Constructing a coherent cross-disciplinary body of theory about designing and designs: some philosophical issues

Terence Love, Edith Cowan University, Pearson Street, Churchlands, WA 6018, Australia

This paper explores some of the philosophical problems associated with building a unified and coherent cross-disciplinary body of knowledge and theory associated with designing and designs. The paper identifies issues that a cross-disciplinary unified body of knowledge would be expected to address. It describes general criteria for improving the definitions of concepts and theories, and outlines relationships and boundaries between design research and other disciplines for nine areas of theory. The paper closes by proposing definitions of core concepts in research and theory-making relating to designing and designs, and draws attention to the practical political difficulties in building a more coherent body of knowledge in this area. *© 2002 Elsevier Science Ltd. All rights reserved.*

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Interest in the development of a unified body of knowledge and theory about designing and designs is increasing (see, for example, the 'Common Ground' International Conference of the DRS[1]). A unified body of work has, however, not yet emerged in spite of extensive research undertaken over several decades, across several hundred domains of practice, and from a wide variety of perspectives[2–7]. The realisation of this goal appears to be receding with the identification of an increasing number of activities, tasks and professions that involve designing and are not yet included in the scope of 'design research'[8].

The failure to develop a unified body of knowledge has several adverse consequences. It results in:

1 Design Research Society 'First announcement Design Research Society international conference common ground' *Design Research News* Vol 6 No 3 (2001)
2 Love, T 'Philosophy of design: a meta-theoretical structure for design theory' *Design Studies* Vol 21 No 3 (2000) 293–313
3 Giard, J 'Industrial design education: incompatibility with education in art and architecture', in *Chicago 99 Design Education Conference Proceedings*, Chicago (1999)
4 Kokotovitch, V and Purcell, T 'Mental synthesis and creativity in design: an experimental examination' *Design Studies* Vol 21 No 5 (2000) 437–450

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- Theoretical conflicts between researchers, especially those working in different domains
- Difficulties in transparently validating theories against their ontological, epistemological and theoretical contexts
- A lack of clarity about the scope, bounds and foci of fields of research and theory-making about designing and designs
- Significant hurdles for early career/post-graduate researchers in establishing satisfactory reviews of literature, identifying sound epistemological foundations for their research, and building theory that is useable across a wide spread of disciplines associated with designing and designs.

Many of the reasons why a unified cross-disciplinary body of theory has not developed are well known[9–15]:

- Theory being tied to single domains of practice
- A neglect of epistemological and ontological issues in theory-making
- A lack of agreement about definitions of core concepts and terminology
- Poor integration of theories specific to designing and designs with theories from other bodies of knowledge.

In general terms, there is a lack of philosophical foundations. All the above issues point to a need for the development of a sound coherent cross-disciplinary theoretical, epistemological and terminological basis for research and theory making. This paper focuses on identifying ways of improving the foundations to support the development of a coherent body of knowledge and theory across *all* areas of practice and research associated with designing and designs. The primary question that is addressed is,

What characteristics would a coherent cross-disciplinary body of theory relating to designing and designs possess?

Answers are sought through exploring the question in three ways:

- Mapping out theories of designing and designs against theories of other disciplines
- Mapping out key issues that a coherent body of cross-disciplinary theory should address
- Clarifying definitions of core concepts

5 **Sargent, P** 'Design science or nonscience' *Design Studies* Vol 15 No 4 (1994) 389–402

6 **N** (ed.) *Developments in design methodology*, Wiley, UK (1984)

7 **Cross, N** 'Science and design methodology: a review' *Research in Engineering Design* Vol 5 (1993) 63–69

8 **Love, T** 'Educating those involved in changing human futures: a more coherent programme for design education' in **C Swann and E Young** (eds) *Re-inventing design education in the university*, School of Design, Curtin University of Technology, Perth (2000) pp 242–248

9 **Eder, W E** 'Definitions and methodologies' in **S A Gregory** (ed.) *The design method*, Butterworths, London (1966) pp 19–31

10 **Hubka, V and Eder, W E** *Theory of technical systems* Springer-Verlag, Berlin (1988)

11 **Love, T** *Social, environmental and ethical factors in engineering design theory: a post positivist approach* Praxis Education, Perth, WA (1998)

12 **O'Doherty, E F** 'Psychological aspects of the creative act' in **J C Jones and D G Thornley** (eds) *Conference on design methods*, Macmillan, New York (1964) pp 197–204

13 **Oxman, R** 'Viewpoint: observing the observers: research issues in analysing design activity' *Design Studies* Vol 16 No 2 (1995) 275–284

14 **Ullman, D G** 'A taxonomy for mechanical design' *Research in Engineering Design* Vol 3 (1992) 179–189

15 **Pugh, S** 'Engineering design—unscrambling the research issues' *Research in Engineering Design* Vol 1 No 1 (1990) 65–72

1 *Background*

The absence of commonly agreed theoretical and terminological foundations presents obstacles to addressing the problem because key terms such as ‘design’, ‘design process’, and ‘designing’ have different meanings in different domains, are used in different ways by researchers in the same domain, and are found in the literature referring to concepts at different levels of abstraction[2]. One way round this linguistic problem is to step outside the specific terminologies of the different domains of Design Research and use more everyday language. In this paper, the terms ‘design’ and ‘designing’ are used without overlap to avoid the use of flawed jargon. Other meanings of ‘design’ are avoided, especially the widespread and epistemologically problematic use of ‘design’ as an *entity* with agency, for example, ‘‘design’ seeks to change individuals’ perceptions’.

The background perspective of the paper is meta-theoretical, applying critical analysis in a pragmatic manner. The lack of theoretical coherency across the different sub-domains of Design Research is a practical problem. The benefits of resolving this problem are in the objective world inhabited by those who will be designing, who use artifacts that have been designed, who educate designers, or who otherwise utilise theories about designing and designs. The analyses in this paper mainly involve the upper levels of the meta-theoretical hierarchy described by Love[2] (see Appendix), focusing on epistemological issues, and the characteristics of theories and concepts.

Using a meta-theoretical method for analysing theories about designing and designs helps to identify ambiguities and inconsistencies by mapping out theories and concepts in terms of their hierarchical relationships as co-dependent abstractions. It focuses on the structural characteristics of theories in ways that support analysis and critique in confused situations where theories, concepts and arguments have not been well defined or well justified. The meta-theoretical hierarchy is, however, not well suited to developing theories. Identifying the factors critical to creating a new and unified body of theory is delegated to other methods in this paper that take into account how people, objects and contexts are involved.

2 *Mapping concepts, theories, processes and disciplines*

Theories about designing and designs have been developed by researchers using a wide variety of perspectives from a large number of disciplinary and sub-disciplinary cultures. This has resulted in a large collection of individual theoretical, analytical, conceptual and terminological elements that in many cases are contradictory, ambiguous or limited in scope—often whilst claiming to be universal[10,11,16]. Building a unified body of knowl-

16 Hubka, V and Eder, W E *Design science: introduction to the needs, scope and organization of engineering design knowledge* Springer-Verlag, London (1996)

edge and theory across all areas involving designing and designs requires an understanding of the relationships between these elements[17,18]. Understanding the relationships requires clarity about the boundaries between host disciplines, sub-disciplines, individual terms and concepts, and the contexts that shape theory making about designing and designs. Mapping out these contextual structures, theoretical considerations and terminological limitations helps identify the changes needed to integrate individual theories and concepts into a more coherent whole.

2.1 Properties of a body of theory

Individual theories are by necessity conjectural, descriptive and partial—a theory that attempts to describe all reality has a probability of being falsified of around 100%[19]. What is required of a coherent body of theories that it:

- Is composed of clearly bounded individual theories whose assumptions and theoretical underpinnings are well defined
- Addresses all the significant issues that lie within its scope
- Has clear boundaries so it is possible to see what is included and excluded

Design theories depend on researchers' choices about the ontological and epistemological positions they use. Transparency about the theoretical perspectives underpinning individual theories about designing and designs is an important aspect of developing a coherent body of theory because it enables researchers to fully understand, validate and utilise the theories of others. Researchers' theoretical perspectives are often described in terms of generic research approaches such as, phenomenological, constructivist, constructionist, behaviourist, scientific, or positivist. The distinctions, however, between the many combinations of ontological and epistemological choices that are possible, can be subtle yet important to differentiating between theories. The meta-theoretical hierarchy is helpful in building transparency about the ontological and epistemological underpinnings of theories.

2.2 Humans, objects and contexts

The targets of theory making in Design Research are unusually numerous and complex. This is due in part to the ubiquitousness of designing and designs in human endeavours. Most attempts to classify design theories to make the outcomes of Design Research more coherent have been based on one of two premises; 'everything is design' or ' design is X'; where the choice of X depends on the particular domain to which the definition will be applied. Neither approach is appropriate to building unified cross-disciplinary theories. Standing back from individual disciplines of practice

17 **Stegmüller, W** *The structure and dynamics of theories* Springer-Verlag, New York (1976)

18 **Smith, J K** 'Alternative research paradigms and the problems of criteria' in **E G Guba** (ed.) *The paradigm dialog*, Sage Publications, London (1990) pp 167–187

19 **Magee, B** *Popper* Wm Collins Sons & Co Ltd, London (1973)

enables the key elements of designing, 'humans', 'objects' and 'contexts', to be more clearly seen, in ways that are independent of the needs, cultures and practices of domain-based design professionals. Together with their relationships, these form nine areas of research and theory making:

- Humans
- Objects
- Contexts
- *Human* to *human* interactions
- *Object* to *object* interactions
- *Human* and *object* interactions
- *Human* and *context* interactions
- *Object* and *context* interactions
- Interactions involving *human(s), object(s)* and *contexts* together.

2.3 *Theories of other disciplines*

The above nine areas provide a framework for identifying the relationships between theories about designing and designs and theories of other disciplines. They also offer the basis for identifying a boundary between a coherent body of knowledge specific to designing and designs and other disciplines and bodies of knowledge. Table 1 lists disciplines and bodies of knowledge that address each of the above nine areas of theory.

Care is sometimes needed in identifying relationships. For example, some visual properties of an object are studied in Æsthetics, and this implies that Æsthetics should align with 'Objects' in Table 1. The visual properties that relate to Æsthetics, however, are irrelevant without human participation; hence Æsthetics is more properly associated with 'object and human interactions'.

The categories of Table 1 can be further refining by differentiating between 'internal human processes' and the 'external aspects of behaviour of individuals and groups' (Table 2).

Taken together, Tables 1 and 2 demonstrate that many theories and research projects described in the design research literature are more naturally classified under other disciplines. This is a key point for developing a coherent and unified body of knowledge about designing and designs. A critical review that clarifies the philosophical foundations should distinguish between contributions to theories about designing and designs, and the ways that researchers contribute to, and draw on, the bodies of knowledge of other disciplines.

20 **Rosen, S** *The limits of analysis* Yale University Press, New Haven, CT (1980)

Table 1 Areas of theories and discipline

Area of theory about designing and designs	*Disciplines that address this area of theory*
Behaviour of individual *humans*	Biology, Psychology, Anthropology, research into designing, History…
Behaviour of *contexts*	Environmental Studies, Geography, History, Physics, Social Psychology, Sociology, Management, Business Studies, Systems…
Behaviour of *objects*	Engineering, Natural Sciences, History…
Human to *human* interactions	Psychology, research into designing, Sociology, Anthropology, Social Psychology, History, Management, Soft Systems…
Object to *object* interactions	Engineering, Natural Sciences…
Human and *object* interactions	Æsthetics, Ergonomics, Philosophy, Psychology, research into designing, research into designs, Social Psychology…
Human and *context* interactions	Æsthetics, Ergonomics, Psychology, History, Geography, Philosophy, Social Sciences, Anthropology…
Object and *context* interactions	Engineering, Natural Sciences…
Interactions involving *human(s), object(s)* and *contexts* together	Æsthetics, Biology, Engineering, Environmental Studies, Ergonomics, Philosophy, Psychology, Natural Sciences, research into designing, research into designs…

Table 2 Internal and external aspects of human designing

The 'internal' aspects of designing include the ways that individuals	• Represent objects, systems, activities contexts in their internalised cognition (conscious and unconscious) • Depend on values, beliefs, the physical underpinning of their cognition, and feelings • Manage human communications—including managing the flows of information in and out of themselves • Manage the human creative activities of themselves and others that lie in Rosen's[20] terms, 'beyond analysis'
The 'external' aspects of designing include the ways that humans	• Collect, compose, classify and manage data • Identify, bring together and manage human expertise

2.4 The core of a discipline

There are core areas of research and theory making about designing and designs that lie substantially outside the boundaries of other bodies of knowledge. For example, theories about cognito-affective processes specific to designing are not easily included in the positivist cognitive science model of cognition central to Psychology because this model excludes feelings and emotions as part of reasoning. Similarly, core topics in designing and designs such as 'the communication of creative gestalts between designers' and 'feelings associated with human interactions with artefacts' are peripheral to other disciplines. Inspection of Tables 1 and 2 points to several of these areas of research and theory-making that are central to building a discipline and body of knowledge about designing and designs that are peripheral to the main foci of the more established disciplines. In other words, if boundaries are drawn to exclude topics that are central to other disciplines, there remains a core containing the main conceptual elements of a discipline relating to designing and designs. This core of concepts and theories is distinct from other disciplines. This identification of a core conceptual basis forms the second key point for the establishment of a unified and coherent discipline of research and theory making relating to designing and designs.

3 Issues for a coherent body of theory to address

The use of the meta-theoretical hierarchy[2], and the mapping of research themes and disciplinary boundaries, provide a structural framework for a coherent cross-disciplinary body of theory relating to designing and designs. A mature body of theory would be expected to have more than a good structure, however, it would also be expected to have a richness of well-developed content that addresses significant issues in the field. This content would contain effective overarching metaphors with epistemologically consistent theories based on well-defined core concepts.

3.1 Metaphoric issues

The existing metaphors found in Design Research, such as 'designing as creative genius', 'designing as problem solving', 'designing as searching in a solution space', and 'designing as synthesis (assembling from parts)' have resulted in mixed outcomes[21]. On the positive side, the use of theoretical representations of physical or abstract situations as metaphors, predictive analogies or reified abstractions[17,21–23] has helped make the patterning of ideas and concepts and individual theories conceptually more manageable; it has improved communication between researchers and practitioners; and helped reduce mental effort. On the negative side, the different worldviews[24,25] that different product domains have developed to efficiently achieve outcomes, have resulted in conflicting metaphors for

21 **Coyne, R and Snodgrass, A B** 'Problem setting within prevalent metaphors of design' Working report, Faculty of Architecture, University of Sydney, Sydney (1992)
22 **Indurkhya, B** *Metaphor and cognition* Kluwer Academic Publishers, Dordrecht (1992)
23 **Nideau, R L** *Mind, machines and human consciousness* Contemporary Books, Chicago (1991)
24 **Reich, Y** 'Layered models of research methodologies' *Artificial Intelligence in Engineering Design and Manufacturing* Vol 8 (1994) 263–274
25 **Reich, Y** 'Annotated bibliography on research methodology' *Artificial Intelligence in Engineering Design and Manufacturing* Vol 8 (1994) 355–366

describing designing, designs and associated theoretical concepts[21,26,27] that are tied to domains of practice. This domain-based use of metaphors suited to professional practice is problematic because researchers have adopted it and created theories based on domain-specific practice metaphors rather than cross-disciplinary, epistemologically sound foundations. Instead of asking radically and critically 'What are the appropriate definitions of concepts on which to build theories about designing and designs?' or 'What is to be included in a particular theory about designing or designs?' the main focus over the past five decades has been on 'How can we improve the design for X?' The consequence (as indicated in Table 1) is that the Design Research literature contains a substantial number of theories that are more properly theories of Engineering or Social Sciences or Natural Sciences.

3.2 *Paradigmic issues*

Paradigmic factors related to cultural influence and the existence of prior theory[28,29] have also limited the development of coherent cross-disciplinary design theories and encouraged the proliferation of practice-based theories[2]. These include the forces arising from:

- The subject areas from which the researchers are drawn
- The history of research into designing and designs in that practice/research area
- The social or geographic cultural contexts in which designing and designs are being studied.

The importance of all these factors in shaping theories of designing and designs is evident in comparisons of theories generated under different paradigms in similar domains. Even such close cousins as Mechanical Engineering Design and Product Design have many differences in theories that relate back to different theoretical perspectives, different designed outputs, and different processes of designing. This can be seen, for example, in differences between theories designing the internal mechanisms of a computer printer (an engineering design) and designing the printer's appearance (a product design). Differences are also found between theories of Process Plant Design and Mechanical Engineering Design, in spite of their considerable overlap in scientific and technical knowledge, and techniques. National and cultural differences also exist: evident in differences between the publications of (say) the US-based Design Methods Group and the UK-based Design Research Society.

3.3 *Key questions*

Table 3 lists some key questions that a unified cross-disciplinary body of theory about designing and designs might be expected to address. These

26 **Coyne, R D, Snodgrass, A and Martin, D** 'Metaphors in the design studio' Working report, Faculty of Architecture, University of Sydney, Sydney (1992)
27 **Coyne, R D and Newton, S** *Metaphors computers and architectural education* Dept of Architectural and Design Science University of Sydney, Sydney (1992)
28 **Kuhn, T S** *The structure of scientific revolutions* Chicago Press, Chicago (1962)
29 **Guba, E C** (ed.) *The paradigm dialog* Sage Publications Inc, California (1990)
30 **Popper, K** *Unended quest* Open Court, Illinois (1976)
31 **Feyerabend, P** *Against method* New Left Books, London (1975)
32 **Levin, M** 'Reliabilism and induction' *Synthese* Vol 97 No 3 (1993) 297–334
33 **Phillips, D C** *Philosophy science and social inquiry* Pergamon Press, Oxford (1987)
34 **Berger, P and Luckman, T** *The social construction of reality* Penguin Books, England (1987)
35 **Margolis, J** 'The technological self' in **E F Byrne and J C Pitt** (eds) *Technological transformation: contextual and conceptual implications*, Kluwer Academic Publishers, Netherlands (1989) pp 1–16
36 **Guba, E G** 'The alternative paradigm dialog' in **E G Guba** (ed.) *The paradigm dialog*, Sage Publications, London (1990) pp 17–27
37 **Galle, P** 'Design as intentional action: a conceptual analysis' *Design Studies* Vol 20 No 1 (1999) 57–82
38 **Pacey, A** *Culture of technology* Basil Blackwell Ltd, Oxford (1983)
39 **Crane, J A** 'The problem of valuation in risk–cost–benefit assessment of public policies' in **E F Byrne and J C Pitt** *Technological transformation: contextual and conceptual implications* Vol. 5, Kluwer Academic Publishers, Dordrecht (1989) pp 67–79
40 **Churchman, C W** 'Operations research as a profession' in **R Flood and M C Jackson** (eds) *Critical systems thinking*, Wiley, Chichester, UK (1991) pp 19–40
41 **Gardner, H** *Developmental psychology* Little Brown, Boston (1982)

Table 3 Some key questions in building a unified body of knowledge about designing and designs

Topic area	*Key questions*
Theory	What is a 'theory' and what are its properties?[17,28,30–32]
	How does this body of knowledge make judgements about the reliability of theories?[32]
	How are theories tested? Is testing theories possible across the entire field?[17,28,30–32]
	How does this field resolve the problems of under determination in theory making?[28,30,33]
	How are the problems of induction relating to theories about human cognition, action and perceived properties of artefacts addressed?[32]
	How does the field address problematic uses of theory, concepts, models and language (see, for example, the 'negative analogy' problem described by Phillips[33])?
	How are decisions made about the boundaries of disciplines and theories?
	What are the bounds of the body of knowledge? What is in and what is out?
Reality	What assumptions are made about reality and the ways it is constructed?[34–36]
Power & hegemony	When and where does designing occur, on what basis, and for what purposes?
	Who defines the bounds of the concept of 'designing'?
	How do theories include the control of intentionality?[37]
Values, ethics and æsthetics	How are human values included in theories about designing, the use of designs and the internal processes of designers?[11,38]
	How does the field address the issues associated with problematic use of the fact-value dichotomy?[39,40]
	How are ethics included in different categories of theory and at different levels of abstraction?
	How are the relationships between human values, ethics and aesthetics represented in theoretical terms?

(*continued on next page*)

questions have emerged during the author's research. They are drawn from a variety of sources and chosen as representative of fundamental considerations that have often been ignored or weakly addressed in this field. The list is not intended to be complete or definitive. The value of the questions is in the way they point to core issues in building a complete and more comprehensive body of theory.

4 *Definitions & core concepts*

The definition of core concepts is the third key point in the development of the unified body of theory. Creating improved foundations for a unified body of knowledge requires that the epistemological details of concepts and theories are defined so as to distinguish them from different theories with similar names built for other purposes and on other foundations. Currently, it is difficult or impossible to build a coherent cross-disciplinary body of theory because key terms and core concepts are given definitions that are: too broad, too narrow, inappropriate, ambiguous, multiple, incon-

42 Gardner, H *Frames of mind* Harper & Row, New York (1985)
43 Lazear, D *Seven ways of knowing: teaching for multiple intelligences* Hawker Brownlow Education, Australia (1990)
44 Lai, T 'Cryptanalysis: uncovering objective knowledge in hidden realities' in **E F Byrne and J C Pitt** (eds) *Technological transformation: contextual and conceptual implications*, Kluwer Academic Publishers, Dordrecht (1989)

Table 3 Some key questions in building a unified body of knowledge about designing and designs (*Continued*)

Topic area	*Key questions*
Issues of cognition	How are the affective aspects of cognition and human functioning addressed? How are feelings and experiences included? How are human values, ethics and aesthetics included in theories of human cognition relating to designing and designs? How do theories represent the communication of gestalts, worldviews, or emergent solutions situated in individually shaped mental 'worlds' between team members and teams? How are multiple intelligence theories (such as those of Gardner[41–43]) incorporated? Is it appropriate to regard an activity as designing after it has been automated? How is Meno's paradox (in simple terms, how can we know what we don't know) addressed, or its equivalent in cryptanalysis (see, for example, Lai[44])? How are new insights from brain research and neuro-psycho-biological research findings included in theories of designing, human cognition processes associated with designing, and human use of designed artefacts? How does the body of knowledge incorporate subjective human activities, such as intuition, that appear to lie 'beyond analysis'[20]
Paradigms	How do theories about designing and designs take into account Kuhn's[28] insights into the development of scientific theories and the implication that theories are constructed from within particular relatively rigid worldviews that are specific to specialisms? Is there a body of supporting literature that guides researchers in choosing between different traditional or alternative research paradigms, e.g. natural science, positivism, post-positivism, hermeneutics, phenomenology, neuro-psycho-biology, and Darwinian evolution?
Methodology	Where are the theoretical bounds drawn between 'designing' and other associated activities? What are the theoretical foundations that underpin how skills of designing are evaluated and assessed across multiple disciplines? How is the status of 'elegance' in solution formulation characterised in theories? How does the field address the problems associated with the weaknesses of cost–benefit, multi-criteria and similar quantitative weighted-parameter design evaluation techniques?[39] What are the limits of various systems analyses methodologies as applied to designing and designs? How do theories about designs and designed artefacts include 'self managing systems'? How do theories about designing include those factors that shape designers' cognition and have both qualitative and quantitative attributes?
Training & education	On what theoretical basis are pedagogies and curricula of education for designers based? Are 'competencies in designing' defined across fields of design practice and associated domain knowledge areas? If so, how?

sistent, and different in different areas of study or practice. Resolving this problem requires tightening the definitions of core concepts specific to theory making about designing and designs so that a common foundation can be established across and independent of domains of practice. This runs contrary to parts of the literature in which key terms such as 'design' have been, and are currently being, broadened to enable them to be loosely applied to a very wide range of ideas: the slackening in definition that makes it impossible to use concepts as the basis for analytical discourse.

This section focuses on resolving some of these problems by identifying the characteristics of good definitions, and proposing definitions for core concepts to apply consistently and coherently across all areas of practice involving designing and designs.

4.1 Characteristics of a definition

Effective definitions of core concepts have several important characteristics. They must:

- Be an epistemologically well-bounded theoretical construct
- Have the same role and purpose across all the intended areas of research and theory making
- Be distinct and not overlap other core concepts
- Provide both necessary and sufficient conditions for the definition to apply
- Not be constructed solely of other concepts at a similar level of abstraction
- Fit with other core concepts to form a complete set of theoretical building blocks with which to construct and develop a larger body of theory/knowledge.
- Align well with the concepts and definitions developed in other disciplines that interface with designing and designs, or whose bodies of knowledge researchers developing theories about designing and designs use.

4.2 Existing core concepts

There is a continuing dilution of definitions of core terms such as 'designing', 'designs', 'design' and 'design process' to the point where they potentially include so much that they no longer clearly define anything. In 1992, the author reviewed around 400 texts: most contained definitions of 'design' or 'design process' that were both unique and insufficiently specific (e.g. 'design is a process of engineering', 'design is drawing'). This problem is not trivial. It is unlikely that any substantive, coherent and unified body of theory can be developed in a situation where the most important core concepts are indeterminate.

Strategies for resolving the above situation are relatively straightforward and involve, at least:

- Tightening the definitions of core concepts so that they have the characteristics listed in Section 4.1
- Defining core concepts in ways that are not specific to particular domains of practice or research
- Giving priority to meanings for core concepts that support building coherent theory (rather than attempting to identify 'true meanings' or defining meanings by past useage).

These strategies to define core concepts are an important prerequisite for building a unified cross-disciplinary body of theory and knowledge. Undertaking these strategies to resolve the problems of confusion, conflation and confabulation in the theoretical literature about designing and designs is, however, a radical step, and one that has been avoided so far by many researchers. This is, to some extent, understandable because it would, of necessity, mean that theory contributions shaped to support the development of new unified body of theory would likely lie at odds with much of the existing literature.

5 *Developing definitions of key terms*

One of the most direct approaches to clarifying the foundations of theories is to start with the key term 'design'. Currently, 'design' is used loosely, sometimes as a noun, sometimes as a verb, sometimes an adjective, and sometimes as an adverb. Each of these uses is epistemologically different: they point to different forms of concepts. The noun form of 'design' refers to a *representation* or *plan*[16,45]. The verb form of 'design' refers to the human activity that results in a 'design' (noun)[16,45]. The adjectival and adverbial uses of 'design' might be expected to have meanings that reflect the different noun and verb forms. 'Design' as an adjective or adverb is frequently used uncritically, however, to supplement the description of an object or process with the intention of adding to its status, for example, a 'design' folder, 'design' cognition, 'design' management or 'design' theory.

An obviously beneficial step for creating the foundations for a unified body of theory is to differentiate between the noun and verb forms, between 'a design' and 'designing', and many recent authors follow this path (see, for example, Galle[37] and Gero[46]). Preliminary definitions that align with the common usage are:

- 'Design'—a noun referring to a *specification* or *plan* for making a particular artefact or for undertaking a particular activity. A distinction is

45 Marckwardt, A H, Cassidy, F G and McMillan, J G (eds) *Webster comprehensive dictionary* J.G. Ferguson Publishing Company, Chicago (1986)
46 Gero, J S *Research methods for design science research: computational and cognitive approaches* University of Sydney, Sydney (2000)

drawn here between a *design* and an *artefact*—a design is the basis for, and precursor to, the making of an artefact.
- 'Designing'—human activity leading to the production of a *design*.

From this perspective, it follows that a 'designer' is someone who is, has been, or will be *designing*: someone who creates *designs*.

This clarification can be extended in several directions. It supports the separation of the concepts of *designing* and *information* (a problem caused by conflating noun and verb forms of 'design' with 'designing as information processing'). This is an important issue because they are epistemologically different sorts of entities (designers *use* information but this information (noun) is not designing (verb)) and confusing them is problematic in building a sound theoretical foundation. Resolving this issue also points to the benefits to be gained by differentiating between 'designing' and activities associated with information. That is, the activities of *collecting* information, and *analysing* information are activities distinct from designing.

5.1 *Separating designing from other activities*

A theoretical cornerstone begins to emerge in which the concepts of 'a design' and 'designing' are transparently clarified, and regarded as different from concepts, theories and activities associated with specific practices and disciplines. This is the fourth key point in developing a coherent cross-disciplinary body of theory.

The approach above helps with extending the differentiation between designing and associated but different activities into areas in which the conflation with designing is relatively entrenched. For example, it implies that the activity of 'drawing' is best regarded as different from, yet parallel to, the activity of designing. This separation offers the benefits of improving conceptual definition, whilst allowing the understanding that for many designers there is a very close relationship between their designing and their sketching/drawing (for further details see, for example, Goldschmidt[47] and Love[48]). Differentiating between designing and associated activities such as 'drawing', 'researching' and 'thinking' appears to conflict with self-reports from designers for whom associated activities are symbiotically so close to their designing activity they are unwilling or unable to identify them as different. *The fact that some designers can make this differentiation, however, indicates that the conflation of the activities is not essentially grounded in physiological reality*. Where designers do not observe designing as different from associated activities, it may be explained by a

47 **Goldschmidt, G** 'On visual thinking: the vis kids of architecture' *Design Studies* Vol 15 No 2 (1994) 158–174

48 **Love, T** 'New roles for design education in university settings' in **C Swann and E Young** (eds) *Re-inventing design education in the university*, School of Design, Curtin University of Technology, Perth (2000) pp 249–255

lack of individual skill at reflective practice or subjective contemplation—supported by linguistic traditions.

There are other important reasons not to conflate designing with associated activities:

- It leads unhelpfully back towards indeterminate epistemological foundations in which 'all and every activity or object is 'design''
- It implies that all other disciplines are subsets of the 'design discipline'—a direction in which broad agreement across disciplines is unlikely to be found
- It implies other disciplines' literature should define these associated activities as 'designing'—again unlikely
- The definition of designing is then tied to many activities that are widely defined as distinct. This causes poor integration with other bodies of knowledge, logical difficulties, and a general loss of conceptual and linguistic precision. For example, defining musical composition and electronic circuit analysis as designing implies falsely that designing, musical composing and electronic circuit analysis are equivalent. This negates the use of 'designing' as a foundation concept because its definition does not have the epistemologically sound characteristics on which to build.

5.2 *Distilling definitions of core concepts*

Differentiating between 'a design' and 'designing', and defining 'designing' as different from other human activities with which it has been frequently conflated, offers a basis for researchers to transparently create a strong conceptual foundation for a coherent and unified cross-disciplinary body of theory. This foundation supports the definition of other important concepts to give each an epistemologically useful and distinct identity. For example, it makes good sense in differentiating between 'designing' and 'associated activities' to define 'design process' as 'any process or activity that includes one or more acts of designing with other associated activities'. This latter move allows 'designing' to be used as a concept describing a specific human activity, whilst making a bridge to existing literature in which the term 'design process' is widely used in much the same sense that it is defined in the sentence above. In addition, it helps address the epistemological problem of the terms 'design' and 'design process' being widely and problematically defined as identical.

This definition of 'designing' can be distilled further by reflecting on the epistemic status of design-related activities on the spectrum between *novel* and *routine*: a similar criterion to that used for assessing whether activities

are more or less creative. This criterion is based on an underlying argument that an activity is creative the first time it is undertaken, less creative when it is repeated, and not creative when it is routinised or automated. The parallel is that 'designing' is *essential* the first time a design is created, but a different sort of activity, or mix of associated activities, involving *copying* occurs when the design is repeated or part of it is reused. In other words, the essential aspect of the human activity of 'designing' relates to those elements of creating a design that are *non-routine*. Following on from this, a 'designer' may be defined as someone who is skilled at addressing non-routine issues. This is different from defining a designer in terms of their skills at being an artist, engineer, or photographer. Instead it defines a designer as someone who uses his or her skills of designing in association with domain-based practice skills. This separation between designing and associated domain-based skills implies that 'design skills' are essentially different from the skills required for associated activities such as drawing or calculating.

6 *Summary and conclusions*

The concepts outlined in this paper define a foundation for research and theory making about designing and designs and a coherent cross-disciplinary body of knowledge that does not overlap with other disciplines. The key element of this foundation is defining *designing* as 'non-routine human activity that is an *essential* aspect of processes that lead to a design of an artefact'. This definition points to *designing* being a primary human function similar to *thinking* or *feeling*.

Currently, core concepts are defined in many different and problematic ways that are ill suited to their use in a coherent and unified cross-disciplinary body of theory. This paper suggests that it is unlikely that a coherent cross-disciplinary body of theory and knowledge can exist in this area without considerably tightening the definitions of core concepts such as 'design' and 'designing' to reduce ambiguity and inconsistency and enable these concepts to fulfil their role in providing epistemologically and ontologically sound foundations for theory-making.

The analyses in the paper point to a significant political question to be resolved by the field: whether researchers who have an investment in past literature with its philosophically problematic foundations and domain-specific theories can be persuaded to support the development of new and more coherent cross-disciplinary foundations and the building of a single body of theory and knowledge about designing and designs.

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Appendix A. Meta-theoretical hierarchies

In the mid-1990s, the author developed a meta-theoretical abstraction hierarchy model based on the work of other researchers in this area such as Reich[24], Franz[49], Ullman[14] and Konda & associates[50]. This structural model was developed to assist in clarifying the relationships between different fields of study, and for checking the coherency and sufficiency of general theories, theoretical perspectives, theories and concepts[2,11,51,52]. It locates theory in a human context, especially focusing on human skills at addressing wicked problems and creating new knowledge and artefacts. It therefore includes the human activity of designing as a key factor.

The hierarchy consists of a generic structure with a family of different forms suited to analysing theory in different situations. Versions have been developed for research into designing and designs, cognition, information systems, e-business education, and the inclusion of qualitative social, environmental and ethical factors in quantitatively based activities[2,53–56]. A relatively generic form of the hierarchy[56] relating to theories about human activities is outlined in Table 4.

49 **Franz, J M** 'A critical framework for methodological research in architecture' *Design Studies* Vol 15 No 4 (1994) 443–447

50 **Konda, S, Monarch, I, Sargent, P and Subrahmanian, E** 'Shared memory in design: a unifying theme for research and practice' *Research in Engineering Design* Vol 4 (1992) 23–42

51 **Love, T A** 'Meta-theoretical basis for design theory' in **D Durling and K Friedman** (eds) *Doctoral education in design*, La Clusaz, France (2000)

52 **Galle, P** 'Metatheory in practice' *Design Studies* Vol 22 No 1 (2001) 101–102

53 **Love, T** 'Affective information systems: contributions to IS from design research', *We-B Research Seminar*, We-b Research Centre, ECU, Perth, WA (2001)

54 **Love, T** 'Educating e-business designers: some implications of a post-positivist theory of design cognition' in **S Stoney** (ed.) *Working for e-business: challenges of the new e-conomy*, We-B Research Centre, School of Management Information Systems, Edith Cowan University, Perth, WA (2000)

55 **Love, T** 'Computerised affective design cognition' *International Journal of Design Computing* Vol 2 (2000)

56 **Love, T** *Design research & management information systems: symbiotic factors* Edith Cowan University, Perth (2001)

Table 4 Meta-theoretical hierarchy of concepts and theories in human activities

Level	*Classification*	*Description*
1	Ontological issues	The ontological basis for theory making. This level includes the human values and fundamental assumptions of researchers, designers and those involved in critiques of theory
2	Epistemological issues	The critical study of the nature, grounds, limits and criteria for validity of knowledge. This is the level that contains the relationships between ontology and theory
3	General theories	Theories that seek to describe human activities and their relationship to designed objects and human environments
4	Theories about human internal processes and collaboration	Theories about the reasoning and cognising of individuals involved in designing and researching, of collaboration in teams, and socio-cultural effects on individuals' behaviours
5	Theories about the structure of processes	Theories about the underlying structure of processes of designing and researching based on domain, culture, artefact type and other similar attributes and circumstances
6	Design and research methods	Theories about, and proposals for, methods and techniques of designing and researching
7	Theories about mechanisms of choice	Theories about the ways that choices are made by designers and researchers between different elements, designed objects, processes, systems or other types of possibility
8	Theories about the behaviour of elements	Theories about the behaviour of elements that may be incorporated into designed objects, processes and systems
9	Initial conception and labelling of reality	The level at which humans' descriptions of objects, processes and systems are coined, e.g. 'a vacuum cleaner', a 'database', 'sitting' at a 'desk', 'hearing' 'noise', and 'watching' 'sunsets'