The Culture and Politics of Knowledge in Design Research: How to Develop Discipline Specific Methodologies

Dr Kristina Niedderer
Reader in Design and Applied Arts
School of Art and Design
University of Wolverhampton
Molineux Street
Wolverhampton WV1 1SB

email: k.niedderer@wlv.ac.uk
tel: +44 (0)1902 321 550
web: http://www.niedderer.org
web: http://www.experientialknowledge.org

Abstract

This paper discusses some of the issues concerning the culture and politics of knowledge in research in the UK that have stifled the development of discipline specific methodologies in design research.

Over the past two decades, design research in the UK has developed and emancipated itself from traditional humanities and engineering based research. However, as yet there is no consensus as to what the conceptual model[s] for design research are or should be, and how it should be conducted (Durling et al 2002).

This paper unpacks the cultural and political baggage of research, which is centered on the understanding of knowledge, and examines how design research can begin to understand itself as an autonomous discipline.

The paper begins by explaining the situation of research in the UK. It examines the understanding of knowledge in research and the impact of this thinking on the format and conduct of research. It then looks at alternative approaches (e.g. March 1984) to develop discipline specific approaches to design research and, based on previous research by Niedderer and Imani (2008), tests the applicability of the proposed research framework through case analysis.

The purpose of this analysis is to provide a practical demonstration of how the framework can be used to develop discipline specific methodologies in relation to different problem settings. It serves further to provide examples for developing discipline specific design research.

Introduction: The culture and politics of research

Over the past two decades, design research in the UK has developed and emancipated itself from traditional humanities and engineering based research. However, as yet there is no consensus as to what the conceptual model[s] for design research is [are] or should be, and how it should be conducted (Durling et al 2002). This research therefore investigates some of the issues of the culture and politics of knowledge in research, which have stifled the development of discipline specific methodologies in design research, and proposes an analytical framework for developing discipline specific methodologies.

Since the early 1990's, Research in Art & Design has developed as never before. With the integration of (vocational) Art & Design education into the academy in many countries, Art & Design research has received for the first time formal recognition and also research funding. For example in the UK, Art & Design had been ineligible for research funding under its own categorisation until the introduction of the Research Assessment Exercise in 1992 (Frayling 1993). With this development, the 'invention of ideas, images, performances, and artefacts including design where these lead to new or substantially improved insights' were for the first time formally recognised as [part of] research (HEFCE, 1992, Annex A).

Durling (2000) points out that prior to these developments, Art & Design departments in the UK undertook both 'research' and 'practice'. The former being undertaken by staff engaged in theoretical and contextual studies within a humanities tradition, whilst the latter involved staff that sought to maintain their professional standing and skills within a vocational education system. The 1992 RAE legitimised activities previously considered to be professional practice as research, but the post rationalisation of work submitted and evaluated through the peer review process confused the previously held status quo of research operating within strict scholarly conventions leading to publication and further knowledge in the field.

The abrupt introduction of research into Art & Design has caused questions in terms of research conduct and quality (Park 2005: 201), especially with regard to the inclusion of creative/professional practice. While diverse models of so-called practice-based research, or 'practice as research', have been invented to legitimise the use of practice within research, this has not resolved the problems concerning research conduct and quality (Niedderer and Roworth-Stokes 2007).

The intrinsic problem seems to be that Art & Design is searching for it's own model of research, while the requirements for research such as the contribution to knowledge remain the same, and any submissions for funding agencies or for the degree of PhD is still judged against the conventional criteria for rigour and validity of research to achieve equity in terms of research conduct and quality. A successful model for Art & Design research therefore needs to negotiate the two positions: that is the needs and aspirations of Art & Design as well as established criteria for research, which are important to ensure equity and quality of research across disciplines. In order to do so, one needs to understand both.

In the following, this paper first examines the established criteria of research, key to which is the understanding of knowledge and the impact of this understanding on the format and conduct of research. It then looks at the needs and aspirations of design to develop a discipline specific approach to design research. In support of this approach, this paper introduces a framework developed by Niedderer and Imani (2008), and tests the applicability of this framework through case analysis.

The Politics of Research and Knowledge

Traditional criteria of research, such as rigour and validity, have developed to achieve equity in terms of research conduct and quality across different disciplines, projects, etc. and they are embodied through a number of research requirements. This section examines some of the political positions embedded in these established criteria and requirements in order to look at the impact of this understanding on the format and conduct of research in general, and the implications for design research in particular.

One of the core requirements of research, which is part of most research definitions (e.g. AHRC 2008: 24; RAE 2005; as well as many university research definitions worldwide e.g. Curtin 2001:2, 3; Indiana 2005: 19, 50), is the contribution to knowledge because it is a key criterion for judging research. While knowledge itself is not defined in any of these research definitions, it is further specified by the subsidiary requirements and criteria for research that we find concerning the stages, format, conduct and evaluation of research.

Requirements for the stages of research specify different parts, such as the problem, context, method, outcome/findings as documented by the Arts and Humanities Research Council (2007), which is one of the major Research Councils in the UK. Thereby the problem section identifies the 'gap in' knowledge in a particular area. The context section shows that the researcher is adequately informed of existing knowledge, while the description and justification of methods used indicates the researchers beliefs in how the desired knowledge can be found/acquired, and thus to a particular way of reasoning. The presentation and conclusion on the research findings constitute the contribution to knowledge.

The requirement for the contribution to knowledge in itself implies a particular logic of reasoning, which is for example expressed in research regulations for PhD's through the requirement of putting forward a *thesis/proposition*, and of defending this definition through an *argument* (e.g. Hertfordshire 2006: A6). In this way, the contribution to knowledge determines the conduct and procedures of research.

In terms of the format of the contribution to knowledge, research findings are required to comply with concepts of generalisability and transferability, and which need to be capable of communication/publication in whole or in part in a permanent form. (e.g. Hertfordshire 2006)

Judgment of the application of the various requirements within research is used to determine the quality of research. Criteria for judging the quality of research are rigour and validity. Rigour is usually linked to, and understood as intrinsic logic or causality embodied through "the chain of reasoning" (Gorard 2002; Freeman 1990; Millo, Lipton and Perlis 1979). Rigour has at times been disputed as a criterion of positivist science. However Tobin and Begley (2004: 390) demonstrate that rigour is a criterion that transcends individual paradigms:

> Rigour is the means by which we demonstrate integrity and competence (Aroni et al. 1999), a way of demonstrating the legitimacy of the research process. Without rigour, there is a danger that research may become fictional journalism, worthless as contributing to knowledge (Morse et al. 2002). However, in response to Morse's caution, we suggest that qualitative researchers are not rejecting the concept of rigour, but are placing it within the epistemology of their work and making it more appropriate to their aims.

Their last observation is of particular importance, because it indicates that the concept of rigour is applicable to every research, but that it has to be adapted to the kind and type of study at hand. In this sense the notion of rigour can pertain to both

scientific as well as philosophical study, positivist and constructivist, quantitative as well as qualitative study. However, its indicators may vary according to the paradigm of a study (Hamberg et al 1994; Tobin and Begley 2004). Hamberg et al. (1994: 178) discuss how rigour is determined by different parameters, and how traditional parameters of rigour, such as validity, reliability, objectivity, and generalization are re-interpreted as credibility, dependability, confirmability and transferability to accommodate the particularities of, for example, qualitative research. These parameters have a clear impact on the conduct (methodology) of any research study, as well as of the judgment about their quality.

I finally want to discuss how these parameters are driven by our understanding of knowledge. For this purpose, we need to look briefly at the position of knowledge and what it implies. In previous research, I have analysed the position of knowledge that is implicit in research regulations and requirements, and I have shown that these definitions implicitly prioritise what is known as propositional knowledge (Niedderer 2007a). To understand this, we need to look at the nature of propositional knowledge and how it determines the nature of research. Propositional knowledge is most commonly defined as "justified true belief". Grayling (2003:37) says,

> this definition looks plausible because, at the very least, it seems that to know something one must believe it, that the belief must be true, and that one's reason for believing it must be satisfactory in the light of some criteria – for one could not be said to know something if one's reasons for believing it were arbitrary or haphazard. So each of the three parts of the definition appears to express a necessary condition for knowledge, and the claim is that, taken together, they are sufficient.

Despite the continued criticism, the definition of knowledge as "justified true belief" has remained the prevailing definition, and Niedderer (2007a:7) has shown that this understanding of propositional knowledge is implicit in the definition of research because of additional requirements such as the presentation of an intellectual position (proposition, thesis – 'true belief'), because of the logic of verification and defence of this intellectual position through argument and evidence (justification), and the requirement for explicit and unambiguous communication.

In this way, we can say that the understanding of knowledge as propositional knowledge determines the logic of the chain of reasoning. If rigour guarantees the quality of the chain of reasoning, as we have discussed above, then the quality of research is dependent on the quality of rigour, as determined by the logic implied by the understanding of knowledge.

The implicit prioritisation of propositional knowledge has led to a number of problems concerning the conduct of research, and in particular concerning the role and format of knowledge in relation to the use of practice within research (Niedderer 2007b: 5). However, upon detailed analysis, these problems seem to pertain to issues of explicit communication rather than to issues of knowledge per se (Niedderer 2007b: 10).

To explain this further, the two (or more) different versions of the parameters defining rigour (e.g. validity - credibility, reliability - dependability etc.), each follow the same reasoning prescribed by the understanding of knowledge, but follow different paradigms of justification. Post-positivism (in the sense of Guba 1990: 17) follows a foundationalist model where evidence is taken in form of data from the 'real word' (Williams 2001: 117ff), while constructivism (Guba 1990: 17) assumes the social construction of knowledge, which relies on the internal coherence of its claims (Williams 2001: 117ff). In this way, researchers can follow different paths of research, which adhere all to the same reasoning, but still allow choosing the appropriate conduct and methodology of their research.

An area where there seem to remain problems is with the communication of tacit knowledge (Niedderer 2007b: 5). For example, because of the language-based mode of propositional knowledge, the implicit prioritisation of propositional knowledge seems to exclude certain kinds or formats of knowledge associated with practice, which are often called practical, experiential, personal, or tacit knowledge and which evade verbal articulation. These problems seem to relate mainly to requirements for the explicit analysis and explanation, i.e. justification, which is required for example by university regulations and regulations of national research funding bodies in the UK, such as AHRC (2006) and RAE (2005). However, these seem to be practical problems, which ought to be solved on a practical level related to the choice and use of methods.

In conclusion of this section, I suggest that the solution is not abandoning current concepts of knowledge and rigour, but to find ways of accommodating both, the needs of the sector and the requirements of research.

Developing Discipline Specific Methodologies

Having established that the interrelated concepts of knowledge and rigour are essential requirements to all research, this section examines what might distinguish design research from research in other disciplines, e.g. history, philosophy, or engineering and how to develop discipline specific approaches to design research.

As indicated above, this question has arisen historically, because design has been recognised only recently as an academic discipline eligible of research. Therefore previously, any research relating to design had to be conducted in a recognised discipline such as history, philosophy, education, or engineering.

This has brought methods and methodologies from these disciplines into design research. While this may not be a problem in itself, for many design researchers it has been difficult to identify with the established positions that are 'imported' together with the conduct of research from those disciplines. This is because the established positions (and thus their contributions) remain bound to their disciplines, rather than making a genuine contribution to design. For example, using a firmly historical or philosophical approach is unlikely to deliver results that contribute to the creative development of a new design and its understanding, unless integrated in an appropriate design research methodology.

From this the question arose how are researchers in design to conduct research that makes a contribution to (knowledge of) design practice?

The recognition that design is an extremely broad discipline, which overlaps with many others, such as social sciences or psychology (e.g. user-centered design), engineering, biology and social sciences (environmental design), philosophy (ethical design) and so on, suggests that rigorous design research will have to draw on any methods that are suitable for a particular research study, regardless of the discipline it originally comes from. Further, generic research methods are used which are common to all research, such as methods of analysis and comparison, although they may be adapted dependent on the nature of the study in question.

The thinking about discipline specific research has also introduced the use of design practice as (part of) research, as method and/or as outcome. A lack in understanding how design practice relates to, and can be integrated within research, especially regarding the contribution to knowledge, has raised issues with the conduct and rigour in design research. In due course, several studies over the last two decades

have been concerned with the development and use of design methods within and for design research. Publications by Cross (1984, 2001, 2003) have influenced design research and how designers work. Further, a number of research studies have been developed, which have set precedents for research in design to date. Among these are studies by Whiteley and colleagues (2000; Rust & Whiteley, 1998), Wood (2004), and Niedderer (2007c) where the creative potential of designing is used to generate insights and/or new solutions.

These studies use a variety of methods from various disciplines which confirms that the problem does not lie so much in what methods are used, but how any methods are used, and that this ought to depend on the overall aim of any research study, and not be dictated by the wish to use any particular method because of being familiar with it. When developing research, it is therefore essential to understand and determine first of all what kind of contribution any study is intended to make. This is the kind of approach in which Tobin and Begley's response holds weight calling on researchers not to reject "the concept of rigour, but [to place] it within the epistemology of their work and making it more appropriate to their aims" (2004: 390).

Upon analysis, these studies further seem to show two particular characteristics concerning their aims, which are manifest through the use of practice as a method and/or outcome: one is the aim to find something out that is not yet in existence which is bound to the creative nature of design. The other is the need to access methods that facilitate and integrate the tacit knowledge of design researchers into their research and thus to tap into knowledge that would not otherwise be accessible.

One of the first attempts towards a discipline specific approach that recognises the creative nature of design comes from March (1984) who, referring to Peirce's notions of deductive, inductive and abductive reasoning (also: productive reasoning) (Hartshorne & Weiss, 1998, vol. 5: §171), proposes that the latter is the most appropriate for design. This is based on Peirce's understanding that

> Deduction proves that something must be; induction shows that something actually is operative; abduction merely suggests that something may be. (Hartshorne & Weiss, 1998, vol. 5: §171)

Peirce defines abductive reasoning further as

> the process of forming an explanatory hypothesis. It is the only logical operation which introduces any new idea;… (Hartshorne & Weiss, 1998, vol. 5: §171)

Presenting the concept of abductive reasoning in the context of design methodology, March (1984: 269) argues that this mode of reasoning is most appropriate as framework for design knowledge, because of the nature of design as a creative and conjectural process. This concept is most important because it provides sound philosophical foundations for building a discipline specific approach for design research that embraces both its epistemology and methodologies, and intrinsically recognises the creative nature of design. What March's approach does not do is to bring together the different parameters required for building a model that can offer practical help to design researchers in developing their design-specific research, and that deals with the integration of tacit knowledge.

Following the discussion above, it seems that such a model needs to be led first and foremost by the aim to make a contribution (of knowledge) to its own discipline. This aim will be specific to each [design] research project and cannot be predefined by any model or framework. However, a framework is needed to relate the aim and the contribution to knowledge via the research methods.

Such a framework then needs to adhere to the identified requirement of research (stages, format, and conduct), directed by the underlying logic of knowledge and judged by the rigour of its application. It also needs to be able to accommodate the needs of the specific discipline, which – in the case of design – are the creative nature of design, and the tacit nature of a significant part of the knowledge on which it is based.

In the following section, this paper introduces such a framework, which was developed by the author and her collaborator in 2008 (Niedderer and Imani 2008). The framework uses knowledge as the common denominator in order to provide continuum through all stages of research.

Developing discipline specific methodologies using the knowledge framework

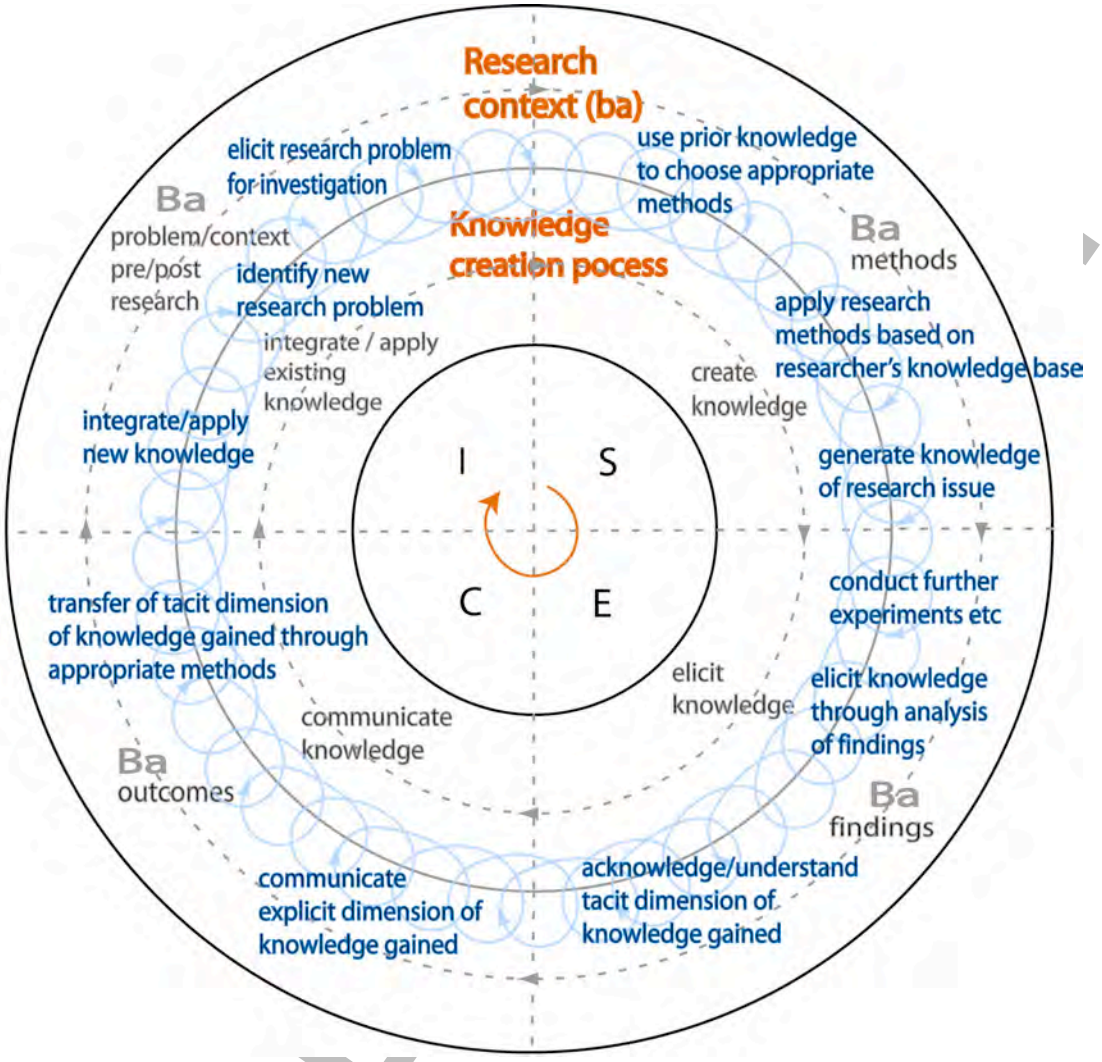
This section introduces the framework by Niedderer and Imani (2008), which brings together the different requirements discussed above and relates them. It understands knowledge as the key parameter that determines all parts of research. In due course knowledge is used as a common denominator to analyse and relate all parts of research regarding the format in which it occurs, and the appropriate conduct (methods) by which knowledge is integrated, generated and communicated. In this way the framework is intended both as a tool for analysis and as help to researchers for devising discipline-specific research methodologies.

In order to make this understanding and use of knowledge as common denominator tangible, we have adopted and adapted the so-called SECI-Model by Nonaka and Takeuchi (1995) from knowledge management. This model is based on an acknowledgement of the format of knowledge as dichotomy of explicit and tacit knowledge, and in due course proposes a cycle of four stages (Socialisation, Externalisation, Combination, and Internalisation = SECI) to manage the transition between the different stages. Socialisation refers to the passing on of tacit knowledge; externalisation to making tacit knowledge explicit; combination refers to the communication of explicit knowledge, and internalisation refers to gaining the tacit knowledge, which any explicit knowledge may refer to, through application and 'learning by doing'. (Niedderer and Imani 2008: 9)

In our paper (Niedderer and Imani 2008) we have explained that we believe that there is not a transition or 'conversion' of knowledge from one state to another, but a shift in emphasis from explicit to tacit knowledge and vice versa at, and within the different stages of research. The implication of this for the framework is that the parallel flow of explicit and tacit knowledge has to be managed at all times, which is expressed in the two parallel columns dealing with explicit and tacit knowledge respectively.

How the framework works in theoretical application:

There are two parts to the framework: one is explanatory, the second analytical. The first part is a representation of how the stages of research and of the SECI model interlink (Ill. 1). Thereby the SECI model can be related to research in two ways: first to the cycle of research as a whole (four quarters of the circle, each quarter equating to one stage of research and of the SECI model); second the SECI cycle as a whole can also be seen to relate to each stage of research (spiral movement). For each stage, the kind of knowledge transaction is indicated in relation to the corresponding transaction in research (blue type) as a negotiation between the research context (stages) and the knowledge creation process.



Ill.1 (taken from Niedderer and Imani 2008): Knowledge Cycle in research based on the four modes of knowledge conversion in the SECI model (Nonaka & Takeuchi 1995: 62).

By applying the SECI model in this way to the process of research, we can construct a generic framework (Part 2; Table 1) which offers an understanding for how explicit and tacit knowledge co-exist in research, and how the emphasis shifts between the different stages of the model/of research. The shift of emphasis offers pointers towards the importance of each dimension at any particular stage and/or difficulties in managing them, e.g. in applying explicit knowledge or transferring tacit knowledge from one stage to the next. Because of its generic nature, the framework provides the flexibility of using discipline specific methods as appropriate. In order to give the framework practical relevance, an indication is included of the kinds of methods that can be used for managing knowledge at each stage, including methods and processes to facilitate the integration/application, creation, elicitation, communication/transfer of knowledge.

Table 1 (taken from Niedderer and Imani 2008): Knowledge framework for research based on the four stages of research and the four modes of knowledge transfer in the SECI model (Nonaka & Takeuchi 1995: 62).

Stages of Research / SECI stages, level 1 (fig 3)	Roles of knowledge (fig. 2)	Methods for knowledge management related to SECI (level 2, fig. 4	
		Explicit Knowledge	Tacit Knowledge
Research Problem: *Combination / Internalisation* **Research Context:** *Combination / Internalisation*	**Drawing on/Integrating knowledge as a starting point for research** *Knowledge is collected in various ways and analysed to ascertain a knowledge gap.* In the process, the emphasis shifts from explicit knowledge (easy to research & communicate) to tacit knowledge (comprehension, intuition), and back again to explicit knowledge for evaluation.	**Collect explicit knowledge** (combination) in form of verbal/textual account or description of propositional, experiential, or procedural knowledge through methods of data collection such as literature search, archival searches, recorded interviews, questionnaires, etc. **Integrate knowledge** (internalisation) through formal methods of knowledge acquisition and data analysis such as literature review, reading, analyses (of various kinds), comparison, etc. **Identify Knowledge Gap** (socialisation) through reflection individually or in dialogue with others.	**Collect tacit knowledge** (internalisation) from observation through field trips, museum & exhibition visits, or from observation of own practice etc. **Elicit knowledge** (externalisation). Tacit knowledge acquired through observation will have to be made explicit through description and documentation to be available for methods building on explicit knowledge. **Identify Knowledge Gap** (socialisation) through individual reflection – according to Polanyi (1966: 22), this stage is also strongly routed in tacit knowledge (intuition).
Research Methods: *Internalisation / Socialisation*	**Integrate and utilise knowledge** *Knowledge is applied in form of methods within the process of research.* Available knowledge is being internalised through the shift from explicit to tacit knowledge until it can be used within (research) practice.	**Utilise knowledge** (combination) in form of verbal/textual account or description of propositional, experiential, or procedural knowledge of theories & models of paradigms, methodologies, and methods to devise a specific methodology for a specific study. **Integrate knowledge** (inernalisation) by creating knowledge structures (methodologies) that guide the (tacit) process of applying or conducting research methods in the process of research.	**Integrate knowledge** (internalisation). Some tacit knowledge may already have been internalised (e.g. experience from practice). In other cases tacit knowledge may still need to go through the stage of internalisation, and tacit knowledge may need to be learned or absorbed through empathy, through imitation, through own experience, through 'learning by doing' (Nonaka et al, 2000: 45), or through expert training, coaching and mentoring (Ball et al 2004; Miles et al 2005) before it can bee applied in form of research methods. **Utilise knowledge** (socialisation), both explicit and tacit, that has been internalised in the conduct of research through the experiential and skills-based application of research methods.

Research Methods *(continued)*	**Create knowledge** *The chosen methods are used to ascertain new knowledge.* Tacit knowledge is applied and/or tested and in the process extends, generating 'new knowledge'.	**Create explicit knowledge** (externalisation). The creation of tacit knowledge is intertwined with reflection in action and reflection on action (Schön 1983, Cowan 2006) to make individual processes conscious and available for evaluation, and to adjust the use of methods during the process as required.	**Create tacit knowledge** (socialisation) through the experiential and skills-based application of research methods, and – according to Polanyi (1966: 22), this stage is routed in tacit knowledge (intuition).
Research Outcomes: ***Externalisation / Combination***	**Elicit knowledge** *The explicit dimension of the (as yet tacit) new knowledge is articulated in order to evaluate and share it.* In the process, the emphasis shifts from tacit knowledge (rich, complex) to explicit knowledge (conscious analysis).	**Elicit knowledge** (externalisation) –happens in the phase following knowledge creation through (Schön 1983), and through various methods of analysis. Through *externalisation*, tacit knowledge is articulated providing a base for new knowledge. "Concept creation in new product development is an example of this conversion process" (Nonaka et al 2000: 45).	**Elicit knowledge** (externalisation). Through *externalisation*, tacit knowledge is articulated providing a base for new knowledge. While the tacit dimension of knowledge can be described, but not articulated, it it required to facilitate comprehension.
	Communicate knowledge *New knowledge is communicated and/or transferred on both explicit and tacit level to disseminate and share it.* The communication of both dimensions of knowledge is equally important. Explicit communication serves dissemination; tacit transfer serves comprehension and subsequent application.	**Communication of knowledge** (combination). Through *combination* processes explicit knowledge is converted into more complex sets of explicit knowledge (Nonaka et al 2000: 45). It can be communicated through various language based means such as papers, seminars, conferences, books, teaching materials etc.	**Transfer of knowledge** (socialisation): In order to transfer tacit knowledge, it may need to be learned or absorbed through empathy, through imitation, through own experience, through 'learning by doing' (Nonaka et al, 2000: 45), or through expert training, coaching and mentoring (Ball et al 2004; Miles et al 2005). The use of metaphors, analogy and models can support the transfer of tacit knowledge (ibid).
	Post Research: Application of new knowledge *This can be the starting point for new research or for application of new knowledge in practice.*	**Knowledge is available** (combination) for sharing, consumption and further use independent of individuals through storage in books, databases etc. **Application of explicit knowledge** (internalisation) will be dependent on its comprehension through complementary experience and tacit knowledge.	**Integrate knowledge** (internalisation). Some tacit knowledge may have been internalised (e.g. experience from practice). In other cases tacit knowledge may still need to go through the stage of internalisation, and tacit knowledge may need to be learned or absorbed through empathy, through imitation, through own experience, through 'learning by doing' (Nonaka et al, 2000: 45), or through expert training, coaching and mentoring (Ball et al 2004; Miles et al 2005) before it can be applied in practice, or become the basis for new research.

How the framework works within practical application:

In order to make the framework really useful, it is essential to discuss how it should be applied. The table shows in what format knowledge appears at each stage of research. What is not yet included in the table is the application of the individual methods at each stage, the rigour of their application and their relationship to each other, and thus how the knowledge of each stage relates to and conditions the next. This is what will be discussed in the following.

This discussion has to take into account that the understanding of knowledge and the reasoning it implies determines the concept of rigour by which any research methodology and the application of its methods are judged. This is important to guarantee the quality of research. To accommodate the creative nature of design, this concept needs to accommodate the particular characteristics of [productive] reasoning that the creative nature of design entails. It has to do so no matter what paradigm the study is set in (post-positivist, critical theory, or constructivist) and what the correlating mode of reasoning is (empirical, dialogic, or dialectic). However, the mode of reasoning will determine how rigour is interpreted, e.g. whether the criteria of judgment should be validity or credibility, reliability or dependability and so on. Which mode of these criteria of rigour applies to any particular study depends on the research aim and conceptual approach.

At the begin of any new research study it is therefore important to determine the aim of the study, and which paradigm (i.e. mode of reasoning) a study will follow because this will determine what and how methods will be used to work toward the projected outcomes and contribution, and how they will be judged. Within this process, the proposed framework is intended to help elicit and analyse the knowledge and reasoning embedded in the methods used in order to help determine whether and how they should be used within any particular study.

In order to do so, and once the aim and approach have been determined, it is useful to ask the following questions at the beginning of the study, and at each stage:

At the beginning:

- What is the main aim of the research?
- What is the intended outcome and contribution to knowledge, and how does it result from the methods chosen?
- What is the conceptual approach of the study (i.e. paradigm)?
- Which type of indicators of rigour does this entail (validity or credibility, reliability or dependability, etc)?

At each stage:

- What methods are (intended to be) used?
- To what purpose are the methods being used, i.e. how do they help to manage what kind/format of knowledge at each relevant stage?
- How do the methods (incl. the kind and format of knowledge) at each stage condition/relate to each other?
- What is the rigour with which they are applied?

Case Analysis

This section looks at the application of the proposed research framework through case analysis. The purpose of this analysis is to provide a practical demonstration of how the framework can be used to develop discipline specific methodologies in relation to different problem settings. It serves further to provide an example for developing discipline specific design research.

In order to do so, this paper discusses one case study along the guidance set out above. The example includes an element of design practice in order to demonstrate the integration of both explicit and tacit knowledge, and to include the creative characteristics of design. The analysis shows how the framework can be useful in the analysis and evaluation of research, and also how the framework can be used to build the methodological structure of a research study.

The case study is a completed research project, which is taken from the author's own work to enable her to know and analyse both explicit and unspoken aspects of the work, which would not otherwise be accessible to the author. While an analysis of external studies might have been of interest to gain insights about the analytical power of the framework, this will need to be part of later research due to the constraints of this paper.

Case Study:

The example is taken from a research project completed in 2005. The 6 month project set out to research the use of Argentium Sterling Silver (AS) in the complex context of practice. The work was conducted by Niedderer at Middlesex University and with support of the Arts Council England (Niedderer, Harrison, and Johns 2006).

Background and Rationale:

AS is a new silver alloy, which was developed to combat an oxidation process called 'fire scale', which occurs when standard Sterling Silver (SS) is heated during the fabrication process. Fire scale appears as bluish-grey stains in the surface of silver and is difficult to remove. AS has been recognised for a number of advantages, most significantly for being firescale-free.

The alloy was developed by Peter Johns at Middlesex University. During the development, the alloy was mainly tested using scientific methods, e.g. measured melting temperature, hardness, etc. There were also individual practitioners using and reporting on the alloy. However, this was not in a systematic and reliable fashion. This project therefore set out to test the performance of AS in the complex context of practice.

Aims:

The aim of the project was twofold:

- firstly, it set out to test the performance of the new alloy in the complex context of practice when used with traditional silversmithing methods and new technologies, such as laser welding;
- secondly, the research explored the opportunities that might arise for silver design from the use of AS with new technologies, such as laser welding.

The expected outcomes and contribution were therefore

- firstly, a range of silversmithing pieces which were made to test the performance of AS using established methods/new technologies, and resulting in knowledge about its performance in different situations;
- secondly, some insight and evaluation of the opportunities arising for silver design from the combined use of AS and new technologies (especially laser welding).

The conceptual approach of the study and the indicators of rigour

We now need to look at what these aims mean for the conceptual approach and conduct of the study.

The first part of the inquiry was set to be a comparative testing. However, this was not based on quantitative testing as would be in scientific study, but a qualitative evaluation that would provide some insight about the qualitative difference in the performance of Argentium silver as compared to standard silver. This testing was therefore measured by human perception, and the factor against which results were compared were either a direct comparison of examples, or an evaluation against the previous 15-year experience of the researcher of working with standard silver. This allowed to take into account that – in the complex context of practice - a single phenomenon could not necessarily be viewed in isolation, but that a any results in the materials performance are based on a number of factors.

For example, the elasticity of the material was to be tested when work-hardened. This was conducted in a comparative test with both alloys under the same conditions as one would expect from scientific testing. However, the results were not measured quantitatively. Instead the flexibility and springiness of the material was assessed and how it felt when handled, and whether or not the material would break when subjected to further steps achieving a particular design.

An example from the second part of the inquiry would be the comparison of the opportunities available through the new technology of laser welding as compared to the traditional technique of soldering. Both are joining techniques, nevertheless there are essential differences. The benefit of laser welding is in minimal heat application, which allows the use of thin, flexible, work-hardened material. In contrast, the traditional use of soldering requires heating the whole piece during fabrication, which softens the silver. Any design using soldering processes therefore has to use sheet material of sufficient thickness to avoid easy indentation within use, commonly ranging between 0.8 - 1.5 mm. This makes silverware expensive and puts a range of constraints on the designing and making of silverware. Because of the softness of the material, pieces made of thinner material may e.g. distort during heating; need to be work hardened after the last soldering stage; or need to be filled with supporting material (pitch).

The inquiry into new possibilities of the combined use of laser welding with AS for silver design is driven by creative inquiry. It can be systematic to a certain extent, and it can be justified following any intervention through theoretical analysis, but it is essentially based on creative synthesis and productive reasoning.

As demonstrated by the two examples, the two parts of the inquiry follow different approaches, because they have different aims. The first is to test the performance of the alloy; the second assesses the creative possibilities and potential.

In terms of a conceptual approach or paradigm, the first approach is clearly routed in an external reality, but it also acknowledges an internal reality and that both have to be negotiated. This suggests following a critical paradigm. The second part is even more based on normative judgment and evaluation, in that it assess the creative possibilities, and thus suggest following a constructivist paradigm, which acknowledges a socially constructed reality. Therefore it seems that both parts follow the second set of parameters of rigour: confirmability, credibility, transferability; dependability, which should be applied when judging the application of methods.

Methods

Although, some of the methods used have already been mentioned, we now need to look at what the conceptual approach means for the choice and use of methods in more detail and their relation to reasoning and knowledge.

Methods Part 1

As indicated above, the first part was a testing of the performance of the alloy. This testing was partly accomplished through comparative testing, which produced and used samples to test one particular characteristic at a time. This testing was complemented by observations of the performance of the alloy when used within complex processes, i.e. the making of a finished silver piece. For this purpose, apart from the sample tests, a small number of designs where produced that included different processes and techniques to see whether any differences might be found in working with AS, compared to traditional silver. The first design used traditional methods and processes such as sawing, filing, spinning, soldering, and polishing. The second design used laserwelding (as the main technique).

Considering the flow of knowledge here, both tacit/experiential knowledge and explicit knowledge were brought into the project. The latter was included through documented scientific information such as metallurgical charts (combination). The former was brought in through the researchers experience of techniques and processes, of interpreting the scientific charts, and of evaluating any results gained through the work (internalisation, socialisation). This knowledge was then utilised to conduct the actual research, i.e. the comparative tests and the execution of designs (socialisation). The results of both procedures were judged against the experience of the expert silversmith, because it is the performance in use that is of interest here. Where appropriate, metallurgical information was used to support the experimental findings and experiential assessment. In this way, the results were evaluated both on an experiential/tacit and an explicit level. The research and its result were elicited afterwards through descriptive accounts (externalisation) that offered an explicit analysis, interpretation, and evaluation of the findings and of the judgments made. The results (descriptive accounts) were finally published (combination).

Considering what the criteria of rigour mean in the context of this research, *confirmability* refers to the possibility of a trial being repeated with the same results, although the results may not be numerical, but rather in form of a narrative judgment such as, 'AS in this state is more flexible than Sterling, and it breaks later than Sterling when bent by 180 degrees over a sheet of 0.5 mm. *Credibility* refers here to the appropriateness of the methods used and conditions for judgments made. Because we wanted to know how the material performs in use, it would have been irrelevant to perform the usual scientific tests, which would be more accurate, but would say nothing about the material in use. This was helped hat the scientific

parameters were already available and helped to inform any judgments and to draw any conclusions. Furthermore, it was important that the researcher had sufficient (15 years) experience with Sterling and therefore would have a stock of experiences (results) to which the new results could be compared. Someone, who has never before worked with silver could not have conducted the research appropriately. Therefore, the appropriateness of the context, and of the expertise of the researcher are of vital importance to the credibility and to the *dependability* of the results of the first part, i.e. whether the results can be trusted. While specific to the designs produced, the findings were also *transferable* where they pertained to knowledge of the alloy and to specific generic methods and processes.

Methods Part 2

The second part of the research tried to find and evaluate the potential creative possibilities of the new alloy that was expected especially in connection with the use of new technologies such as laser welding. For this purpose, the inquiry into new possibilities for silver design was driven by creative inquiry. It first determined some of the differences in the technique (compared to soldering), and then searched for potential beneficial applications for silver design through creative synthesis, the results of which were justified through theoretical analysis.

Tacit and explicit knowledge here was integrated in the same way as in *Methods Part 1,* through experience and through explicit technical accounts (internalization, socialisation). This knowledge was used in conducting the research through the methods used (combination/socialisation). In this case, additional to what has been explained for *Methods 1*, there had to take place creative synthesis of the knowledge of material properties and how these can be used within design, of the technique, and how this can be used in combination with the properties of the material to develop new design opportunities. For example, because of the minimal heat application in laser welding, thin, flexible, work-hardened material can be used, which offers a very different way of working with silver and gives a very different quality oto the design. Results were evaluated and communicated in the same way as described above.

Finally, similar as for the first part, *credibility and dependability* refers to the appropriateness of the methods used and conditions for judgments made. Where creative synthesis is concerned, the reasoning has to be understood not to prove anything, but to demonstrate that something may be, that it may be useful and beneficial, for example, new opportunities for production, or for social use, or aesthetic expression. *Confirmability* refers here not necessarily to the possibility of a trial being repeated – that is, not everyone would come to the same design if starting from scratch, but that it can be followed and rationalised after the research. *Transferability* can here pertain to different levels. For example, on a generic level, the insight that a new material used with a new technology can offer new design opportunities can be transferred to searches with other materials and/or technologies. On a lower level, the findings of how the use of laser welding with thin hard-rolled AS can offer new opportunities for silver design can be applied or transferred to find new designs.

In summary, with the description and analysis of this research project, I have tried to provide an example of how the understanding of the format, knowledge and rigour of research are connected and influence research and its conduct at every stage.

Conclusion

In this research, I have first introduced the problematic of the culture and politics of knowledge in research. I have shown how this has influenced the development and understanding of research, and how a particular understanding of knowledge has been the driver for this.

I have then shown that this position is useful, if its understanding is expanded to a more holistic view on knowledge, which allows an appropriate qualification of the criteria of rigour, which are used to judge research and its conduct.

I have shown how knowledge, reasoning, and the judgment of research are related, and I have introduced a generic framework developed by Niedderer and Imani (2008), as a tool to help researchers to understand how methods can be used to manage knowledge throughout a research project, and thus to understand the flow of knowledge, and the connection between methods better when devising their research methodologies.

This paper has concluded with the presentation of one case study, which has been analysed according to the parameters developed in the paper, in order to demonstrate how the framework can be used to aid researchers.

In conclusion, the key to building successful discipline specific research seems to lie

- in the clear understanding of the aim and purpose of any project about its contribution, both to the field and to knowledge, and its conceptual approach, which determines the criteria of rigour;
- in the understanding of the format and requirements of research including the understanding of knowledge;
- and in how the conduct of research and use and connection of methods can be developed rigorously through establishing a coherent flow of knowledge and through evaluation through the appropriate criteria of rigour.

References

AHRC (2007) *Research Funding Guide 2006/07*, Arts & Humanities Research Council, Bristol. Online: http://www.ahrc.ac.uk

Aroni R., Goeman D., Stewart K., Sawyer S., Abramson M. & Thein F. (1999) Concepts of Rigour: When Methodological, Clinical and Ethical Issues Intersect, Vol. 2000. AQR. Available at http:// www.latrobe.edu/www/aqr/offer/papers/RAoni.htm, last accessed May 2001.

Barrett, E. & Bolt, B. (eds.) (2007). *Practice as Research: Approaches to Doing Creative Arts Inquiry*. I.B.Tauris Publishers.

Cross, N. (1984). *Developments in Design Methodology* (Ed). Chichester, NY: John Wiley & Sons.

Curtin Univ. of Technology (2001). *Principles for doctoral coursework programs*. Australia: Curtin University of Technology.

Durling, D., Friedman, K. & Gutherson, P. (2002). Editorial: debating the practice-based PhD. *International Journal of Design Science and Technology,* 10 (2), 7–18.

Frayling, C. (1993) *Research In Art and Design.* Royal College of Art Research Papers Volume 1 Number 1 1993/4. London: Royal College of Art.

Freeman, J.W. and Neely, R.B. (1990). A structured approach to code correspondence analysis. *Proceedings of the Fifth Annual Conference on Computer Assurance* Volume 25-28, pp. 109 – 116.

Gorard, s. (2002). Fostering Scepticism: The Importance of Warranting Claims. *Evaluation and Research in Education,* 16(3), 136-149.

Hamberg, K., E. Johansson, G. Lindgren, and G. Westman. (1994). Scientific Rigour in Qualitative Research—Examples From a Study of Women's Health in Family Practice. *Family Practice.* 11(2): 176-181.

Hartshorne, C. & Weiss, P. (Eds.) ([1931–58] 1998). *Collected papers of Charles Sanders Peirce (vol. 5)*. Bristol: Thoemmes Press.

HEFCE (1992) *Research Assessment Exercise 1992: The Outcome,* Universities Funding Circular 26/92, Bristol.

Hertfordshire, University of. (2006). Research Degrees Handbook 2004. University of Hertfordshire.

Indiana, University Southeast. (2005). *Research policy manual*. Indiana, USA: Indiana University Southeast.

Mäkelä, M. & Routarinne, S. (eds.) (2006). *The Art of Research: Research Practices in Art and Design*. Helsinki: UIAH.

March, L. (1984). The logic of design. In N. Cross (Ed.) *Developments in design methodology.* Chichester, NY: John Wiley & Sons, 265-276.

Millo, R.A. de, R. J. Lipton and A. J. Perlis. (1979). Social Processes and Proofs of Theorems and Programs. *Communications of the ACM*. 22(5), 271-280. Accessed from: http://www.loai-naamani.com/Academics/Concepts/Social_Processes.pdf

Morse J.M., Barrett M., Mayan M., Olson K. & Spiers J. (2002) Verification strategies for establishing reliability and validity in qualitative research. International Journal of Qualitative Methods, 1(2), Article 2.

Niedderer, K. and Imani, Y. (2008). Developing a Framework for Managing Tacit Knowledge in Research using Knowledge Management Models. In *Undisciplined! Proceedings of the Design Research Society Conference 2008*. Sheffield, UK: Sheffield Hallam University. URL: http://www3.shu.ac.uk/Conferences/DRS/Proceedings/Papers/N/Niedderer_Imani_DRS2008_027.pdf

Niedderer, K. (2007a). A Discourse on the Meaning of Knowledge in the Definition of Art and Design Research. *European Academy of Design Conference 2007*. Izmir, Turkey.

Niedderer, K. (2007b). Mapping the Meaning of Experiential Knowledge in Research. *Design Research Quarterly,* 2 (2).

Niedderer, K. and S. Roworth-Stokes. (2007). The Role and Use of Creative Practice in Research and its Contribution to Knowledge. *IASDR International Conference 2007.* Hong Kong: Hong Kong Polytechnic University.

Park, C. (2005), New Variant PhD: The changing nature of the doctorate in the UK, Journal of Higher Education Policy and Management, Vol. 27, No. 2, July 2005, pp. 189–207.

RAE. (2005). RAE 2008: Guidance on submissions. URL: http://www.rae2008.ac.uk

Rust, C. (2004), Design enquiry: tacit knowledge and innovation in science, *Design Issues,* 20(4), pp. 76-85.

Scrivener, S. (2007). The roles of art and design in research. *The Art of Research*. Helsinki: UIAH. (in press).

Scrivener, S. (2002). Characterizing creative-production doctoral projects in art and design. *International Journal of Design Sciences and Technology,* 10 (2), 25-44.

Tobin G.A. and Begley C.M. (2004). Methodological rigour within a qualitative framework. *Journal of Advanced Nursing*, 48(4), 388–396.

Williams, M. (2001). *Problems of Knowledge: a critical introduction to epistemology.* Oxford: Oxford University Press.