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Explorative Materiality and Knowledge:
The Role of Creative Exploration and Artefacts in Design Research

Abstract

Juxtaposing the nature of design and the foundations of research in the traditional science and humanities disciplines puts their differences into sharp relief. The comparison highlights the key characteristics of design – its creative and experiential nature – which any design research must take into account, as well as the theoretical foundations of research. The aim of this article is to develop an understanding of the ontological, epistemological and methodological issues of design research, and to offer a framework that can embrace equally the notions of creativity and experiential knowledge, and of academic rigour.

Furthermore, the potential roles of the design process and artefact within research are examined within this theoretical framework, which suggests that design processes and artefacts can – if appropriately framed – play an important part in the research process, facilitating an approach commensurate with the aims of design enquiry. A case study of the Niedderer's own work serves to illustrate the balance and integration of theory and (creative) practice within the research process, and how this integration can enable a multi-layered contribution to the theoretical and practical advancement of the field.

Keywords: design, research, practice, knowledge, creative exploration, artefact

Introduction: the emergence of research in art and design

Since its emergence, research in art and design has grappled with the problem of how the practices of art, design and research, and their respective processes and products, could or should be seen to relate (Biggs 2002, 2004; Niedderer 2009). This problem is three-fold: it is ontological in that one needs to consider which questions could or should be asked in art and design research that are appropriate and worthwhile; it is epistemological in that one needs to consider which perspectives or approaches could or should be incorporated into the enquiry; and it is methodological in that one needs to consider how any enquiry could or should be undertaken from the point of pragmatic conduct.

This problem has arisen from the historic situation in the United Kingdom: In the 1990s, two major developments within the higher education sector introduced the idea of research into art and design. Firstly, the integration of art and design education within the university sector has enabled doctoral studies in art and design (Durling, Friedman, and Gutherson 2002). Secondly, the Research Assessment Exercise (RAE) 1992 recognised for the first time the 'invention of ideas, images, performances, and artefacts including design where these lead to new or substantially improved insights' (HEFCE 1992, Annex A) as research. Prior to this, 'research' and 'practice' in art and design were conducted separately. Practice was undertaken by academics who sought to maintain their professional standing and skills within a vocational education system (Durling 2000), while research relating to art and design was conducted according to established research traditions such as history, philosophy, psychology or education. This meant that academics in art and design had to conduct research within the aims and approaches intrinsic to these disciplines and with their contribution bound to them, rather than making a genuine contribution to design.

The 1992 RAE thus legitimised activities as research that were previously considered to be professional practice. This challenged the previously held status quo of the scholarly conventions of research and instilled a need to understand the role of creative practice within research, especially with regard to its contribution to knowledge and the related requirements,

which remained unchanged. This question remains pertinent even today. The pivotal point appears to be both the clear distinction between research and practice, and their relationship in terms of process and outcomes. On the one hand, 'research' is clearly defined and is widely understood to denote the formal, systematic and rigorous process of enquiry with the goal of gaining new knowledge, insight or understanding, and which uses theory building as the formalisation of any insights or understanding gained from practice or otherwise, either by descriptive, explanatory or predictive research (Fawcett 1999: 1-25; Durling and Niedderer 2007: 3). On the other hand, 'practice' is not well-defined. For RAE purposes, it was defined as referring to professional and creative practice, or to the processes used within such practice, in order to produce work for any purpose other than the (deliberate) acquisition of knowledge, insight or understanding (Durling and Niedderer 2007: 3).

In an attempt to define creative practice in a more positive way, one could say that the aim of creative practice in the first instance is to create artefacts or services, usually for commercial gain. While knowledge is being used in the process, and insight and understanding may be gained from the development of new work, this knowledge has traditionally remained hidden for a variety of reasons. One reason is that procedural knowledge is largely experiential and tacit, and is not usually made explicit; another is that knowledge is frequently kept secret to retain trade advantages. In addition, no justification is required in creative practice for how a result was achieved or how an artefact was made. For example, the decanter (Fig. 1) or the Slinky toy (Fig. 2) do not betray what or how much research has gone into their development, and therefore what knowledge gain they constitute for their field. Indeed, replicability may be undesirable in certain areas of design where uniqueness is a sales factor.

Figure 1: Kristina Niedderer, 'Kris' Decanter with cups, silver-plated, 2000, produced by Paola C., Italy.

Figure 2: Richard James, "Slinky Toy", 2012, made by Poof®; original design Philadelphia, USA, 1943. Photograph: Kristina Niedderer

Thus, while creative practice may well be linked to the generation of new knowledge, design and research appear to have a number of opposing tendencies concerning the format and communication of this knowledge, which must be resolved in order to conduct satisfactory creative research. In the following, I shall forgo any political and commercial issues, assuming them to be resolved or irrelevant within the context of academic research, since academic research is generally publicly funded and is therefore increasingly required to be publicly available. Instead, I shall focus on the intrinsic characteristics of creative practice and their scholarly implications in the context of research.

In the following, I compare the nature of research and design in order to understand which questions art and design research might usefully ask, and how they may be approached to maintain both the rigour and validity required of research, as well as the creativity intrinsic to art and design. The theoretical discussion is supported by a discussion of a practical example of the author's creative research. When talking about 'art and design' or 'creative disciplines' in this paper, both terms are used interchangeably and are taken to refer to the creative field as a whole, assuming a common problematic within the sector regarding the requirement for the contribution to knowledge, as well as for research regulations and requirements. When referring to 'design' only, this is to simplify terminology and to indicate that the examples used are broadly situated within the area of design.

Defining the Nature of Design Research

In order to understand the nature of design research, it is necessary to examine both the nature of design and of research separately. This enables an appreciation of how design research is based on both subjects, and how this characterises its format and content compared to that of other disciplines, such as history, philosophy or the sciences. While the format is determined by the strictures of research, which design research has to adhere and stand up to if it hopes to be taken seriously, it must at the same time accommodate the nature and aims of design as its content. It is this need to negotiate these two aspects that has caused most confusion over the years, either because they were not understood or not accepted. However, if both are negotiated successfully, any apparent difficulties can be overcome. In the following, the characteristics of research and design are discussed, along with how these merge within design research, and what the implications are for negotiating both.

The Requirements of Research

Like any activity, the format and interpretation of research have been subject to changes over time. The continual refinement of its rules is evident, for example, in the different iterations of the definitions and regulations of major research funding bodies in the UK, such as the AHRC (2003, 2006, 2008) or HEFCE (RAE2001, RAE2008, REF2014). However, the underlying principles of research have remained largely untouched (Niedderer 2007a,b). At the core, research regulations – especially those for PhDs – require a 'contribution to knowledge' or understanding or insight, a requirement shared worldwide (e.g. Curtin University of Technology 2001: 2, 3; Indiana University Southeast 2005: 19, 50; Ulster 2012: 33).

The position of knowledge implicit in regulations and requirements is one that prioritises what is known as propositional knowledge (Niedderer 2007a: 6). The concept of propositional knowledge is defined as 'justified true belief' (Grayling 2003: 37), and is characterised by the 'proposition' or 'thesis' ('true belief') on the one hand, and justification through adequate evidence on the other. The need for justification traditionally requires all parts to be made explicit and for the knowledge gained to be generalisable (Niedderer 2007a: 6, 11). Propositional knowledge, therefore, is traditionally communicated as precisely formulated definitions or statements supported by a rigorous argument, and/or in the form of numerical values and equations. For example, the generalisable understanding of material density can be defined as 'The degree of consistence of a body or substance, measured by the ratio of the mass to the volume, or by the quantity of matter in a unit of bulk' (OED 2012) and is expressed as gram per cubic centimetre (g/ccm) (Table 1).

Table 1: Scientific data for Sterling Silver and Argentium Sterling Silver (details from Davis and Johns 2007) demonstrating the condensed form in which propositional knowledge is often communicated.

Condition	Sterling Silver	Argentium Sterling Silver
Silver fine content	925/1000	925/1000
Density (g/ccm)	9.32	9.261
Hardness (DPH) annealed	66-76	50-70
Spring hard	132-148	150-160
Heat conductivity	96%	68%

The understanding of propositional knowledge and its requirement for justification is operationalised in research through a particular concept, termed 'rigour'. Rigour is understood as the intrinsic logic or causality embodied in 'the chain of reasoning' (Gorard 2002; Freeman 1990; Millo, Lipton and Perlis 1979). Traditionally, the parameters of rigour have been validity, reliability, objectivity and generalisation. Validity indicates that data have been gained by appropriate methods, such that they are deemed to be trustworthy. For example, using a thermometer is valid for ascertaining temperature, but not for measuring colour or density. Related to this stance, reliability refers to the repeatability of methods and results, while objectivity indicates that results are deemed independent of the subjectivity of any particular individual researcher; for example, anybody can use a thermometer to determine temperature. Finally, generalisation refers to the applicability of the findings to a wide variety of cases, e.g. the definition of temperature applies to any material, whether solid, liquid or gas.

This understanding of rigour has been criticised by researchers who follow critical and constructivist paradigms for being rooted in a (post-)positivist paradigm. Paradigms indicate a 'worldview' taken with respect to knowledge (Guba 1990: 1ff) and, hence, on what counts as evidence. The post-positivist approach assumes knowledge to be 'out there', independently of the researcher, and that knowledge therefore has to be gained by reference to evidence from the external word. This position is called Foundationalism (Williams 2001: 81ff). In contrast,

the constructivist paradigm assumes the opposite, i.e. that all reality emerges from human consciousness and therefore that all knowledge is normative. This leads to a position that assumes that there is no outer reality to refer to and any argument must therefore be internally coherent. This position is called Coherentism (Williams 2001: 117ff). In negotiation of these two positions, Williams (2001: 159-172) proposes a third approach, which he calls Contextualism, and which assumes that we can rely on our experience of external reality until we have reason to challenge it (default and challenge requirement). As it is context-dependent, this approach allows researchers to assume certain beliefs as foundational beliefs. However, they may be open to scrutiny if the context changes, using a normative argument where necessary, but without the necessary circularity of Coherentism. Williams argues that this approach is permissible because of the normativity of knowledge, which is not an *a priori* given, but is itself a human construct.

In line with Williams' holistic approach to knowledge, Tobin and Begley (2004: 390) argue 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.

The notion of rigour can thus be expanded to embrace both scientific and philosophical, positivist and constructivist, and quantitative as well as qualitative study. Its parameters will vary accordingly, depending on the paradigm of study (Hamberg et al. 1994; Tobin and Begley 2004). For example, for the purpose of qualitative research, the traditional parameters of rigour (validity, reliability, objectivity and generalisation) may be re-interpreted as credibility (something is believable), dependability (similar results can be achieved in similar contexts), confirmability (others can follow what has been done) and transferability (knowledge gained from one case may be adapted for another) (Hamberg et al. 1994: 178). (Fig.3)

This internal logic of research has found its expression in the formal requirements of research (e.g. Langrish 2000, AHRC 2006: 19), which guide its unequivocal communication. These require explicitly stating the research problem or question (what is to be found out?), the research context (indicating the knowledge gap within that field and thus the originality of the contribution), the methods (how has the research been done – allowing one to judge the rigour of the study) and the outcomes (indicating what has been found and how these findings constitute a contribution to knowledge). This structure is generally expected in the cases of, for example, PhD research, funding applications, etc.

In summary, this discussion highlights three key requirements of research: the contribution to knowledge; the justification of the research process and its findings within a particular (knowledge) system; and the unequivocal communication of this process and its findings.
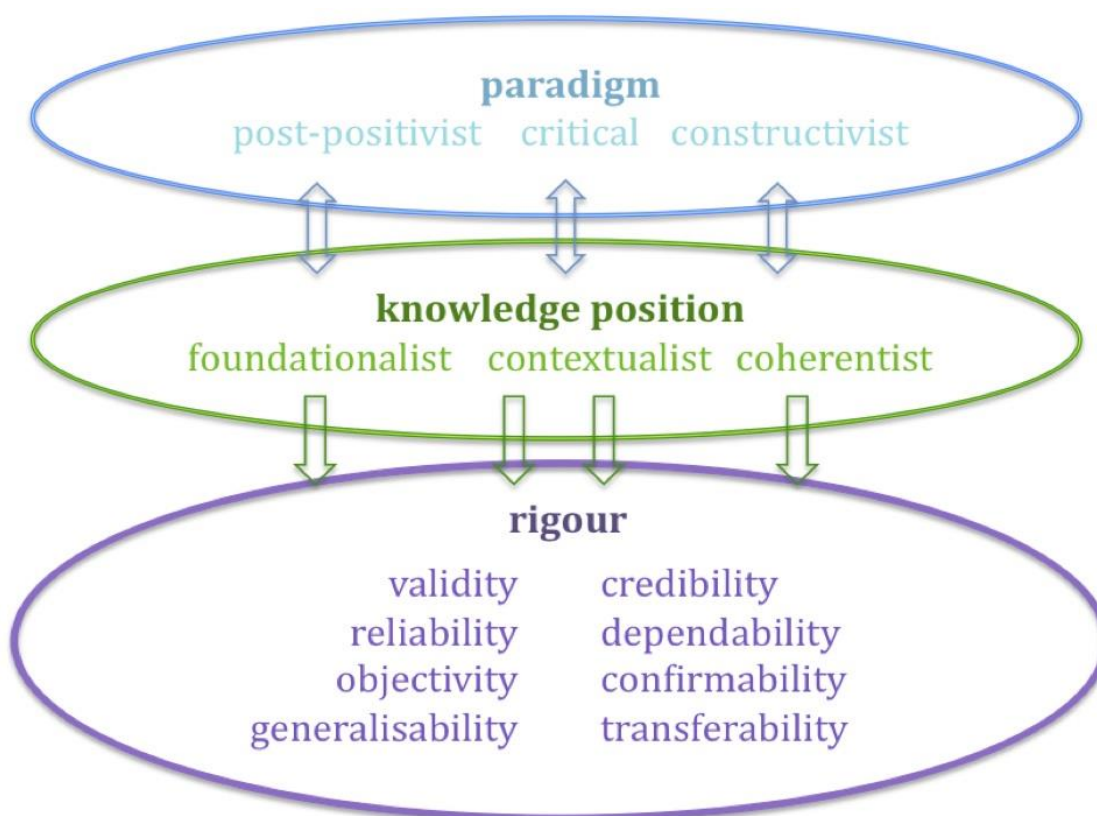
Figure 3: Parameters of the internal logic of research

The Nature and Purpose of Designing in Research

Over the last two decades, several studies have been concerned with the development of design research, attempting to define it and to provide examples. Publications by Archer (1964), Cross (1984, 2001, 2003), Durling (2000), Durling and Shackelton (2002), Frayling (1993), Langrish (2000) and Rust (2004), to name but a few, have influenced the field. In addition, a number of PhD studies have set precedents for research in design to date (e.g. Rust and Whiteley 1998, Evans 2002, Niedderer 2004, Wood 2006, Pedgley 2007, Lyons 2008, Wade 2009). Characteristic of all these studies is that they use design practice as part of the research. While the use of practice in research on the whole is not new – engineers and many experimental scientists have used practical experiments in research for a long time – the use of design practice to access the creative potential of designing in order to generate new insights and/or solutions reveals two distinct characteristics of design.

The first characteristic is the aim of finding something out that does not yet exist, which is bound to the creative nature of design, with designing being used to create this 'new reality'. This is a major difference to most research in science and humanities disciplines, which is generally concerned with understanding existing phenomena. In instances of research concerned with creating new possibilities, typically the term 'design' is added, such as in 'genetic design'. 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 (Hartshorne and Weiss, 1998, vol. 5: §171), proposes that the latter is the most appropriate for design, because abductive reasoning, as 'the process of forming an explanatory hypothesis […] is the only logical operation which introduces any new idea…' (Hartshorne & Weiss, 1998, vol. 5: §171). Presenting the concept of productive reasoning in the context of design methodology, March (1984: 269) argues that

this mode of reasoning is most appropriate as a framework for design knowledge, because design is a creative and conjectural process. Peirce's concept thus provides important philosophical foundations for building a discipline-specific approach to design research that recognises the creative nature of design in a way that ties into the established conventions of research.

The second characteristic is the strongly experiential and procedural (skill-based) nature of design. Experiential and procedural knowledge (also termed non-propositional knowledge) are broadly regarded as knowledge derived from experience (e.g. Williams 2001: 98, Grayling 2003: 38ff). While experiential knowledge or skill can be described, some parts of it evade communication, because 'we can know more than we can tell' (Polanyi 1967: 4). Therefore, it is also termed 'tacit knowledge'. Experiential knowledge is perceived as important for design because it can provide observational and other data that can help generate or verify theoretical conjectures, etc. Designing in the context of research can be used to access the experiential knowledge inherent in design methods, processes, materials, artefacts and concepts, which would not otherwise be available. For example, in the process of working with silver, a silversmith needs to know how soft silver is, when it breaks upon bending sheet or wire, and so forth. These values are traditionally measured scientifically, in which case they are verbally described and defined, and codified in the form of numeric values, such as for hardness, tensile strength, density or colour (cf. Table 1). However, while definitions provide a generic understanding, and numeric values quantify them for specific materials under specific conditions, the silversmith (or other maker/designer/artist) requires a third set of information, which is acquired experientially: for example, bending a piece of metal physically in your hand until it breaks is very different from simply having a numeric value. While the former is informed by the latter, the latter can only be understood through the experience of the former. Both types of knowledge are thus important and need to be recognised as complementary, but design (or any other creative practice) both strongly relies on, and is able to generate, experiential knowledge.

These two characteristics of design have important implications for the formation of 'design research'. Firstly, its creative nature entails that design research must be able to inquire into new or hypothetical realities. In practical terms, this requires the inclusion of design practice as part of the research process in order to be able to create these new realities. Adopting March's proposed use of Peirce's concept of abductive reasoning also provides a sound basis for incorporating the creative element into the established canon of research in theoretical terms. Secondly, the reliance of design on non-propositional knowledge, with its partly tacit nature, poses some challenges for the explicit justification and communication required for research (Williams 2001: 98; Niedderer 2007b: 7). One way to deal with this is to regard propositional and non-propositional knowledge as two sides of a coin (Niedderer 2007b: 9-11; Niedderer and Imani 2008: 11): non-propositional knowledge refers to the sensory data with which we comprehend our external environment and which is derived from design practice; propositional knowledge refers to the codified and verbally communicable interpretation of these data, which provides evidence and justification, and which is expressed in form of theory (Fig. 4).

This understanding allows the seamless integration of two elements of research – theory and practice – which in art and design is often perceived as a challenge. In this sense, any research that is not purely philosophical-critical needs to comprise and integrate both theoretical and practical elements such that they adhere to the requirements of research, including the contribution to knowledge and its rigorous justification through unequivocal communication. In order to achieve this, any research project has to establish a theoretical framework that guides the conduct of its practical enquiry. How such a framework can be established to accommodate the needs of design enquiry is discussed in the next section.
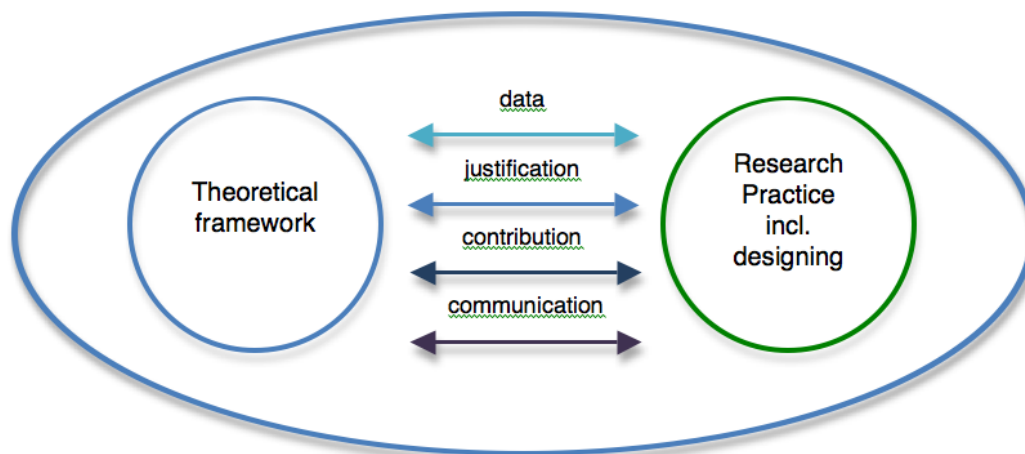
Figure 4: The interplay of theory and practice in research

Constructing a Theoretical Framework for Creative Enquiry: The components of the theoretical framework and its purpose

The above discussion of research has indicated a number of requirements, including the contribution to knowledge, its justification and its communication, which determine the internal and external logic and shape of any enquiry. The theoretical framework needs to accommodate the logic of these various requirements, linking the aim of the enquiry to its conduct, contribution and justification, thus guiding the format and process of any research enquiry appropriately. Therefore, it is important to understand how a theoretical framework is constructed, what components it must comprise, and how it aids the conduct of research, including the use and integration of creative practice within the research process.

The term 'theoretical framework' is used here to refer to the entirety of logical components that are used to construct any one research project. Any theoretical framework must comprise a number of components, including a conceptual model, a theory or theories, as well as various concepts and propositions. Fawcett (1999) explains that 'a conceptual model is a set of relatively abstract and general concepts and the propositions that describe or link those concepts' (p.3), while she defines a theory as 'a set of relatively concrete and specific concepts and the propositions that describe or link those concepts' (p.4). With respect to the relationship of conceptual model and theory, Fawcett notes that

> Many disciplines exist to generate, test and apply theories that will improve the quality of people's lives. Every such theory-development effort is based on a particular frame of reference that provides an intellectual and socio-historical context for theoretical thinking, for research and, ultimately, for practice. That context is provided by the conceptual model that guides theory development by means of empirical research. (Fawcett 1999: 1)

The conceptual model thus offers a specific frame of reference for a coherent and rigorous way of thinking about the processes, conduct and 'phenomena that are within the domain of enquiry of a particular discipline' (p. 3). The choice of conceptual model has an important role for knowledge generation, because it determines the knowledge framework (paradigm), including the mode of reasoning underpinning any particular enquiry, and the indicators of rigour applied. The choice of conceptual model, in turn, is dependent on the research question and the context within which it is asked, since the research question determines what outcomes are being sought. Together, the conceptual model and research question determine

what methods are to be used, and how to evaluate the outcomes of the enquiry. Most importantly, the research questions and conceptual model mutually determine each other. For example, an investigation into creativity, if investigated in psychology, might use empirical testing within a post-positivist paradigm; philosophy might use criticism within a constructivist paradigm; and design enquiry might use creative processes and personal knowledge within a critical paradigm. The relationship of the different components is visualised in Fig. 5.
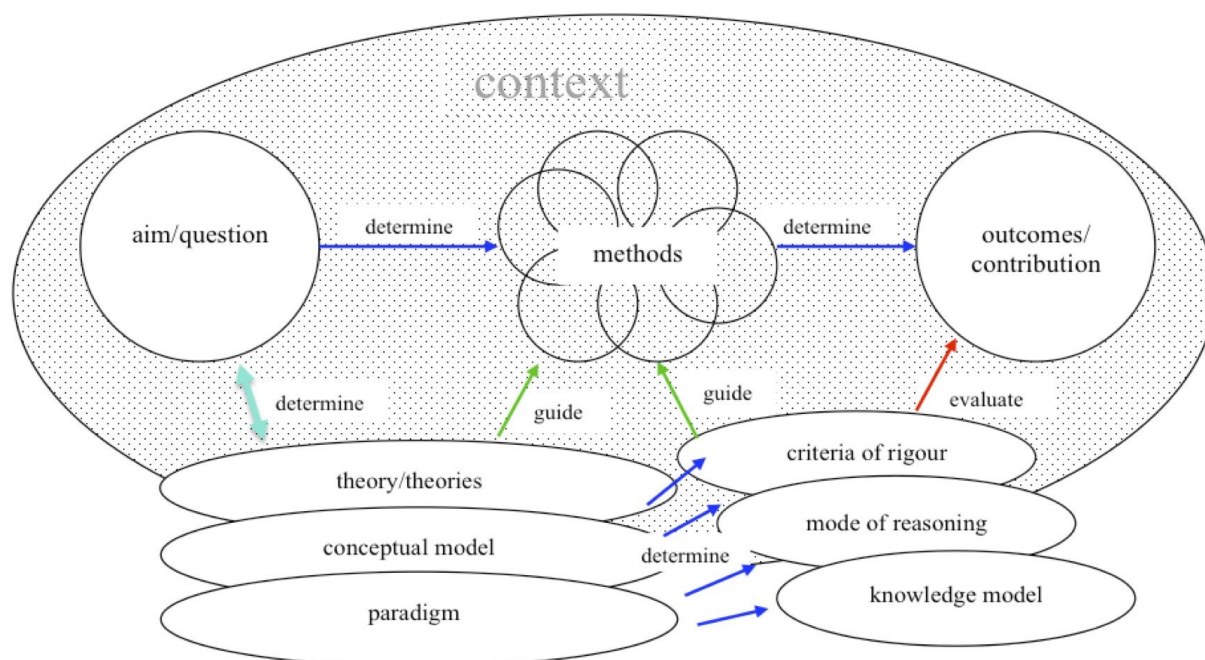

Figure 5: The theoretical framework with its components

Because of their pivotal role for the direction of any enquiry, it is important to ask what research questions specific to art and design might address, in particular concerning enquiry into creative practice. I focus here on both art and design, because one often finds that a distinction is made between art knowledge and design knowledge, art enquiry and design enquiry, and so on, with questions being separated accordingly. However, this separation appears to be more political than disciplinary in nature, which is not helpful for our purposes. While there are no doubt different *preferences* in art and design for different modes of enquiry, in essence, the questions that *can* be asked are the same. For example, in fine art, the subject of painting might be approached from a scientific perspective, investigating the visual quality of oil paint through chemical analysis to improve its quality; in contrast, an aesthetic approach based on expert judgment might evaluate the results of the scientific development from a visual-aesthetic point of view. A similar two-pronged approach might be applied in design for assessing the development of lacquer/paint for cars, etc.

I therefore propose thinking about research questions primarily in terms of content, relating to *material*, *process*, *concept* or the *use* of objects. Each of the four content categories can be addressed by a multitude of approaches which may be suitable to art and/or design, which may be empirical or interpretive, and so on. For example, material can refer to paint as in painting or car lacquering; process can pertain to creative ideation, co-designing or manufacturing; the conceptual approach might address issues of aesthetics, semiotics, emotion, etc., and use might pertain to user-testing or the observation of object uses as in material culture studies. Depending on the aim and purpose of the research, any one investigation might be, for example, of scientific or interpretive nature, or both

simultaneously. This leads back to the understanding that the content and format of any enquiry are determined by the interplay between question and conceptual model. The question effectively indicates the content of the enquiry and the kind of answer that is being sought. The way it is asked infers the choice of conceptual model, which in turn defines how the question is approached and answered within the desired context and direction. Together, question and conceptual model provide guidance for the choice of methods and their appropriate mode of application to guarantee rigour.

Fawcett (1999: 14) lists a number of examples illustrating the relationship of specific conceptual models/knowledge areas and corresponding methodological approaches within the context of the practice of nursing, but which are equally relevant to art and design (Table 2). This list can be extended using design-specific approaches, most of which can be addressed by several methodological approaches due to their interdisciplinary nature (Table 3).

Table 2: conceptual models and corresponding methodological approaches (Fawcett 1999: 14)

Conceptual model/knowledge area	Methodological approach
Empirics	Empirical research
Personal knowledge	Reflection and response from others
Aesthetics	Criticism and consensus
Socio-political knowledge	Critique and hearing all voices
Ethics	Dialogue and justification

Table 3: design-specific conceptual models and corresponding methodological approaches

Conceptual model/knowledge area	Methodological approach
User-centred model	Dialogue with users
	Empirical testing with users
Inclusive design model	Dialogue with users
	Response from users
	Empirical testing with users
Ergonomics	Response from users
	Empirical testing with users
Safety	Empirical testing
Semiotic/Semantic model	Interpretive approach
	Empirical testing with users
Emotion design model	Interpretive approach
	Empirical testing with users

Research Practice and Creative Enquiry: framing designing as a research method
The theoretical framework is complemented by the conduct or practice of research. This section considers how creative enquiry can be integrated with research practice as a key characteristic of designing. When talking about the practice of research, I refer to the entirety of all the actions that are part of research, its methods and conduct, whether this is designing and making, observation, analysis, evaluation or interpretation. All of these methods have an act of doing and thus are 'practical'.

Research methods can be categorised broadly into two groups: data generation/collection methods and data analysis/evaluation methods. The former traditionally includes experiments, interviews, participatory and observation methods, while the latter includes various methods of analysis, comparison and interpretation (Marshall and Rossman 2006: 97, Creswell 2003, Denzin and Lincoln 1994). Designing and its sub-processes, such as

creative ideation, sketching, making, etc., are but one set of methods within the whole of research practice (Fig. 6). As such, practice can take the role of a data generation method, commensurate with abductive reasoning, creating a new reality. This is generally related to the generation of artefacts (in the broadest sense), which then become the subject of further enquiry through analysis and evaluation using traditional methods. Creative practice as a process can also take a role in the collection and analysis of data. For example, in order to investigate a particular process, such as the role of sketching within idea generation, it may be necessary to carry out this process to collect data about it. Most controversial is perhaps the evaluative role of creative practice within research as relating to the often tacit judgments made within design practice, such as the intuitive evaluation of what works and what does not. These judgments can be important because the intuitive and experience-based expertise of an investigator can be used to identify and interpret crucial bits of information that would not be accessible otherwise. Finally, creative practice can be used in an analytical way for the analysis of theoretical concepts, usually in connection with, and framed by, a conceptual framework.
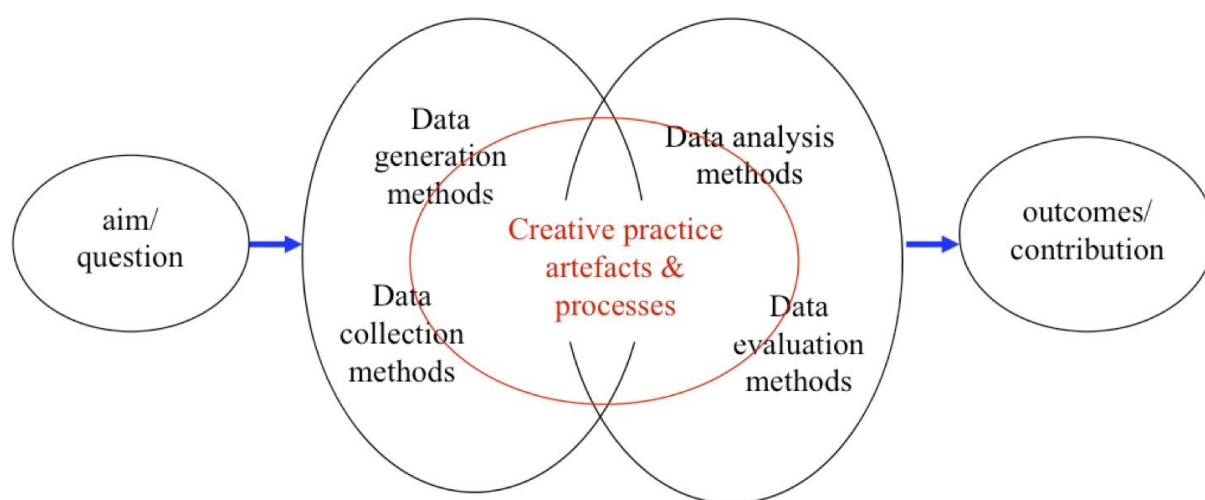

Figure 6: The role of creative practice within the canon of research methods

When examining designing as a research method, in addition to determining which role it will play in the canon of research methods, it is useful to distinguish two different modes of designing and two different approaches to researching designing: first, designing can either pertain to the process of designing, or to its creative output in form of artefacts, services, etc. Furthermore, research into designing can be conducted either by observing someone else, or by investigating into one's own practice (Durling and Niedderer 2007: 9). Thus, there are four different options (Table 4), each of which could be applied to either data generation/collection or analysis/evaluation.

Table 4: Four different basic modes of design research

	Research/observation of other's design practice	Research into own design practice
Designing (process)	(1)	(2)
Design outcomes (artefacts)	(3)	(4)

When investigating designing as a process and method, its contribution will also usually be in this area, such as investigating and contributing to the development of methods of creative ideation; technical reporting, recording and communication; or sketching (e.g. Udall 1996, Wood 2006). In this case, any creative output produced during the process tends to be of

secondary importance and is usually neither evaluated nor part of the contribution of the research. Research into design processes can be conducted either through observation or self-observation. Research by observation of others' designing (1) is usually conducted within a set of established protocols (Durling and Niedderer 2007: 9), e.g. from social sciences or psychology, which appears unproblematic and is therefore not of concern here.

Research conducted through self-observation of one's own design process (2) can be problematic in terms of objectivity and validity. Reflective practice based on Schön (1983) and his followers is a term or method often used to conduct and report on practice. However, reflection may or may not be rigorous, depending on how it is operationalised. More usefully, reflection can be deconstructed into traditional methods of observation, analysis and evaluation/interpretation, which allows for a more accurate description. Heuristics, hermeneutic and mindful methodologies provide useful frameworks for self-reporting (e.g. van Maanen 2000, Moustakas 1990, Langer 1989). If conducted in a rigorous way and in a manner comparable to research models from other disciplines, research into design methods and processes tends to be non-contentious. An unusual example of a process-oriented PhD thesis is by Lucy Lyons (2008). Lyons has made drawings of ossified muscular tissue of patients with Fibrodysplasia Ossificans Progressive as part of her thesis. In this case, the drawings were not interpreted by herself but became a means for medical doctors and pathologists to gain new knowledge about the disease, which is why the thesis argued for the contribution to be in the method, not in the artistic work.

Where production of creative output is the focus of research, investigation into existing artefacts (3) has many established models (e.g. history, material culture). However, where the researcher's own creative work is evaluated as part of the contribution to research (4), this is often debated. Concerns centre on whether – if an artefact is unique (one of its kind) – it makes an original contribution, or how to judge work in the context of research that is good as art but poor in terms of research or vice versa, raising questions as to whether it should be subject to artistic judgment, research judgment or both. Within the theoretical framework presented within this paper, the simple answer is that originality has to be shown through a review of the state of the art in the field (literature review), and that any work that is declared research must stand up to the criteria of rigour and justification. However, dependent on the nature of the enquiry, the quality of the creative work and the ability of the designer might have some influence on the outcomes of the research and thus on any conclusions drawn (Durling and Niedderer 2007). Therefore, the answer to the latter question is more complicated.

In this regard, Durling and Niedderer (2007) have distinguished a number of different approaches to making and using creative output within research. These relate to both the different methods categories (data generation/collection and data analysis/evaluation) as well as different research foci, such as the investigation and demonstration of technical and creative processes, and theoretical concepts such as function or emotion. The three most pertinent approaches are summarised in the following section, although this list is not exclusive.

Firstly, 'Designing to Test' explains the making of prototypes as a means for testing and improving artefacts. Using the PhD study by Evans (2002) as an example, Durling and Niedderer (2007: 10) explain that Evans' focus 'was on the development of professional practice, with the aim of evaluating and facilitating the integration of emerging rapid prototyping techniques into the industrial design process. The intention was to provide guidance to designers on the benefits and disbenefits of rapid prototyping, and the fit of the new technology with designers' traditional ways of working'. In this approach artefacts serve for data collection to enable assessing for example the technical or aesthetic success or shortcomings of the process under development (Evans 2009: 4).

Secondly, 'Designing as Demonstration' is explained as the identification of 'a number of features of a product which, if incorporated into a design, would lead to product improvement' (under some previously specified criteria). Here, designing has the 'purpose of demonstrating that the specification could have practical outcomes.' (Durling and Niedderer 2007: 11). Owain Pedgley's study of the plastic guitar (2007) is a pertinent example of this approach, where the artefact is a demonstration of the concept, and forms part of the data generation stage.

Both above examples follow the traditional design process model, but are conducted in an investigative and 'evidence-based' manner with the question, context, methods and outcomes documented to allow scrutiny and validation.

The third approach, 'Designing as Creative Exploration' differs from the nature of the first two in that it uses designing not to demonstrate a process or concept, i.e. for data generation, but for data analysis to investigate and better understand a theoretical concept, such as emotion, function, etc. 'Designing as creative exploration is perhaps the strongest way of using creative practice within research, and the way that is both most desired and most debated. By designing as creative exploration we mean the working through of a research problem through designing.' (Durling and Niedderer 2007: 14). Designing here can be used both analytically to investigate and better understand a given concept, or synthetically to explore the combination of different parameters to generate new concepts, insights, etc.

For example, a previous project (Niedderer 2004, 2007) used creative practice to understand better the concept of function. In this example of analytic exploration, function was explored through deconstruction, i.e. through gradually making certain aspects of an object (cup) dysfunctional, to see what happened. In this way, the creative processes acted as a thinking tool in that neither the process nor the artefact was the object of the investigation, but rather the concept of function. Another example is the 'PhD by Published Work' by Ed Wade (2008), who re-classified selected snake species by drawing the scales and skeletons of dead snakes, which was compared against genetic classifications.

An example of synthetic enquiry conducted in 2009 sought to understand how complex emotions can be designed into an object using elastic movement (Niedderer 2012). Here, several concepts were related (elasticity, semiotics, somatics, emotions) and explored through creative production.

In both cases of analytic and synthetic enquiry, a theoretical framework was constructed, which provided the intellectual space, as well as the parameters and boundaries, for creative exploration.

To summarise, creative practice can take variable roles within research, pertaining to data generation/collection or analysis/evaluation, to creative process or output. Also, the investigation can be conducted into the researcher's own practice or someone else's, whereby the first is of particular concern to many art and design researchers. The following section offers an example of synthetic enquiry, including the application of the theoretical framework.

Conducting Creative Enquiry: Designing for complex emotions

This section presents an example, drawn from my own research in 2009 (Niedderer 2012), to demonstrate the application of the theoretical framework to the conduct of research, and the role of creative practice within it, using synthetic and analytic exploration. The project investigated how complex emotions can be expressed in silver design using elastic movement. The investigation was situated in the context of both silver design and emotion design, focusing on the bowl as an example. Using conceptual analysis, the research constructed a soma-semiotic framework, which serves both as a design tool and as an aid for the interpretation of artefacts. This conceptual framework provided space for the open-ended

practical exploration of designing complex emotions through elastic movement. In turn, the practice produced insights concerning the theoretical framework, helping to refine it.

The soma-semiotic framework enabled the somatic reading of emotional movement through empathic experience, and the social-cultural interpretation of visual images through semiotic reading. It guided the process of designing, starting from the material understanding of how elasticity can create different movements through additive construction (Niedderer, Harrison, and Johns 2006). Using a combination of drawing, model-making and conceptual reasoning, three different ways of constructing elastic movement within the bowl form were identified (Fig. 7).
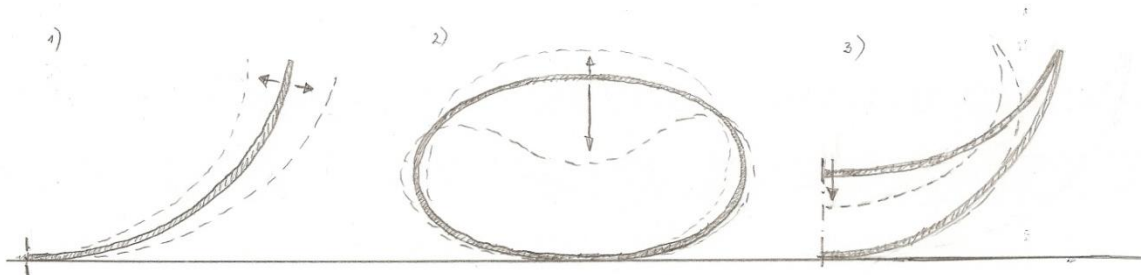

Figure 7: Three ways of constructing elastic movement: 1) single strip, 2) loop, 3) double-layered strip.

Based on the formal solutions identified through the exploration of the relationship of form and elastic movement (synthetic exploration), the second step investigated the relationship between elastic movement and emotion in order to understand what emotions these movements can be used to express (analytic exploration). In this way, synthetic and analytic modes of creative exploration were combined to allow for the creative leap that is the characteristic strength of designing, and to generate novel solutions that may not otherwise be predicted.

The creative exploration generated three designs: designs 1 and 2 used elastic movement in an expressive way to invoke emotions (Fig. 8 and 9), while design 3 used functional-behavioural movement. The designs were analysed using the soma-semiotic framework to demonstrate how the framework can provide designers with a deeper understanding of their own designs. For example, bowl 1 (Fig. 8) shows a gentle upward quiver, which can be read as joyful excitement, while bowl 2 (Fig. 9) has a strong bounce communicating elated joy, an uncertain sideways movement communicating unsteadiness and, additionally, if laden with fruit resembles a long-legged spider. Put together, joy (bounce) and fear/scariness (spider) are a contradiction of emotions. Adding the third component of 'unsteadiness/helplessness, together, they can be read as incapacitating the potentially scary 'spider', creating a comical image that elicits laughter and feelings of 'fun'.

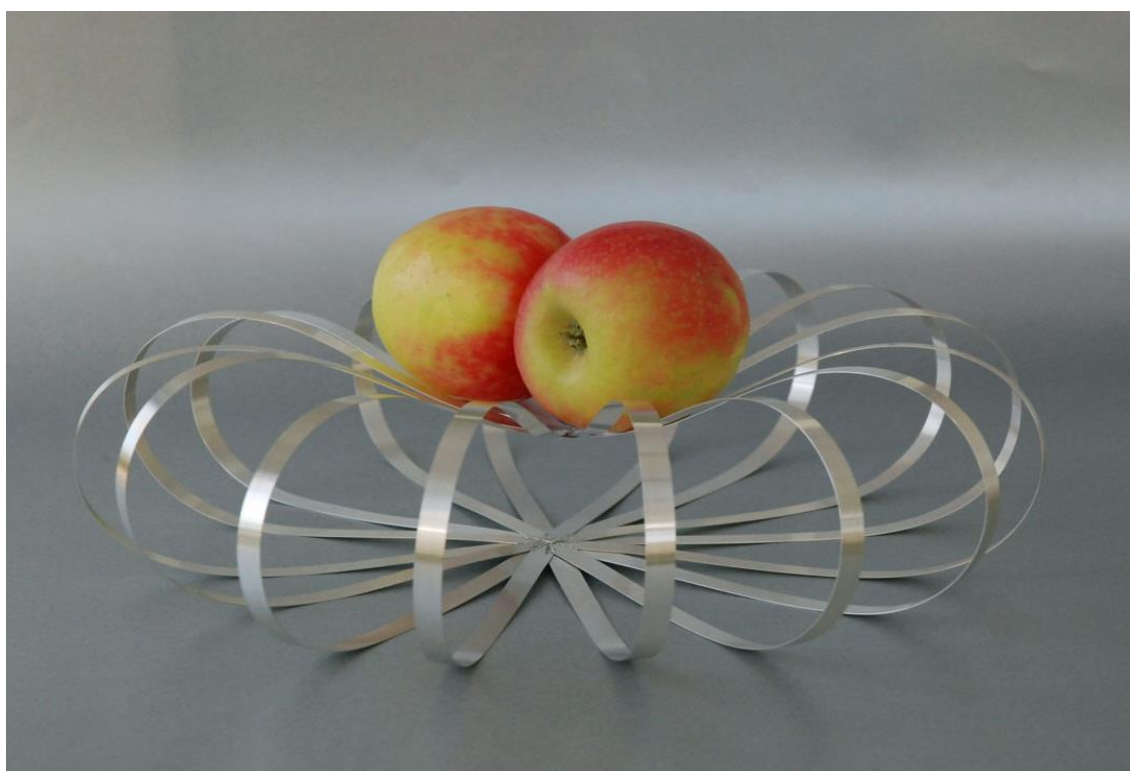Figure 8: Kristina Niedderer, 'Anemone', 2009. Photo © Niedderer

Figure 9: Kristina Niedderer, 'Fruit Bowl 1', 2009. Photo © Niedderer
Video available from: http://youtube.com/o6CMaPODZbo and http://youtube.com/03mvN0jmj_U

In this way, theoretical and creative practical enquiry and development were intimately intertwined. While the theoretical investigation adopted an interpretive conceptual model suggestive of a constructivist paradigm, the creative exploration combined both internal and external realities, empirical and personal knowledge, all characteristic of the critical paradigm. The project thus had to negotiate interpretive and critical paradigms in the sense of William's contextualist approach to knowledge (2001: 159-172), using the second 'soft' set of parameters of rigour (credibility, etc.).

The use of personal knowledge introduced the application of normative judgment, by means of which invisible connections are made and assessed, for example, between the technical performance of the alloy and the formal, functional or conceptual opportunities arising from it; these provide the necessary insights that facilitate new design developments. This open-ended exploration is characteristic for creative exploration. By setting boundary parameters (material, elasticity, movement, emotion), the exploration is at the same time both tightly bounded and non-predictive, open-ended and open-minded, enabling new possibilities and propositions to emerge from this combination through abductive reasoning. Fig. 10 provides a complete overview of how the theoretical framework is applied to this case study.
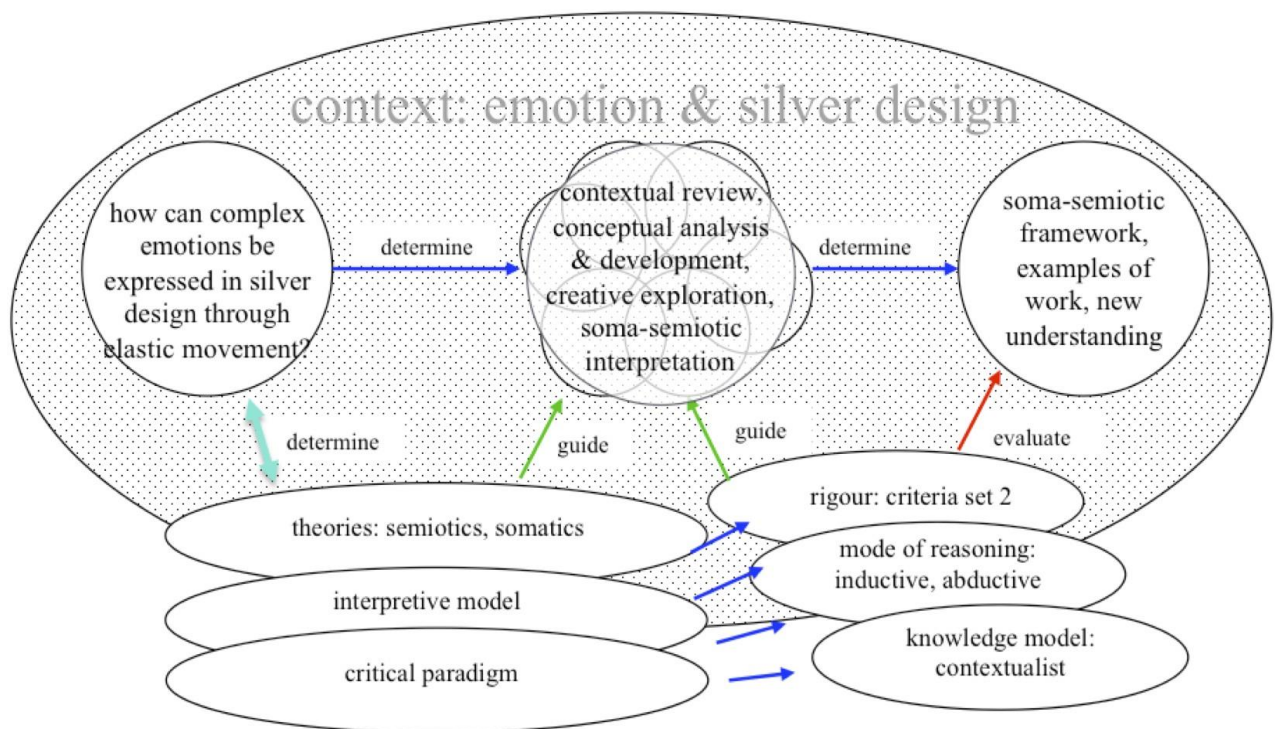

Fig.10: The theoretical framework applied to the example.

Conclusion

This paper has discussed the positions of design and research in order to understand how the two can be negotiated to form design research. The discussion has firstly revealed the reliance of research on a certain understanding of knowledge, called propositional knowledge, which also implies certain rules for the conduct and rigour of research. Secondly, it has revealed experiential or non-propositional knowledge and creativity as the key characteristics of design, which – together with the traditional requirements of research – determine the nature of design research and the particularities of its conduct.

The discussion suggests that design research can negotiate the two positions by understanding propositional and non-propositional knowledge as two sides of a coin, and by adopting Peirce's understanding of abductive reasoning to accommodate the creative nature of design. It needs to accommodate the theoretical foundations through internal and external structuring, whereby the former serves to guarantee validity and rigour, and the latter to communicate unequivocally the intellectual positioning and conduct, including its contribution to knowledge, originality and justification. In this context, theory and practice serve as complementary elements to frame and conduct research, respectively.

The paper has further demonstrated how a theoretical framework can be constructed for the purpose of design research, and how creative enquiry can be used within this framework as part of the canon of research methods. It found that creative practice can be used both as process and output, and that, as such, it can have an important role in the process of data generation/collection and data analysis/evaluation. Thereby, the creation of artefacts mostly pertains to the process of data generation, although artefacts can also be used in an analytical way for the analysis of a theoretical concept. In contrast, designing as a process often combines data generation, collection and evaluation, which can be problematic in the context of research if the process is not made adequately explicit to communicate the knowledge gained and objectivity in the conduct (e.g. through triangulation).

The paper has concluded with the presentation of an example that demonstrates and explains the application of the theoretical framework in relation to the practical research conduct, including the generative potential of creative enquiry.

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