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Main Article:

Researcher Practice: Embedding Creative Practice Within Doctoral Research in Industrial Design

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Abstract

This article considers the potential for a researcher to use their own creative practice as a method of data collection. Much of the published material in this field focuses on more theoretical positions, with limited use being made of specific PhDs that illustrate the context in which practice was undertaken by the researcher. It explores strategies for data collection and researcher motivation during what the author identifies as "researcher practice." This is achieved through the use of three PhD case studies. Methods of data collection focus on: (a) the use of output from practice for quantitative data collection (i.e., for comparative analysis), (b) the use of output from practice for qualitative data collection (i.e., reflection on new working practice), and (c) the use of output from practice for data translation (i.e., using research output to produce a creative design solution for a tool that can be used for further data collection and validation). The article discusses the methodologies employed in the case studies to identify themes which enable the definition of a generic researcher practitioner methodology. It notes the significance of creative practice in support of data collection and the differences between researcher practice and commercial practice, and emphasises the contribution of researcher practice towards personal motivation.

Keywords: researcher practice; industrial design; product design, PhD

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1. Introduction

In his text on *Innovative Product Design Practice*, Liu (2007) provides a valuable insight into the methods and tools used during his career as an industrial design practitioner. The case studies show examples of the creative process and final proposals for highly visual products that were undertaken as corporate research and development for global brands. It must be recognised that, in isolation, professional practice is not academic research: "practitioner activity can count as research if, and only if, it accords with the criteria of research" (Archer, 1995, p. 13). To be identified as academic research, the practice must be integrated within a strategy that is *purposive* (based on the 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), and *communicable* (generating and reporting results which are testable and accessible by others) (Cross, 1999, p. 9).

During the early stages of the debate on the role and contribution of practice as a method of data collection, the United Kingdom Council for Graduate Education published an overview and policy statement. The document makes extensive reference to PhDs in music but the generic distinction of outcome from methodology is clearly made: "The *process*--the programme of research and the research methods followed--can be distinguished from the *product*--the outcome of the research--although the product is a significant indicator of the process" (UK Council for Graduate Education, 1997, p. 16). In parallel with the development of understanding of practice as a component of research methodology within the creative arts, nursing has been evolving similar but distinctive methods, with Evidence Based Practice (EBP) emerging in the 1970s (Leach, 2006). EBP is a five-stage process that involves: (a) identification of a (clinical) problem/questions, (b) search for a solution, (c) evaluation of the solution, (d) integration of the solution into practice (in conjunction with clinical expertise) , and (e) conclusions. Research into the practice undertaken by professional groups is widespread and provides an essential means for reflection and the development of strategies for the management of new and emerging working practices.

While a decision to employ a methodology that includes creative practice undertaken by the researcher might be made for a variety of reasons, it must be acknowledged that there would be every likelihood that the research could be addressed using a methodology that did not include such practice. This could, for example, involve engagement with other practitioners using methods such as interviews, questionnaires, focus groups, observations, and case studies. In many respects, methods that do not include creative practice may be more straightforward due to the problems associated with employing a single subject (the researcher) to provide data from a creative activity that may well be expressive, emotional, ill-defined, and with open-ended solutions. However, for research into design practice, the scope of a PhD programme remains relatively broad and it is helpful to note the fundamental requirements identified by Archer (2004) as these have a degree of overlap with the characteristics previously identified by Cross (1999). The following is the list of requirements identified by Archer (2004):

(a) to demonstrate competence in higher levels of research skills
(b) to make a substantial contribution to knowledge in a given discipline
(c) to become qualified to supervise others in the conduct of research programmes
(d) the critical appraisal by the candidate of prior research
(e) close attention to the principles and practice of research methodology
(f) the conduct of a single major systematic investigation

Discussions in the use of practice as a research method for PhDs in design have evolved through conferences such as Doctoral Education in Design in 2000 (Durling & Friedman, 2000), on-line forums (e.g., PHD-DESIGN), and review effort by the Arts and Humanities Research Council (AHRC) in the United Kingdom (Rust, Mottram, & Till, 2007). Despite discourse and progress in the level of understanding of the PhD in creative disciplines, the AHRC report acknowledges the limited of amount activity in the field:

> The doctoral "production" rate is slower than in most disciplines and is building on a very low base. This is not helped by the limited number of experienced PhD supervisors, especially as practise-led research requires a good deal of flexibility from the supervisor if they are to navigate a sound route in the very complex territory indicated by the case examples (Rust, Mottram, & Till, 2007, p. 67)

In the context of limited examples of PhDs in the creative arts that have employed practice as a method of data collection, the aim of this article is to provide case studies from the field of design, identify key issues, and define a generic methodology for what the author defines as *researcher practice*. The article draws on evidence from three PhDs that include creative practice as a central research method to support data collection. The case studies were either undertaken or supervised by the author.

2. Data Collection Methods

Data collection methods fall within the broad categories of quantitative, qualitative, and mixed methods. The quantitative method involves measurement of variables so that the data can be analysed mathematically or statistically; whereas the qualitative method "is a means for exploring and understanding the meaning individuals or groups ascribe to a social or human problem. . . . and the researcher making interpretations of the meaning of the data" (Creswell, 2009, p. 4). Data collection using the qualitative method may involve observations, interviews, documents, and audiovisual material. Mixed methods integrate both quantitative and qualitative methods with the aim of generating outcomes that are strengthened through the use of both (Creswell, 2009, pp. 3-5).

Data collection from creative practice tends to follow the qualitative method. This is summed up by the UK Council for Graduate Education in the following words:

> Research in the practice of the Arts related subjects is more likely to employ qualitative research methods. This kind of research does not, typically, begin with a predetermined set of questions or assumptions but arises from

> particular situations or contexts, which can be described with sufficient precision for a project to emerge which can be scrutinised and approved by the institution and supervisor. (UK Council for Graduate Education, 1997, p. 16)

Ultimately, the research methods adopted will be dependent on the nature of the research questions. There is no definitive way of undertaking research for a PhD, but the methodology must always result in robust and reliable outcomes.

The use of creative practice undertaken by the PhD candidate falls under the general heading of case studies, which Moore (1983**,** p. 44) describes as an approach to research as opposed to a research method. Birley and Moreland extend this when they state that case studies have the capacity to, "describe and understand the phenomenon 'in depth' and 'in the round' (completeness). In this role, case studies serve a useful purpose, since many important issues can be overlooked in a more superficial survey" (1998, p. 36). Robson (2002**,** p. 181) identifies two types of case study, individual case studies ("detailed account from one person that can be used to explore possible causes, determinants, factors, processes, experiences, etc.") and a set of individual case studies ("small number of individuals with some features in common"). A sole researcher undertaking creative design practice would fall within the domain of an individual case study, employing qualitative procedures that involves "specifying the strategy of enquiry, collecting and analysing data, presenting the results, making an interpretation, and writing the research in a manner consistent with a survey or experimental study" (Cresswell, 2009, p. xxiv). However, quantitative data may also be collected during creative practice, as discussed in Section 4.

In focusing on specific methods, action research is of relevance when exploring issues relating to practice (Cohen & Manion, 1980; Gomm & Hammersley, 2000; Moore, 1983). Action research has been defined as:

> an on-the-spot procedure designed to deal with a concrete problem located in an immediate situation. This means that the step-by-step process is constantly monitored (ideally, that is) over varying periods of time and by a variety of mechanisms (questionnaires, diaries, interviews and case studies, for example) so that the ensuing feedback may be translated into modifications, adjustments, directional changes, redefinitions, as necessary, so as to bring about lasting benefit to the ongoing process itself. (Cohen & Manion**,** 1980, p. 178)

The cyclical nature of action research has been discussed by Birley and Moreland (1998) who see it as being conducted by a professional to bring about an improvement in practice. The notion of an "action research cycle" is also noted by Robson and involves "planning a change; acting and then observing what happens following the change; reflecting on these processes and consequences; and then planning further action and repeating the cycle" (2002, p. 217). There are similarities between action research and *reflective designing*, in which the subject or researcher undertakes creative practice and

articulates the process and outcomes. The process of reflective designing is described by Schön:

> The designer's moves tend, happily or unhappily, to produce consequences other than those intended. When this happens, the designer may take account of the unintended changes he has made in the situation by forming new appreciations and understandings and by making new moves. He shapes the situation, in accordance with his initial appreciation of it, the situation "talks back," and he responds to the situation's back-talk. (Schön, 1983, p. 79)

The use of reflective designing and action research is by no means straightforward, as a convincing case must be made for the capacity to make generalisations from the practice of an individual who may have had little or no experience in a professional environment. There is also a degree of uncertainty when attempting to develop tools to enhance practice as the possibility exists for them to fail to deliver the required benefits. Despite these difficulties, the use of practice remains an attractive option for researchers who have a background in creative practice and it is necessary to explore the issue of motivation to identify reasons behind a desire to include practice within a PhD. These issues draw from the author's experience of undertaking, supervising, and examining PhDs that integrate practice.

3. Motivation

In the design field, doctoral projects with a focus on practice tend to use the more conventional data collection techniques such as interviewing practitioners. However, case studies of researcher practice appear to have emerged as an attractive alternative due to the following reasons:

(a) *Designers enjoy designing*: PhD programmes in the creative arts often fail to recognise the wider needs of the researcher who would typically have bachelor's and master's degrees in their discipline (e.g., graphic design, interior design, or industrial design) and where the structure of their degree programme(s) would have had a focus on practice. In other words, they have considerable prior history of creative practice and they may well miss the fulfilment of creative practice if none was undertaken during a PhD programme.

(b) *Academics wanting to maintain capability as practitioners*: For academic staff with a background in creative commercial practice, the typical route to a PhD is through part-time study. The combination of responsibilities for teaching and research roles means that it is all too common for such academics to lose or fail to develop capability in practice as they move through their academic career. The inclusion of practice within a PhD programme can offset this loss and serve as a powerful motivator, putting the academic in a position to eventually move on to confidently supervise practice-led PhDs themselves.

(c) *Research outcomes need designing*: An unexpected outcome from the author's experience of PhD supervision in creative disciplines has been situations where creative professional practice was necessary for the progress of the research. The development of tools to support practice is a common outcome from design-based PhDs and situations arise where the creation of the tool itself necessitates the application of creative design activity for it to be effectively developed, appraised, and validated. The motivation to design such tools must be acknowledged although this activity does not represent a type or method of data collection.

Whatever the motivation of the PhD candidate to employ researcher practice, before such methods can be explored it is essential for the supervisor to make a judgement on the candidate's competence as a practitioner. The AHRC note that, "Quality in the wider field of research is difficult to assess since the outputs and gatekeepers are eclectic and there are many variations in practice and purpose between the different areas of ADA [art, design and architecture]" (Rust, Mottram, & Till, 2007, p. 65). Discussion on the inclusion of practice within a PhD programme has tended to avoid references to practitioner capability but, if generalisations from design activity and designed outcomes are to be made, this represents a key issue for the validity of data (Durling & Niedderer, 2007, p. 9). Although the author and other members of the academy believe that supervisors of PhDs that include researcher practice should have practitioner capability, this is apparently not always the case. Therefore, the author believes that it is sometimes necessary to question the credibility of supervisory advice that is directly related to the execution of practice during PhD research.

4. Case Studies

Having considered some of the academic and motivational issues associated with the use of researcher practice, these will be contextualised through three case studies. The case studies have a focus on the collection of quantitative and qualitative data plus an additional role that has been identified as data translation.

4.1 Case Study #1. Quantitative Data Collection Through Researcher Practice

Thesis Title: *The Integration of Rapid Prototyping During Industrial Design Practice* (Mark Evans, Loughborough University, UK, 2002)

Having been employed as an in-house and consultant industrial designer, the author took up a full time academic post as a lecturer in industrial design at a research-led university. While continuing to undertake professional practice as part of this role, an interest in the potential to undertake a part-time PhD developed although it was apparent that the university would not award a PhD for designing a product. This position led to the formulation of research questions and methodology for a PhD that would facilitate data collection through the design of four consumer products. The focus of the study was in the field of creative industrial design professional practice, with the aim of evaluating the potential to integrate the emerging technology (in the mid-1990s) of rapid prototyping (Evans & Campbell, 2003). This involved a five phase research methodology:

Phase 1. *Literature review*: industrial design; rapid prototyping; research methods

Phase 2. *Draft strategy for integration of rapid prototyping*: definition of strategy; practitioner feedback; revisions to strategy

Phase 3. *Comparative evaluation of model-making/prototyping techniques*: design of product for benchmarking; evaluation of appearance models produced using rapid prototyping and conventional workshop-based techniques; evaluation of appearance prototype; collection of quantitative data

Phase 4. *Resolution of problematic issues*: additional product design case studies required; issues resolved/clarified; final strategy defined

Phase 5. *Validation*: appraisal framework; practitioner feedback

A draft strategy for the integration of rapid prototyping within industrial design practice was employed in the first case study (Phase 3) during which a relatively complicated consumer product (a nylon line garden trimmer) was designed (see Figure 1).

Figure 1. Detail of appearance model produced using rapid prototype components.

This case study employed methods of qualitative data collection (audio visual material, diary) but there was a key requirement for quantitative data as a significant outcome from the PhD was to be an indication of the financial implications of employing rapid prototyping as an alternative to conventional workshop-based techniques. The design for the nylon line trimmer was therefore used to produce one appearance model by using rapid prototyping and a second using conventional workshop-based techniques. This enabled quantitative data to be collected for component production times, component costs, paint finishing times, and assembly time.

The appearance models did not contain any working components, but the cyclical nature of action research and previous experience of commercial practice enabled the researcher

to identify opportunities to further exploit the potential of rapid prototyping, thereby extending its use for the production of a fully working appearance prototype.

Reflective designing (Schön, 1983) supported the identification of problematic issues within the draft strategy during Phase 3, which led to the modifications through additional case studies, thereby applying the cyclical nature of action research as identified by Cohen and Manion (1980).

One additional case study had been planned for Phase 4 but a total of three were actually required to resolve the problematic issues identified during Phase 3. Again, this demonstrated the cyclical nature of action research even though it resulted in extra workload. The additional case studies focused on the following attributes that were not predicted via the literature review: (a) considerable rigour was needed to produce the 3D computer geometry required for rapid prototyping, (b) rapid prototyping could not make a cost-effective contribution to the production of physical sketch models, and (c) as a remote build system, rapid prototyping removed the ability for the designer to engage in the definition of form through the tactile sculpting of a physical material. These issues were the subject of further literature review and, having identified potential solutions, were investigated and resolved to varying degrees of success through the design of three additional products, one for each issue. The final phase of the PhD was to validate the strategy using an appraisal framework that involved interviews with industrial design practitioners. The interviewees received a briefing on the method followed by the completion of a questionnaire that was normalised using a weighting/rating method (Pugh, 1991).

The recording of the quantitative data formed an essential part of the comparative evaluation and provided objective information during validation. The research was undertaken at a time when rapid prototyping was in limited use and when the findings were presented to practitioners as part of the validation process, the use of hard data (i.e., build times and costs) that was of particular relevance provided a commercial realism that was easily interpreted by the interviewees.

4.2 Case Study #2. Qualitative Data Collection Through Researcher Practice

Thesis Title: *The Development of a Curriculum for the Study of Digital Industrial Design* (Noor Al-Doy, Loughborough University, UK, 2011)

The commercial nature of professional industrial design practice necessitates the use of tools and methods with the capacity to meet client needs, often to tight timelines. Despite the availability of a wide range of digital tools that have the capacity to replicate more conventional workshop or paper-based methods with greater efficiency, the profession maintains strategies that mix non-digital with digital methods. The competitive nature of the commercial business model makes it risk averse unless the benefits of new working practices have been proven. A key area where academic research can contribute to professional practice is by challenging convention and exploring alternatives to typical modes of working. Following an extensive literature review, the PhD project undertaken

by Al-Doy (Al-Doy & Evans, 2010) developed an entirely digital strategy for the practice of industrial design with the aim of generating efficiency gains and the process being recorded through reflection and documentation.

The PhD necessitated the typical research methods of literature review, interviews and questionnaires to develop parameters for the research and specify a totally digital workflow that progressed from first concepts through to pre-production. The PhD employed the following five phase research methodology:

Phase 1. *Literature review*: industrial design practice; design tools; design education; research methods

Phase 2. *Development of strategy*: questionnaire to identify tool use; definition of draft digital industrial design strategy; evaluation of strategy via action research; revisions to strategy

Phase 3. *Appraisal of strategy*: interviews with practitioners to receive feedback

Phase 4. *Development of digital industrial design curriculum*: translation of findings into recommendations for an academic curriculum

Phase 5. *Validation of digital industrial design curriculum*: exposure of students to the curriculum; interviews with educators

Having defined the digital industrial design strategy, it was necessary to collect data on its capacity to deliver the benefits that had been identified in the literature review (e.g., efficiency gains and enhanced collaboration with engineers). To achieve this, reflective designing and the use of a diary with supporting audiovisual material were to be used as a means of recording the activities undertaken during the design of two consumer products. A pepper mill was selected for the case study due to its overall simplicity and inclusion of basic mechanical components. To assist in the evaluation of the complete digital strategy, two stylistic directions were chosen for the design of the pepper mill: one using geometric primitives, the other free form curves. These contrasting forms were selected to identify any limitations in the modelling capabilities of the virtual tools. The process included the comprehensive documentation of sketches, models (2D/3D), and prototypes that were produced during design practice using 17 different digital design modelling tools in a single case study. Specific modelling operations that formed elements of the digital industrial design strategy included the use of a digitising tablet with interactive display (Wacom Cintiq®), haptic feedback modelling (SensAble FreeForm®), virtual prototyping, and virtual reality (see Figure 2).

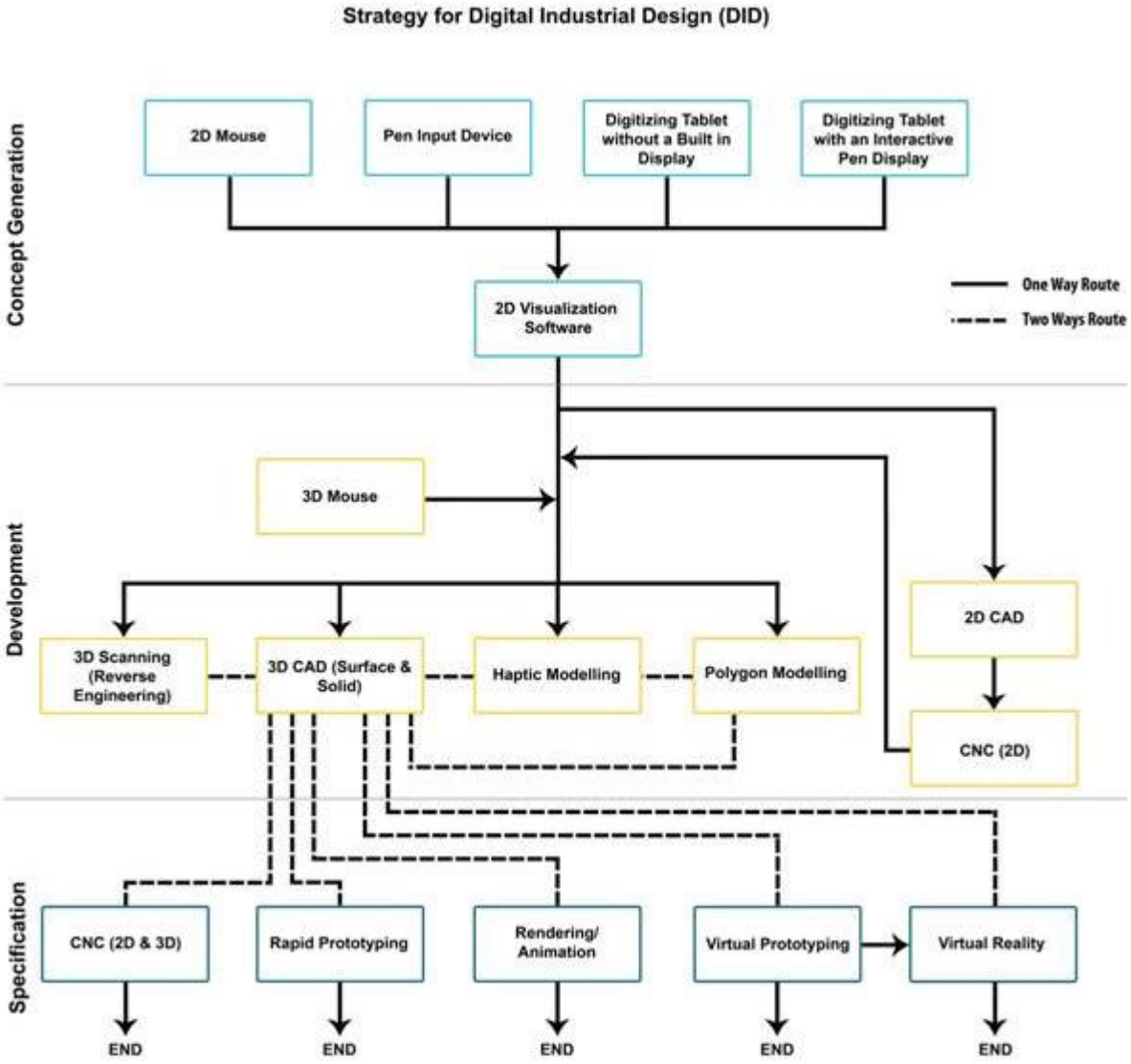

Figure 2. Digital industrial design strategy.

As the researcher had bachelor's and master's degrees in industrial design, she was already a capable designer. However, it was essential that the design-based action research took place in a context that closely followed commercial activity. Modes of practice were cited from relevant literature and use was made of the supervisor's experience as a practitioner to ensure that this was in the format of a commercial project. This resulted in a research methodology that had the capacity to provide a rich source of relevant qualitative data. The methodology employed in this case study differed from that of the line trimmer in that reflective practice did not directly inform the final strategy. The strategy for the digital industrial design case study was one of linear and pre-determined progression as opposed to the integration of rapid prototyping which could be described as evolutionary.

4.3 Case Study #3. Data Translation Through Researcher Practice

Thesis Title: *Enhancing Collaboration Between Industrial Designers and Engineering Designers* (Eujin Pei, Loughborough University, UK, 2009)

When undertaking research in the area of creative design activity, it is not uncommon for the outcome of a PhD project to be a tool that has the capacity to enhance or support practice. For such a tool to be used by designers, it must meet expectations that are both functional and visual. While it is quite feasible for a researcher to commission a consultancy to translate data into a compelling visual solution, if the PhD programme is self-funded or financed by a modest studentship, the cost would rarely make this a viable option. It therefore becomes the responsibility of the researcher to engage in practice that generates neither quantitative nor qualitative data but is essential for the progression of the research agenda: to translate research data into a visually creative tool that is suitable for evaluation and validation by practising designers.

During this doctoral research, which aimed to investigate strategies to enhance the collaboration between industrial designers and engineering designers, a literature review and interviews with practitioners led to the collection of significant amounts of qualitative data that, when collated into a matrix, was of limited or no use to practitioners due to its inherent complexity (Evans, Pei, & Campbell, 2009). The researcher was therefore presented with the challenge of translating the data into a design tool that could be readily and willingly used by practitioners. A need to make the tool readily accessible (without a computer) led to reviews of various formats and ultimately the specification of a playing card format. Once designed, the card-based tool was used by practitioners as part of the evaluation and validation process. The methodology employed for the PhD utilised the following six phases:

Phase 1. *Literature review*: Exploration of industrial/engineering design; collaboration; design methods; research methods

Phase 2. *Practitioner interviews*: Interviews/observations to identify barriers to collaboration

Phase 3. *Categorisation of design representations*: Interviews; taxonomy

Phase 4. *Draft collaboration tool*: Collation of data to produce first embodiment of card-based tool

Phase 5. *Refinement of collaboration tool*: Appraisal through pilot study

Phase 6. *Validation*: Practitioner interviews; case study; specification of final tool

The design of the cards went through three iterations following practitioner evaluation, but the researcher's capability as a designer was essential in making the cards usable, believable, and visually appropriate for the target user. The pack consisted of 134 cards,

67 of which contained information that was specific to industrial designers (red cards) and 67 contained information that was specific to engineering designers (blue cards).

Each set of 67 cards was subdivided into three sections, and each card displayed information on both the front and rear faces. Section 1 defined the four key stages of new product development (NPD) through which projects progress towards manufacturing. Data collected from a sample of designers in professional practice facilitated the inclusion of information on the most popular design representation used during each of the four stages of NPD. The design representations were grouped as types of sketches, drawings, models and prototypes. Section 2 defined the key types of design and technical information used by industrial designers or designer engineers during NPD. This section also indicated the popularity of specific design representations to communicate each type of design or technical information. Section 3 defined the full range of design representations (total 35) used by industrial designers and designer engineers during NPD. These included, for example, the idea sketch, general arrangement drawing, appearance model, and system prototype. A sample card from the industrial designers' design stage section can be seen in Figure 3.

Figure 3. Sample card from the industrial design set for the design stage section, showing information on concept design.

The red card in Figure 3 is for the concept design stage and includes a name for the stage (Concept Design), a card number (01), an orange tab at the bottom to identify that it was from the Design Stages set, and on the reverse is an indication of the popularity of use for specific design representations by industrial designers during concept generation (90 per cent of industrial designers surveyed used Idea Sketches during concept generation and 70 per cent use Study Sketches). The final version of the cards was extremely well received during their validation, with practitioners noting the design effort that had been applied to the ordering of information and visual solution. The final outcome from the

validation was that practitioners felt that the cards would make a contribution to enhancing collaboration between industrial designers and engineering designers.

A requirement to use creative design practice to facilitate data collection typically falls outside the mainstream methods of data collection but, as indicated through this case study, it can form an essential component of a research methodology when used for data translation.

5. Conclusions

This article has discussed three PhD examples in which researcher practice was employed to directly collect data or facilitate its collection. It has demonstrated that, if employed within an appropriate methodology, the use of researcher practice can provide rich contextual data (quantitative and/or qualitative) that would be difficult or not viable to collect using any other means. However, the extension of the role of researcher practice as a means of translating data into a research output presents an additional dimension that has been largely overlooked in the ongoing debate as it falls outside the remit of a data collection methods and the validity of that data.

Having identified the roles of researcher practice within a doctoral project, it is possible to integrate some of the common elements to identify themes and propose a generic strategy that may be of relevance to researchers who are considering employing the integration of practice within a PhD project. The proposed five phase methodology has the potential to move the direction of research from using more conventional and established methods of data collection to one where a tool or method is evaluated and/or designed through a process of researcher practice. Based on experience from the author's involvement in the three PhDs discussed in this article and supervision/examination of an additional nine, the following generic methodology is proposed for design PhDs:

Phase 1. *Literature review*: areas of study defined; prior knowledge identified; research methods selected

Phase 2. *Empirical studies*: stakeholder feedback on output from Phase 1

Phase 3. *Draft tool/method defined*: evaluation of tool/method via case study through researcher practice

Phase 4. *Tool/method refined*: evaluation of refined tool/method via additional researcher practice

Phase 5. *Validation*: practitioner/expert feedback on final outcome

Further examination reveals an association with the five stage process of evidence-based practice that can be employed during research into nursing (Leach, 2006). However, it must be acknowledged that this methodology is not prescriptive and would require modification according to the nature of specific research questions. As such, it forms a

starting point for those wishing to engage in the emerging and expanding area of researcher practice.

While discussions on the notion of practice being regarded as academic research may continue, the methodologies employed in the rapid prototyping and digital industrial design strategy case studies discussed in this article serve to indicate how researcher practice can be used to extend the boundaries of practice beyond commercial activity. This was evident in the need to produce two identical appearance models (using conventional techniques and rapid prototyping) as part of the evaluation process for the line trimmer case study. This would not happen in professional practice as only one appearance model would be required to support commercial decision making. In the case of the digital industrial design strategy, this specified the production of two appearance models using completely contrasting stylistic directions: geometric and organic. Again, the stylistic direction would typically be identified in advance of progression to physical models and the artificiality of the methods employed reflects researcher practice and not commercial practice. By its very nature, some of the detailed activities of researcher practice undertaken within a PhD programme will vary from that of commercial practice and this divergence must be more widely acknowledged.

An issue that will require future consideration is the question of what makes a PhD researcher a practitioner. For example, to become a chartered architect who can practice in the UK (i.e., be a professional practitioner) requires a prescribed level of education and competence (Royal Institute of British Architects, 2010). This is not the case for other art and design fields and independent judgements must be made in terms of the researcher being classified as a practitioner. Who makes such judgements and possibly signs-off the researcher practitioner as being capable of undertaking practice is yet to be defined but this issue remains a potential pitfall in the progress of this distinctive mode of research.

It is of some significance that the three case studies that the examples discussed in the article were from PhDs that required the submission of a conventional 60,000- to 80,000-word thesis, despite the fact that they integrated extensive researcher practice. Some university regulations now offer a reduced word count for PhDs that include creative practice, typically requiring 40,000 words plus the presentation of the practice component as a separate submission. While the case studies are from industrial design, it is necessary to question the need for other visually creative disciplines to accept a reduction in the written component of the examination. In many respects, engaging in creative practice as a method of data collection can be no more time-consuming than analysing lengthy experiments, questionnaires, interviews, or observations as required for PhDs in science, engineering, social science, and humanities. This also applies to the justification and description of the methodology and methods. The collation of the case studies and supervision/examination of other PhDs has led the author to question the need for alternative arrangements for PhDs in the creative arts that include a practice-based component.

If academic rigour in terms of methodology and methods can be facilitated, compelling arguments exist for the inclusion of creative researcher practice within a PhD project. The

three case studies have provided a summary to demonstrate how practice can be employed to propose theoretical models that include tangible examples of enhanced professional output (i.e., designed products) and as such, have the potential to make a difference. This is now becoming an increasingly significant factor in the assessment of research output as the UK Higher Education Funding Council has announced its intention to include a weighting for "impact" in its next review (Higher Education Funding Council for England, 2010).

The experiences discussed in this article also suggest that an element of creative practice within the doctoral project can have a motivational value for the researcher. This is an issue with which those who supervise or have PhDs will be all too familiar, but it is often ignored. The author believes that the nature of creative design activity means that motivation and the use of researcher practice are intrinsically linked and, if managed with tact and rigour, provide a route whereby the number of PhDs in art and design fields can significantly increase. It is hoped that this article will make a contribution to the achievement of this aim.

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