-centred approach to doctoral research in design, the development of advanced design projects 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 doctoral 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 […].

This issue of practice as a form of research requires further study in order to justify the practice-centred approach to doctoral research in design. It is also important to understand whether this approach to doctoral research could be better suited to a Ph.D. in design or a P.D. in design, i.e. a Professional Doctorate in design. The latter has the following definition (UKCGE, 2002):

> A Professional Doctorate is a programme of advanced study and research which, whilst satisfying the University criteria for the award of a doctorate, is designed to meet the specific needs of a professional group external to the University, and which develops the capability of individuals to work within a professional context.

1. Mainly during the 1990s.

2. Refer to Chapter Three, section 3.2: *Studies on the Ph.D. in design*.

3. Among these:
The conference *Doctoral Education in Design*, held on the 8-11 of October 1998. The organizers were Richard Buchanan, Dennis Doordan and Lorraine Justice. The conference proceedings were published in Pittsburgh by the School of Design, Carnegie Mellon University.

The conference *Doctoral Education in Design: Foundations for the Future* that was held at La Clusaz in France on the 8-12 of July 2000. The conference proceedings were edited by David Durling and Ken Friedman. It was published in Stoke-on-Trent by the Staffordshire University Press.

The conference *Doctoral Education in Design*, held at Tsukuba in Japan on 14-17 of October 2003. It was part of the *6th Asian Design Conference*. The editors of the conference proceedings were David Durling and Kazuo Sugiyama. It was published in Tsukuba by the University of Tsukuba.

4. The review of literature revealed that no similar studies had been developed before.

5. In this thesis, "research through design" and "practice-based approach" were used to refer to the same approach to doctoral research in design. While the former derived from the review of literature, the latter is from the empirical works.

6. Here the Ph.D. thesis is meant.

7. As they were articulated, first, by Archer (1979a, 1979b, 1981) and then by Cross (1982, 1999a, 1999b, 2000a, 2000b, 2001). For an in-depth study refer to Chapter Six, section 6.2: *Towards a designerly approach to doctoral research in design?*

8. 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, p 35.

9. Opposed to 'contemplative' research methods.

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