Capturing tacit knowledge: documenting and understanding recent methodological innovation used in Design Doctorates in order to inform Postgraduate training provision

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Abstract

This paper presents a preliminary review of recent Design PhDs that identify and analyse the methodological innovation that is occurring in the field, in order to inform future provision of research training for Design PhDs. Six recently completed Design PhDs are used to highlight possible philosophical and practical models that can be adopted by future PhD design students. Four characteristics were found in Design PhD methodology; thesis-structural innovation, a 'pick and mix' research design approach, situating practice in the enquiry and the validation of visual analysis. The paper concludes by offering suggestions on how research training can be improved for Design PhD candidates. By being aware of recent methodological innovations in the field, design educators will be better informed when developing resources for future design doctoral candidates, and assisting supervision teams in developing a more informed and flexible approach to practice-led research.

Keywords

Methodological innovation, Design research methods, PhD research training, Approaches to design research

Introduction

Over the last ten years, the United Kingdom has seen an increased interest in Design PhDs. For example, over the past two decades the number of Design PhDs awarded in the UK has more than doubled[1] (Christer, 2006, p. 36). In addition, the emergence of a number of major international conferences such as Doctoral Education in Design (Buchanan, Doorden, Justice, & Margolin, 1998), Doctoral Education in Design: Foundations for the Future (Durling & Friedman, 2000) and Doctoral Education in Design: Practice of Research (Durling & Sugiyama, 2003) reflects the growing interest in the nature of research and practice of the field (Durling, 2000). These seminal conferences provided a platform for educators to share their diverse experiences and insights on challenges arising from the development of Design doctoral programmes. Most of the early discussions at these events centred on the purpose of Design PhDs and how doctoral education will benefit the discipline, which then naturally progressed to discussions that focused on exploring the methodologies, structures and processes particular to Design PhDs.

In recent years, it has been observed that a more established typology of design methodologies have been developed, employed and validated as acceptable forms of research methodology for doctoral level programs. These methodologies have ranged from hybrid methodology, which employs a mixture of qualitative and quantitative methods; to more practice-based methodology, achieved through critical design projects such as examples shown by Seago and Dunne (1999) and Maze & Redström (2007). Saikaly (2005) describes this practice-based type of inquiry as a 'designerly mode of inquiry', distinct from the well-established science and humanities research approach.

Training provision for PhD design students is generally based on a generic university-wide programme, where science and humanities methodologies are dominant. The issue of discipline-specific training for design has improved slightly over the years, as a recent report has shown. According to the Arts and Humanities Review Council[2] (AHRC) review on Practice-led Research in Art, Design and Architecture (Rust, Mottram, & Till, 2007, p. 54), 16 out of the 19 surveyed universities' Art, Design and Architecture departments do provide formal research training designed specifically for their subject (compared to 9 in 2001). Out of these 16 universities, 15 of them now include training in methods for practice-led research (compared to only 2 in 2001). However, the AHRC report does not go into detail on the types of practice-led methods that are being taught, the breakdown between Art, Design and Architecture and whether the students were satisfied with the training provided. In addition to a lack of discipline specific training, research and knowledge around supervision in art and design remains rare, particularly in the case of practice-based research (Frayling, 1993), while existing literature on practice-based research degrees is aimed at helping supervisors manage their students (Newbury, 1996) rather than informing supervisors of the range of research methods available to their students.

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[1] According to the Art and Design Index to Thesis, 180 Design PhDs were awarded during 1996 – 2005, compared to 82 PhDs awarded during 1986 – 1995. The HEFCE report also reported a 232% rise in PhDs completed in the Creative Arts and Design subjects from 1995 to 2005.

[2] AHRC is a UK government funding body that funds research on a very wide range of subjects, from traditional humanities such as history, English, linguistics, French and other modern languages, philosophy and classics, area and interdisciplinary studies to creative and performing arts such as drama, dance, music, art and design.

Design Research Frameworks

If we are to look closely at the range of subject and purpose covered in Design PhDs, it might be useful to review them in the context of different research design frameworks discussed over the years. One of the more widely-used frameworks is Frayling's classification (1993) of art and design research, which identifies three main types of research projects:

1. Research INTO practice
2. Research THROUGH practice
3. Research FOR THE PURPOSE of practice

Research into practice refers to research where art or design practice is the object of the study. Research through practice refers to research where art or design practice is the vehicle of the research, and a means to communicate the result. And finally, research for the purpose of practice aims to communicate the research embodied in a piece of design. I would argue that each method of research is not mutually exclusive. For example, Pedley's (1999) PhD was to study designers' attention to materials and manufacturing processes (a study 'Into' the design processes) by designing and prototyping of an innovative polymer acoustic guitar ('through' the practice). While Hillier's (2006) PhD uses practice as part of a quantitative and qualitative research methodology to identify and test readability and legibility issues. The conclusion of the results is embodied in a piece of design, which is a new typeface called Sylexiad.

Frayling's analysis of art and design research activity seems to cover all design research possibilities. In comparison, Cross (1999, p. 6) offers a design research taxonomy that is based on the *focus* of the investigation rather than in the method of research. He focuses on knowledge that resides in people, process or product:

1. Design epistemology – study of designerly ways of knowing (people)
2. Design praxiology – study of the practices and processes of design (process)
3. Design phenomenology – study of the form and configuration of artifacts (product)

Cross believes that designing is a natural human ability that is inherent in everyone, and not just professionals. Hence the immediate subject of design research is the investigation of how people design. Design knowledge also resides in the processes of the activity, tactics, strategies and tools used for the purpose of designing. Finally, the designed artifact embodies knowledge in its form, material, technology and context of use.

Fallman (2008) offers a more holistic framework in the field of interaction design research that not only refers to academic research, but includes knowledge gained through practice-based and explorative avenues. The model plots the position of design research activity in between three extremes:

1. Design practice
2. Design exploration
3. Design studies

The differences are primarily in *tradition* and *perspective*, rather than the methods and tools being used (see Figure 1). *Design practice* denotes activities that are similar to commercial design work, carried out in commercial consultancy but with a difference in that the researcher becomes engaged in a particular design practice with an appropriate research question in mind. The research question is developed

and explored through either a reflective (first hand experience of the tools or processes) or proactive manner (through an already established research agenda that seeks to change how a specific technique is used). *Design exploration* is similar to design practice but differs in one key point, in that it aims to explore 'what if' questions through the process of designing rather than by answering a particular research problem. Design exploration is a way to comment on a phenomenon by developing an artifact that embodies the statement or question that the researcher is attempting to critique. *Design studies* most closely resemble traditional academic, research whose goal is to contribute to the intellectual tradition and body of knowledge.
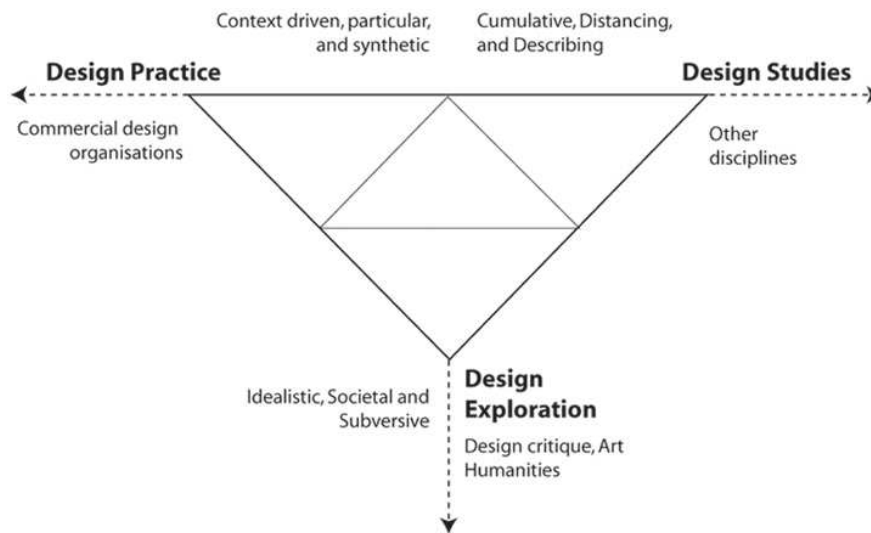

Fig 1. Fallman's (2008, p. 5) Interaction Design Research Model

Each framework presented here has its own function and value as one does not supercede another but instead provides different facets to the understanding of design PhDs. For the purpose of clarity, this review will frame the chosen examples using Fallman's (2008) framework, but uses Frayling's (1993) and Cross's (1999, p. 6) frameworks to analyse the purpose and methods of research employed in the selected PhD studies.

Characteristics of Design PhDs

Langrish (2000, p. 302) describes three areas in which a Design PhD is distinct from other academic areas: (i) the questions asked, (ii) the methods used to answer them and (iii) the type of evidence that is acceptable to a design peer group of academics. Firstly, the questions that Design PhDs ask are concerned with things visual. Secondly, a review of Design PhDs seem to suggest a mix of methods used, ranging from quantitative, empirical methods to more qualitative, social science methods. Thirdly, the evidence produced in response to the research questions can vary from a traditional big-book thesis to a portfolio containing design pieces that are accompanied by a shorter thesis.

Chris Jones (1997, p. 5) differentiates between a PhD in Design and in Art by declaring that a Design PhD has to show exceptional ability to integrate imagination-and-reason, technology-and-art, and to make noticeable improvements to the quality

of industrial life and its products, whereas an Art PhD should show exceptional perceptiveness and originality in art-making.

In recent years, a growing number of PhDs are described as 'practice-based' or 'practice-led'. I would argue that Design PhDs are inherently practice-based (i.e. deriving from design practice, either through studying the people, process or products (Cross, 1999) and the approach has become more widely accepted within the academic community. Durling et al (2002, p. 82) describes practice-led research as 'a study where practice is used as an interrogative process' while Rust et al (2007, p. 11) emphasize that design practice has to play an instrumental part in an inquiry.

Design PhD Case Studies

Six examples were chosen to highlight the spread of research that resides within the three areas of design practice, design exploration and design studies (Fallman, 2008). These examples were also chosen on the basis of their methodological innovation, either in the way the research design has been constructed or the use of a particularly innovative method. The PhDs were sourced from a combination of literature review surrounding design research methodology, and searches through thesis databases. The databases referred to were the Art and Design Index to Thesis (Christer, 2006) and the Index to Theses website (Expert Information, 2009). ADIT claims to be the first comprehensive index of postgraduate research theses in art and design in the UK, while the Index to Thesis database is a comprehensive listing of theses with abstracts accepted for higher degrees by universities in Great Britain and Ireland since 1716. An initial list of design PhDs were drafted and their abstracts reviewed in order to identify suitability and a final shortlist of six were selected. It has to be stressed that the case studies were not only selected on the basis of their innovative approaches, but by their impact on the research methodology applied in subsequent PhDs. At the same time, the review has considered other more 'traditional' quantitative and qualitative methods that have been employed with success in Design PhDs. Figure 2 illustrates where these projects are placed within Fallman's (2008) description of design research activities. These placements are indicated to provide context to the different studies' perspectives, rather than an empirically accurate categorisation.
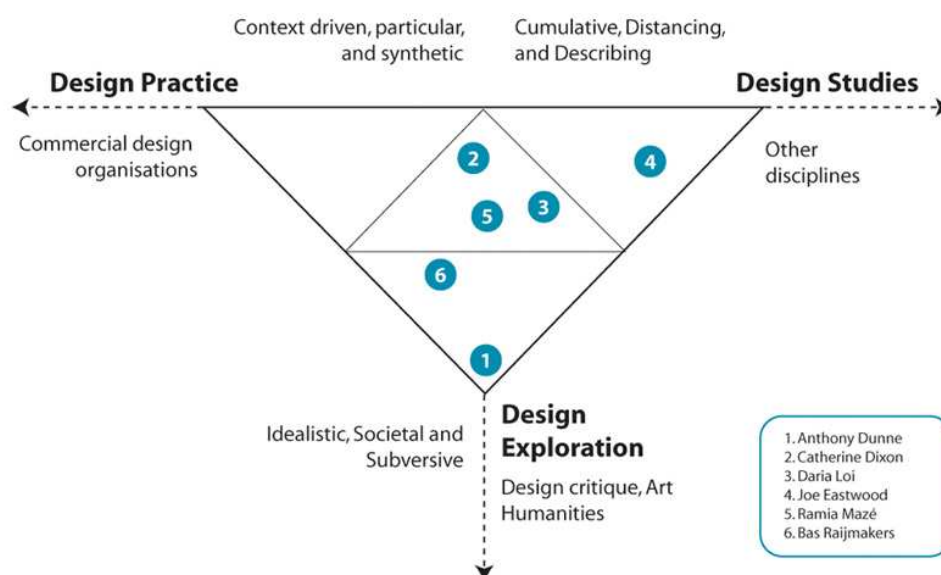

Fig 2. PhD examples placed in Fallman' (2008, p. 5) Interaction Design Research Model

Analysis Method

A descriptive case study approach (Yin, 2003) was used as a general research strategy for this study. The six PhD theses was considered to be 'a set of individual case studies' (Robson, 2002, p. 181), where common features will be studied and compared. In general, case studies are the preferred strategy when 'how' and why' questions are being posed and the focus is on a contemporary phenomenon within some real-life context (Yin, 2003, p.1). This preliminary study aims to find out what types of research methods were used in each PhD thesis and understand how they were used.

The selection and justification of the data for this study was influenced by the method of documentary analysis. This method has generally been used to analyse governmental policy documents or curriculum documents to gain insight into an instructional activity or approach. As the main purpose of this study is to examine the methods employed in practice-based Design PhDs, the theses documents and secondary text written about these studies can provide a wealth of easily accessible, relatively unobtrusive and readily available research data (Forster, 1994 and Hakim, 1983). Additionally, it is a non-reactive process of collecting information and enables the application of a different perspective to a topic (ibid). The main disadvantages to this method as cited by Appleton and Cowley (1997) is the limitation of the data, potential bias in description of an activity or situation leading to 'hearing only one side of the story', missing or incomplete data required for the study, inaccuracies in original material and data studied out of context (Bailey 1982, Treece and Treece 1982, Stewart 1984, Webb et al., While 1987, Hakim 1993). As a method for a preliminary review in preparation for a larger more in-depth study, it is ideal due to its accessibility and readily available data.

Two sources of data were used in the analysis. The primary source of information came from the actual theses. The theses were a source of text that documented the actual methods employed and the justification as argued by the researchers themselves. Specific information was extracted from the theses in order to identify their purpose of enquiry and the methods employed in the studies. All but one thesis was reviewed in order to identify research methods employed and the reasoning for them. Due to the particular nature of Loi's thesis (which comes in a non-standard format of a suitcase containing artefacts and notes), the study used supporting text by Loi and other authors examining her research methods (see Loi (2004a), Rust, Mottram, & Till (2007) and Somerset (2008)).

The secondary data referred to by this study is based on additional academic text written in relation to the PhD studies. Examples of these articles include Mazé and Redström's paper (2007) discussing the operational and intellectual basis for critical practice in design and Seago and Dunne's (1999) paper discussing new methods in art and design. These articles provided additional insight into the purpose and reasoning behind the methods used.

In order to help the study identify the methodological approach taken, the text were coded in the following areas:

- Philosophical approach – What are its ontological and epistemological influences?

- Methodology – How did the researcher describe the general methodology applied in their research?

- Methods used – What were the research methods employed in the data collection and analysis?

- Thesis structure – Does the thesis structure provide clues to the way the study was conducted?

- Research purpose – How was the research conducted using Frayling's (1993) framework?

- Enquiry domain – Which knowledge area did the enquiry focused on? This was analysed using Cross's (1999) framework (see previous section)

Within each analysis category, phrases or sentences were coded when deemed to inform the enquiry of each category. The coded text was then displayed in a conceptually clustered matrix (Robson, 2002) as a method of data display (Miles and Huberman, 1994). A conceptually clustered matrix is a series of columns arranged to bring together items 'belonging together' in order to enable the discovery of patterns, themes and trends as well as enabling comparisons to be made.

Case Studies

A short description of each study is presented, where their purpose of enquiry, methodology and research methods are discussed. The case studies are presented chronologically.

Example 1

Anthony Dunne

Hertzian tales: an investigation into the critical and aesthetic potential of the electronic product as a post-optimal object

Year completed & awarding body

1997, Royal College of Art, UK

This PhD explores how critical responses to the ideological nature of design can inform the development of aesthetic possibilities for electronic products. The outcome of the project is a 'design approach for producing conceptual electronic products that encourage complex and meaningful reflection on the inhabitation of a ubiquitous, dematerialising and intelligent artificial environment' (Dunne, 2005, p.147). Dunne's PhD is considered a methodological pioneer in the development of what would later come to be called a 'critical design' approach (Blauvelt, 2003; Mazé & Redström, 2007). Critical design has since been adopted as an umbrella term for any type of design practice which suggests that design offers possibilities beyond the solving of design problems. (Blauvelt, 2003). This thesis can be considered the 'blueprint' of what a critical design approach might look like, and is described by Seago and Dunne (1999) as using investigative design as a 'mode of discourse' in order to challenge preconceived ideas surrounding the object. The structure of the thesis consists of six essays that discuss existing theoretical perspectives and design approaches for developing the aesthetic possibilities of electronic objects. Five conceptual design proposals were developed as part of the research. Dunne (1997) stresses that these exploratory projects should not be considered as necessarily illustrations of the ideas discussed in the essays, nor are the essays an explanation of these proposals. Instead, they evolved simultaneously and are part of the same design process.

Example 2

Catherine Dixon

A descriptive framework for typeforms: An applied study

Year completed & awarding body

2001, Open University, UK

This PhD is described by Dixon (2001) as 'an applied research study within the field of typeface description. It focuses upon i) the pragmatic investigation of a problematic situation identified within the field and ii) exploration of an appropriate methodology located within the studio-practice of the researcher'. The research uses 'design as research' process, influenced by Schon's (1992) 'designing as reflective conversation with the materials of a design situation'. Dixon also describes the process as research initiated for the purposes of enriching or modifying aspects of a particular profession. The research method employed was reflective practice within a studio environment. The research outcome was a CD-ROM, which contained an alternative typeform description framework that has been tested and applied. The research outcome of this study was explicitly two-part, one part relating to the content of the study, and the other to the methodological approach of a practice-based enquiry. This is often the case with Design PhDs, where methodological innovation is often a required process due to the individuality of each enquiry.

Example 3

Daria Loi

Playful Triggers as keys to foster collaborative practices and workspaces where people learn, wonder and play

Year completed & awarding body

2004, RMIT, Australia

This thesis explored ways to foster organizational spaces where collaborative activities can be undertaken using design tools and methods. Loi (2004b) argued that in order for co-design activities to emerge, participants and designers have to be linked by meaningful relationships. As a result, she developed a series of tools called *Playful Triggers* and proposed them as effective tools to elicit relationships among users who can learn how to work together before undertaking co-design activities. The way the thesis was constructed and presented has been termed *multisensorial writing* (Loi, 2004a), an approach that 'mirrors how people experience and filter the world.' The thesis was presented as a suitcase containing participatory devices to enable readers to have a discourse with the thesis, while at the same time actively demonstrating some of the concepts that the thesis discusses (see Figures 3 & 4). The thesis/suitcase consisted of found and custom-made objects, CD, images and instructional notes. The tools created are based on Cultural Probes (Gaver, Dunne, & Pacenti, 1999) and offer a 'collection of tasks designed to elicit inspirational information from people about their individual lives' (Gaver, Walker, Boucher, & Pennington, 2002).

Figs 3 & 4. Loi's thesis-in-a-suitcase taken from Loi (2004) paper
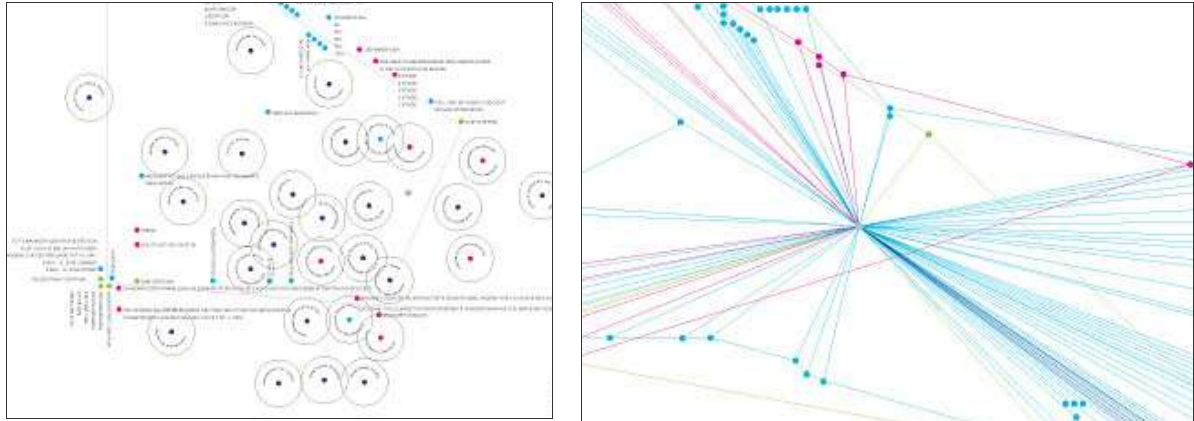
Example 4

Joe Eastwood

An investigation of the relationship between typography and audio-based communication in the urban environment, with particular regard to pedestrian wayfinding.

Year completed & awarding body

2006, University of the Arts, UK

This PhD explores the relationship between text-based messages and audio-based communication within the contemporary urban environment. Issues relating to signage overload and urban movement were identified at an early stage in this study and pedestrian wayfinding was then selected as a form of communication that allowed for exploration of all the key issues. Eastwood uses a phenomenological perspective to reflect the researcher's own perception and understanding of each environment studied. The study was divided into two stages: a contextual review through a series of interviews with designers to identify key questions and two practice-based approaches that utilised analysis and experimentation – using visual analysis methods. The first approach was fieldwork observation of six public sites where a combination of notes, sketches, photographs and audio recordings were made of typographic and audio-based communication. These observations were visually analysed and a series of charts and macroscopic drawings were produced to facilitate data collection and analysis (see Figures 5 and 6).

Figs 5 & 6. Examples of visual documentation of Dam Square in Amsterdam extracted from Eastwood's project website (2009) and thesis (2007)

Example 5

Ramia Mazé

Occupying time: Design, technology, and the form of interaction

Year completed & awarding body

2007, Malmo University, Sweden

This PhD is an inquiry into issues of time in interaction design, and argues that a central concern of interaction design must be the 'temporal form' of interactive objects and their 'form of interaction' as they are used over time. Philosophically, the study draws heavily on critical and 'post-critical' architecture theory. Mazé (2007, pg 20) also refers to Binder & Redström's (2006) 'Provisional Knowledge Regime' approach, a set of theoretical and experimental strategies and relations is presented as 'only one of many approaches, while a common ground is set for constructive and collaborative work' (Mazé, 2007, p. 20). This study's methodology can be described as a 3 x 3 matrix – exploring the themes within historical, practical and critical viewpoints – all underpinned by practice-based projects. Figure 7 is my interpretation of Mazé's research design, which she described verbally but not diagrammatically. I have also incorporated my observation of the discussion of themes progressing from theory to practice through the chapters, and how they relate to Frayling's (1993) framework.

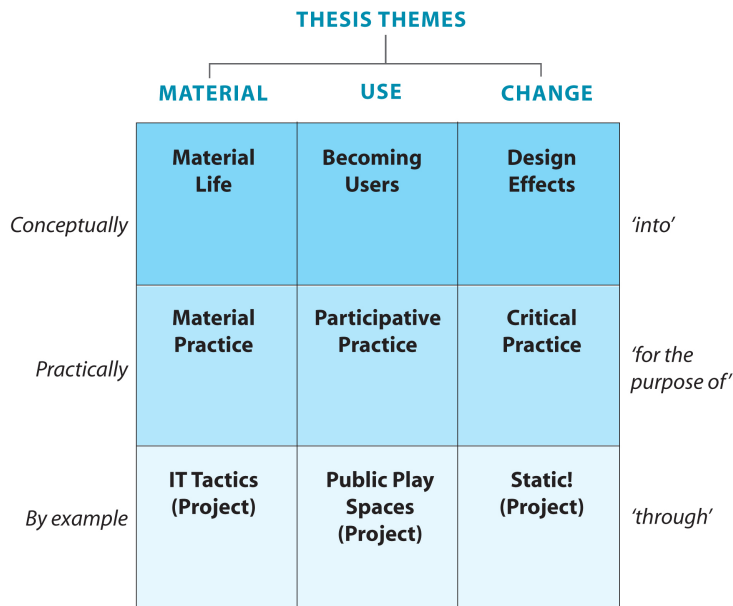|	MATERIAL	USE	CHANGE	
Conceptually	Material Life	Becoming Users	Design Effects	'into'
Practically	Material Practice	Participative Practice	Critical Practice	'for the purpose of'
By example	IT Tactics (Project)	Public Play Spaces (Project)	Static! (Project)	'through'

THESIS THEMES

Fig 7. Maze's research design represented by a 3x3 matrix showing the relationship between chapters.

Design projects (which have been commissioned separately from the research enquiry) are presented as self-contained portfolio or documentary pieces. They are 'anchored' to the argument through open questions posed as speculations. Mazé uses design projects to initiate an internal dialogue 'criticality from within', with reference to Frayling's (1993) model of 'into', 'through' and 'for' design research. The study's outcomes are summarised as a series of questions within the three areas of Materials, Use and Change. These questions are meant to highlight issues that relates to temporal form which needs to be considered during the design of interactive objects.

Example 6

Bas Raijmakers

Design Documentaries: Using documentary film to inspire design

Year completed & awarding body

2007, Royal College of Art, UK

This is an enquiry into how documentary film can be used in discovery research, which is a form of research that inspires and informs design practice through the use of video. The methodology is based on an interpretive viewpoint, derived philosophically from hermeneutics & phenomenology. The films ('artefacts') were created in order for the researcher to explore how design documentaries can be used in discovery research and to offer a critique on the existing practices of using video in discovery research. The process of making inspired Raijmakers' thinking in an iterative process, which was repeated several time in each case studies. At the same time, the films were considered to be 'data', case studies materials to be used in the inquiry. Raijmakers (2007) clarifies the research methods used under three areas:

1. Literature studies: Using hermeneutics and critical reflection to interpret text about films and the films themselves.

2. Film studies: The researcher conducted interviews with film directors and participated in documentary filmmaking master-classes. These were reviewed through content analysis, semiotics and mise-en-scene analysis.

3. Case studies of documentary films made by researcher: phenomenology and thinking-through-making (Seago & Dunne, 1999).

Analysis

The case studies were compiled and analysed based on how each research was conducted using Frayling's (1993) 'Into', 'Through' and 'For the Purpose' framework. In addition, I have also used Cross's (1999) framework of 'people', 'process' and 'product' in order to reveal the focus of the investigations. The philosophical underpinnings of each study are also documented in order to reveal how and where the research methods may have evolved. A summary of these points is listed in Table 1 and key characteristics of the methods used will be discussed in this section.

How was the research conducted?

Almost all the case studies demonstrated multiple methods of enquiry into their respective subject, supporting a viewpoint that these types of enquiry ('into', 'through' and 'for') are not mutually exclusive. It seems that while Frayling's framework is a practical way to describe different types of design research, supervisors will have to be careful not to present the framework as individual routes of design research. The examples have shown that enquiries into design-related matters are much more complex and requires non-conventional research methods to address them. Examples like Raijmakers and Mazé have shown that it is possible to use all three types of enquiry as an appropriate approach to design research. The ability to analyse and articulate the type of research undertaken in a study will enable a new doctoral candidate to quickly grasp certain models of design research and begin constructing their own research model. However, students should not rely on the model to help them determine research methods, as the case studies have shown a range of methods and design research employed.

What was the focus of the investigation?

Three case studies were specifically interested in the study of practices and processes of design (process) while the other three case studies looked at studying both the design process and the configuration of artifacts. None of the studies were focused on investigating the manner in which people design. It's not possible to draw any conclusion as to why there is a lack of focus in this last category due to the small sample size. However, it is possible to infer from the analysis that the focus of investigation seemed to be consistent with the method of enquiry used (see the comparisons between the fourth and fifth column of Table 1). Except for Eastwood's study, Dunne, Dixon and Loi studies ('for' and 'through') are focused on processes and products. Mazé and Raijmakers ('into', 'for' and 'through') use all three types of enquiry to investigate process related issues.

PhD Examples	What are its ontological and epistemological influences?	Description of general methodology applied	Methods used	How was the research conducted? (Frayling, 1993)			What was the focus of the investigation? (Cross, 1999)		
				Into	For	Through	People	Process	Product
Anthony Dunne	Material critical theory	Critical design	- Exploratory projects - Reflective practice[3]		X	X		X	X
Catherine Dixon	Pragmatic and applied	Design as research	- Visual survey - Reflective practice - Peer reviews		X	X		X	X
Daria Loi	Participatory	Multi-sensorial writing	- Cultural probes		X	X		X	X
Joe Eastwood	Phenomenological	Design as research	- Interviews - Fieldwork documentation using photograph, notes and audio recording - Visual analysis - Exploratory projects			X		X	
Ramia Mazé	Critical and post-critical architecture	Criticality from within	- Exploratory projects - Reflective practice	X	X	X		X	
Bas Raijmakers	Hermeneutics and phenomenology	Design as research	- Literature studies - Film studies - Exploratory projects as case studies	X	X	X		X	

Table 1. PhD Examples Summary

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[3] Dunne does not explicitly state the research methods that were used in the review of the projects. However, judging from Seago's description of 'highly considered artefacts' (in Seago and Dunne 1999 paper), it would seem to suggest that some form of reflective practice process took place.

Philosophical and Methodological models

It is perhaps not surprising to see that an enquiry using the practice of designing, as the main source of data generation should gravitate to research models that position the researcher at the centre of the enquiry. The reflective practice method, which involves the researcher thoughtfully considering one's own experiences in applying knowledge to practice, is evident in almost all of the case studies. Additionally, the use of the phenomenological approach was explicitly evident in two of the case studies. Phenomenological research focuses on the subjective experience of the individuals studied, enquiring into their experiences and understanding of a particular phenomenon (Robson, 2002). This approach enables the objective study of topics usually regarded as subjective by a researcher through the process of reflexivity. Crotty (1998) stresses the importance of reflexivity in order to be aware of the ways in which the researcher as an individual with a particular social identity and background has an impact on the research. The use of critical theory in Dunne's and Mazé's works illustrates the focus of their respective studies in using design as a method to critique, to ask questions rather than provide answers. Their approach differs from the other case studies in terms of their intent for their final designed outcome. Dixon, Eastwood and Raijmakers employed the design project as a vehicle to explore the research question rather than as a means to reflect upon and question the social, cultural and ethical implications of design objects and practice.

Characteristics of the Methods Applied

Thesis-structural Innovation

The creation of an innovative methodology seems to go hand in hand with thesis-structural innovation. This is especially evident in the way Mazé and Loi have translated their research methods into a thesis structure. Mazé 3x3 matrix (see Figure 7) succinctly illustrates how she explored her themes through a theory to practice model (and vice-versa), as well as using Frayling's research framework to frame her chapters and research design. Mazé took Dunne's model of interlinking essays and projects and provided an additional layer of complexity by linking theoretical concepts with projects through discussions of practice, using existing design case studies. Loi has taken the thesis-structural innovation to a logical end by changing the actual thesis structure itself. Although it is fairly common for an artefact to accompany a written thesis in Design PhDs, it was unprecedented that an artefact alone should act as the thesis. Indeed, questions surrounding production, accessibility, control, disciplinary, supervision, institutional and examination issues have to be addressed (see Loi (2004) paper on this) in order to determine the viability of such alternative thesis format.

'Pick and Mix'

Research designs employed in all the selected examples can be described as 'pick and mix', a form of bricolage (Galloway, 2008) or assemblage which often combines methods from the social sciences, humanities and hard sciences to derive a suitable model of inquiry. The necessity of this approach is not surprising considering the lack of an established research framework for design. However, perhaps this 'pick and mix' has become the established paradigm for design, and methodological innovation emerges from the way a researcher combines established research methods with practice-based methods. Kincheloe (2001, p. 683) describes this process well through his description of bricolage as a method that 'does not simply tolerate difference but cultivates it as a spark to researcher creativity … Sensitive to

complexity, bricoleurs use multiple methods to uncover new insights, expand and modify old principles, and reexamine accepted interpretations in unanticipated contexts'.

Linking Practice with Theory

Reflective practice (Schön, 1983) seems to be the most popular choice for research that involves a practice-based element, where the process of designing is an integral part of the research. This method is a common model, even where reflective practice was not the main methodological framework for example in Dunne, Mazé and Raijamaker's works. Dixon's work can probably be considered the most 'pure' in terms of its use of reflective practice as the main methodological framework, and all the other methods (peer review and visual analysis) are employed to support this. In contrast, in Mazé's and Dunne's studies reflective practice was used to critically review design projects in order to understand its relationship to the development of theory, which also has been supported by other non practice-based means. In Loi's case, she explicitly links practice with theory through the actual thesis construction, presenting (and defending) the research outcome through the reader's interaction with the piece.

Visual Analysis

In Eastwood and Dixon's studies, the role of visual analysis was an important part of the data collection and analysis. In Eastwood's study, the fieldwork data was translated into a range of visual representations, which enabled him to analyse and derive conclusions from the data collected. These data charts and macroscopic drawings also serve to act as data presentation visuals, and have enabled him to communicate his research to his audiences. Dixon's work investigates the actual form of typeface constructions, and part of her research involves a visual survey of recent typeforms. This type of analysis is similar to the comparative research that is often conducted by designers during the early part of a design process.

Some considerations on training provision

Offering an alternate research model

Students should be made aware at the beginning of their doctoral design research programme that while there are established research models in different disciplines, the 'pick and mix' design-specific model is more pertinent to their discipline. Design research frameworks such as these of Frayling (1993) and Cross (1999) are useful to establish the purpose and focus of enquiry undertaken by the student in order to help them select the most appropriate methods. Supervisors could encourage students to evaluate existing practice-based processes and consider how to make them more 'systematic, rigorous, critical and reflexive and communicable' (Newbury, 1996). The models reviewed should also consider the form and format of the final thesis, as innovative methodological innovation is often congruent with the way the thesis is structured.

Reframing Methods

Instead of discussing research methods by way of their associated discipline (arts, science, humanities), or through the type of analysis employed (quantitative, qualitative) the methods can be discussed in terms of how they might link practice

with research and vice-versa. Similarities drawn from practice-based methods and processes are a useful way to aid the novice design researcher link their existing design activity with research activity and emphasis the relationship between these two. Shared processes such as investigative, iterative and creative processes are evident in both practice and research (Yee, 2007). As such, we should be moving towards a holistic model as expressed by Fallman (2008) in how we discuss and explore knowledge within the design discipline.

A Designerly Way of Researching

The various research methods highlighted from the examples, within this paper have drawn from a mixture of established and new ways of collecting and analysing data. I would posit that this process of creatively combining processes is not dissimilar to how innovative processes are developed in practice (Yee, 2007), and that this should also be encouraged in the research enquiry. Hart (1998) emphasizes how important it is to develop an imaginative approach to research. For him, a research imagination is about:

> 'having a broad view of a topic; being open to ideas regardless of how or where they originated; questioning and scrutinizing ideas, methods and arguments regardless of who proposes them; playing with different ideas in order to see if links can be made; following ideas to see where they might lead...' (1998, p. 30).

Supervisors are encouraged to be open to methodological innovation, and to ensure that the development of these methods is rooted within a research tradition. As long as the student is able to demonstrate that the research conducted is 'academic' as in thoroughly argued and referenced (Glanville, 1998) then methodological innovation will often be part of their eventual contribution to knowledge in the field.

Reflections

This study is designed to be a preliminary review of current Design PhDs. The selected case studies are chosen on the basis of their innovative use of methods and to illustrate a variety of different research design approaches to Design PhDs. Readers should note that the analysis and conclusions drawn are from a limited range of case studies and only provide a glimpse into possible research models. In order to fully inform the design research community, doctoral candidates and supervisors, a more in-depth study enabling deeper critical engagement with a larger sample of case studies has to be conducted.

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