

A Theory of Design?

Ken Friedman

Wed, 4 Aug 1999

Terry Love's recent post to the Design Research Society discussion list encourages design researchers to bring "other sides of design research back into the design debate." In essence, Terry is calling for a general theory of design, an area of inquiry that has languished in recent years. Lubomir Popov questions the possibility of such a theory. I do not. I believe it interesting, possible, and necessary. Many necessary and interesting possibilities are difficult. This is such a case.

It's true, as Lubomir Popov writes, that "Design as a human activity requires object specific methodologies, performance patterns, and skills. "What isn't clear is that design requires these "rather than abstract conceptualizations."

Design also requires conceptualization, and in several forms. These include abstract conceptualization, systemic conceptualization, and grounded conceptualization. Grounded conceptualization is reflected in object-specific methodologies. Abstract conceptualization and systemic conceptualization both involve different aspects of theory, including general theory. Performance patterns, and skills involve tacit knowledge in the form of habit and situated behavior in contrast to conceptualization.

To rely on performance patterns and skills alone is to be an artisan rather than a designer. This is what Terry refers to as the "art and design tradition" To rely on object-specific methods engages a field ranging from a pure craft orientation to the design tradition reflected in applied engineering and industrial design. In contrast, a general theory of design will support a rich, comprehensive understanding of the design process. It will also nourish the specific methods reflected in design practice. This is the distinction between design as a science and design as a craft.

The distinction between a science and a craft is a structured body of knowledge and systematic thought organized in theory. Craft involves doing, perhaps even experimenting. The frame of theory allows us to organize our observations. Theory permits us to question what we see and do, and it helps us to develop generalizable answers that can be put to use by other human beings in other times and places.

Nobel laureate Herbert Simon defines design as the process by which we "[devise] courses of action aimed at changing existing situations into preferred ones." This, in effect, is the central issue in design. To "[devise] courses of action aimed at changing existing situations into preferred ones" on a predictable basis requires understanding "things: how they are and how they work," which is Simon's explanation of science.

One form of design practice is allied to art and craft. It is intuitive. It sometimes produces desired results. On occasion, this practice of design produces desirable results that may have been unpredictable, but results that can nevertheless be seized retrospectively as the useable result of muddling through. The other face of design practice involves predictability. It is created by the effective response to problems, and it has similarities to science, engineering, and technology. This is the basis of design science, an applicable theory of how to devise courses of action aimed at changing existing situations into preferred ones.

Design is of necessity in transition from art and craft practice to a form of technical and social science focused on how to do things to accomplish goals. To meet the challenges of the design process requires understanding the actions that lead from existing situations to preferred ones. This means understanding the principles of predicting and measuring outcomes based on what W. Edwards Deming terms profound knowledge. This knowledge is comprised of "four parts, all related to each other: appreciation for a system; knowledge about variation; theory of knowledge; psychology." According to Deming "Experience will answer a question, and a question comes from theory."

Theory can be described in many ways. Some theories are complex and sophisticated. Others are simple. Mautner defines theory as "a set of propositions which provides principles of analysis or explanation of a subject matter. Even a single proposition can be called a theory." This often depends on the nature of the subject.

Design seems to make use of theories at many levels. In many cases, activities that seem to be rooted in tacit knowledge are rooted in a grounded theory of action that simply hasn't been made explicit. Successful design methodologies that seem object-specific frequently are a reflection of general knowledge on the part of people who have theorized deeply without explicitly articulating their theory. Much of this knowledge is based on the inductive development of general principles from which applications can be fashioned. Not all designers care to theorize. Many guard their professional knowledge in the form of a trade secret, managing their work and training their associates in the craft tradition of the guilds. Others want to understand and generalize this knowledge. While there are abstract theories to be built that address areas of the design task, some cases of generalizing knowledge simply involve rendering explicit generalized theories that already exist in tacit practice.

Nonaka and Takeuchi describe the process of knowledge creation in terms of the cycle of transformation from explicit knowledge to implicit knowledge and back again. Knowing what to do and knowing how to do it increasingly involve knowing why things work in a larger and more general sense. This calls for theory.

In its most basic form, a theory is a model. It is an illustration describing how something works by showing its elements in their dynamic relationship to one another. (The dynamic demonstration of working elements in action as part of a structure distinguishes a theory or a model from a taxonomy or catalogue.)

The ability to theorize design enables the designer to move from an endless succession of unique cases to broad explanatory principles that can help to solve many kinds of problems. Warfield describes the generic aspect of design as "that part of the process of design that is indifferent to what is being designed, being applicable whatever the target may be." He contrasts this with the specific aspect of design, "that part of the design process that is particular to the target class." Warfield further identifies thirty-two basic postulates of the generic design process, which he groups under six categories: the human being, language, reasoning through relationships, archival representation, the design situation, and the design process. This generic design process is inevitably theory-rich. It is no more abstract than science is abstract. Quite the contrary. Theory relies on an engagement with empirical reality.

It is my view that there is nothing as practical as a good theory. To theorize design in a rich and general way opens the field to new methods, new materials, new ideas in a way that case-by-case practice and object-based methods cannot do alone.

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Theory of Theories

John Chris Jones

(from DRS e-mail, Aug. 13, 1999)

Some theories of theory, and other thoughts and interventions, occasioned by this discussion (which I'm enjoying though I can barely keep up with it!):

1. From the Shorter Oxford English Dictionary (1968) entry re theory: *theoria* [or rather its ancient Greek equivalent] originally meant viewing, a sight, spectacle. 'Theorie without Practice will serve but for little.' 1692. 'Were a theory open to no objection it would cease to be a theory and would become a law.' 1850.
2. From Joseph Conrad in a letter to Edward Garnett, 1895 (quoted by Utopia in the 1992 edition of 'Design methods', now published by Wiley, New York): 'Theory is the cold and lying tombstone of departed truth ... But he was right says Utopia and then she pales as she perceives that any assertion about theory can be seen as theory too. We are all vulnerable she adds as she sits down on the nearest tombstone.'
3. I do not believe that it is possible to describe designing, let alone to explain it, for that would be to describe or explain ourselves, and hence everything (as we are a consequence of everything and a, or the, source of such notions as theory, description, design and everything). I prefer to speak of methods, not methodology, and of mnemonics and rules of thumb and of navigation. I avoid speaking of design research as a theoretical science or as an explanation. I believe that the objective (or detached) method of experimental science cannot be applied to people without contradiction as it does not include self-awareness and does not admit that ideas, perceptions (and science itself) are themselves both realities and constructions. As was the stone kicked by Dr Samuel Johnson, was it not. And as is literature.
4. When reading the discussion on scientific theory versus critical theory (much helped by Anthony Dunne's quoting Geuss to point out that, whereas scientific theories are intended for manipulation of the external world, critical theories are intended to make one aware of hidden coercion) I realized that I prefer theories to be neither scientific nor critical but constructive; i.e. useful in imaginative collective action. To me a theory that is not practical is mistaken and theories of design that make no mention of imagination seem unlikely to lead to things new.
5. I have always disliked frames of reference when they are taken to define boundaries to thinking and doing. However, I heard recently of some research showing that only a small minority of people likes to work without boundaries - perhaps the majority find them necessary for peace of mind? But I can't see that as a fit state of mind when you are trying to make something new. You need to be dissatisfied with things as they are, and hence with existing boundaries. Theories also. I imagine that the liking for boundaries is temporary - something that can disappear as people get used to new powers and new freedoms (such as are described in the posting from Wolfgang Jonas (07/08/99, putting us all into the role of jesters!).
6. The defining of variables, meanings and values at the start of a design process, and treating them thereafter as fixed, seems to me to be creative death. I usually begin a lecture on designing with the mnemonic $p=s$ (with a two-way arrow as in a reversible chemical reaction) by which mean that 'problem' and 'solution' (if we must use such terms) are interdependent. One of the aims of

designing is I believe to find designs which can change our perceptions (and hence our 'needs') and thus make 'problems' vanish and allow new possibilities to arise.

7. The designing 'in other fields'* from which this discussion began is now I believe the primary field of design as computing (and other microtechnologies) show the new possibilities of artifacts that are not specialised but adaptable, and hence enable us to give up specialisation (induced by adaptation to mechanical technology) and to recover our biological adaptiveness. I believe that the design methods movement was (and I hope still is?) one of the one of the sources of this widening and demechanising of life.

8. However, after listing these complaints against rigid theory, I admit that it is essential to have a language in which it is possible to discuss designing while doing it, especially when designing things that are beyond the competence of the specialised professions, even when working as teams of specialists (who will often be either unable to understand each other or else be unaware that they do not - see B N Lewis' paper in Conference on Design Methods, Pergamon, Oxford 1963) . But this language should I believe be less and less like scientific theory and more and more like fiction, poetry, colloquial speech and direct democracy, in which people can be political and/or divine presences, not just consumers or specialists or instruments.

9. I have recently come to believe that the presence of the internet, and the possibility of discussions like this, is one of the means by which 'designing in other fields' (or as I prefer to call it 'the collective redesigning everything') can come about. I am have recently completed a book ('the internet and everyone', ellipsis London, forthcoming) in which this view is explored. It is, I suppose, a view of designing as politics, or as a way of life. 'Design without a product', as I once found myself calling it, as an end in itself.

And now unexpectedly the ghost of my Aunt Elizabeth reports that she is delighted with the celestial wheelchair which she has designed herself with the aid of a website for constructive action at which she learnt how to do it. It's so comfortable and convenient that she still uses it in Heaven though her ailment has gone. Thank goodness for good theories, she adds, with a wink at her nephew, I always knew you were a theorist. And there's no need to fear death, nor the universe - they are doors to the unbounded from whence we all came.

But do remember that all you can do while alive is to 'move muscles' says Charles Sherrington** (from Heaven also, where that miracle's not possible)...

*Re-reading the email in which Dr Terence Love began the discussion, I got the impression that he thinks of design research not as academic description of what designers do now but as something that helps people to design 'in other fields', as he put it. And that, it seems to me, is what is needed (and by 'people' I mean everyone).

**Sir Charles Sherrington, 'The integrative action of the nervous system', New Haven, Yale University Press, 1947.

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Definitions of Theory

Ken Friedman

My description of theory is one of several plausible descriptions. It is not based on what Bruce Moon labels assumptions. The word theory has been used in the English language for four centuries. My note hews closely to the meanings that the word theory has had since it entered the English language in 1597 via Latin from the original Greek.

Merriam-Webster defines theory as: "1 : the analysis of a set of facts in their relation to one another 2 : abstract thought : speculation 3 : the general or abstract principles of a body of fact, a science or an art <music ~> 4 a : a belief, policy, or procedure proposed or followed as the basis of action <her method is based on the ~ that all children want to learn> b : an ideal or hypothetical set of facts, principles or circumstances - often used in the phrase in theory <in ~, we have always advocated freedom for all> 5 : a plausible or scientifically accepted general principle or body of principles offered to explain phenomena <wave ~ of light> 6 a : a hypothesis assumed for the sake of argument or investigation b : an unproved assumption : conjecture c : a body of theorems presenting a concise systematic view of a subject <~ of equations>."

The word theory has clear meanings. They involve modeling, structuration, and analysis. Not all theory involves science or even quantitative data. Nearly all theory involves propositions that model, structure, and analyze phenomena in some way.

The pre-Socratic Greek philosophers were the first theorists. They developed a vocabulary of theoretical distinctions in their effort to explain the world around them. To the Greeks *theoria*, meditation, speculation, contemplation, involved seeking to know the highest and eternal principles. Aristotle believed this to be life's highest function.

In Plato's *Phaedo*, Socrates says that it is, "the superlative thing to know the explanation of everything, why it comes to be, why it perishes, why it is." Explanation makes empirical demands. At the same time, empiri must be structured in some way if we are to understand what we are observing.

Science involves three conceptual approaches - observation, experimentation, and theory. Plato's science stood on one leg, Aristotle's on two. It was not until the great age of physics that Galileo, Newton and Bacon developed the concept of robust experiment that made scientific progress possible by stabilizing scientific method with its third leg. The distinction between a science and a craft is systematic thought organized in theory. Craft involves doing, perhaps even experiment, but it is the frame of theory that allows us to organize observations. Theory permits us to question what we seen and do, and it helps us to develop generalizable answers that can be put to use by other human beings in other times and places.

Not everyone defines theory as Bruce Moon does, and not all theory describes actions in the physical world. A theory is a structured set of propositions which provides principles of analysis or explanation of a subject matter. A theory is a model. It is an illustration describing how something works by showing its elements in their dynamic relationship to one another. Not all models reflect physical or material subjects. One can model processes, thoughts, and intellectual artifacts, mathematical objects in fact, one can model any subject, object or process complex enough to be represented as a structure comprised of elements operating in dynamic relationship.

McNeil's proposes eleven characteristics of any general theory.

- 1) A theory has a constitutive core of concepts mutually interrelated with one another.
- 2) A theory has a mutually productive, generative connection between central concepts and the peripheral concepts where theory verges onto practice.
- 3) The core concepts of a theory are stated in algorithmic compression, parsimonious statements from which the phenomena in the theory can be reproduced.
- 4) A theory has an irreducible core of concepts, a set of concepts in which no central concept can be removed without altering the scope and productivity of the theory or perhaps destroying it entirely.
- 5) Two or more of the core concepts in a theory must be complementary to each other.
- 6) The central concepts of a theory must be well defined and must harmonize as much as possible with similar concepts of enlightened discourse.
- 7) The central concepts of a theory must be expressed at a uniform level of discourse. Different levels of discourse must be distinguished and used consistently.
- 8) More general theories (higher-level theories) must relate to less general theories (lower-level theories) and to special cases through a principle of correspondence. This principle confirms and guarantees the consistency of the more particular theories and their applications.
- 9) Explicitly or implicitly, a theory describes dynamic flows with contours that trace relatively closed loops as well as relatively open links.
- 10) A theory states invariant entities in its assumptions or formulas that provide standards for measurement.
- 11) Theories describe phenomena in the context of a conceptual space. This implicitly establishes a relationship between the observer and the phenomena observed.

These can apply to many kinds of theory, and to many kinds of conceptualization.

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A theory of design!

Wolfgang Jonas

4 Aug 1999

Dear colleagues and friends,

I agree with Ken Friedman's view that there can be and there should be a general theory of design comprising everything which fits into SIMON's definition of designing as transforming a situation into a preferred one. Who has the authority today to tell what is design in the "narrow" sense and what is design in a "broader" sense? I think it is a futile effort trying to define the boundaries of the professional field. Practice is far ahead.

The question is how to achieve at this ambitious goal of a theory of design? What should be the basic elements of such a theory? Can it be a theory in the scientific sense? What about the humanities? One of the most counter-productive consequences of the still vivid "2 cultures" dualism in design are fierce struggles as to the dominance, mainly from the side of the humanities vs. the sciences, with claims of (e.g.) "history, theory and criticism" to be the core of the new field (MARGOLIN 1998). The blind spots caused by the own background are overlooked here (and in any other effort to fix the basis). Contributions will come from both the humanities and the sciences. Fights for predominance are futile, because we will experience the emergence of something new, a kind of "3rd culture" (BROCKMAN 1996), the culture of the artificial. The working / research process will be different, the methods used will be different, the outcomes will be different. The uniqueness has to be distinguished and indicated and communicated as precisely as possible in order to gain a status of autonomy comparable to that of the established disciplines. We are far away from that.

So far, there are no foundations, but at best elements of a "science of the artificial". SIMON's contributions are part of it, of course, but they are not useful in all their aspects and implications. There will be no stable identity but only a dynamic one which is permanently re-established in communicative feedback practice. The dynamics is caused by the fact that designing and design as a discipline is a kind of interface activity between moving areas: the context (cultural, technological, etc.) and the subject of designing (the system). This refers to SIMON again. There seems to be structural self-similarity of design as a discipline and design as a problem-solving process.

Design theory is design! We should distinguish a structural meta-level of "strong theories" (Findeli 1998) which is able to conceptualize this dynamic "nature" of the discipline and a processual, operative level of "weak theories", or "small theories" or methods.

Maybe, in the future, a kind of "foundation" might crystallize from this dynamic process. Or maybe not.

The concept of "science" is preoccupied. In consequence its use for design would imply the realization of the ambitious project to redefine designing as the model of scientific research (GLANVILLE 1982). So, provisionally (which might last forever), we should rather talk of a dynamic (highly specialized) social system for the creation of the artificial, the exploration of the new. And we should keep in mind that the specialization does NOT refer to any one traditional disciplinary fields but to relations between them.

One of the consequences of this permanent shift might be that there is (and never will be) anything like progress in design. There is fit (between the context / environment and the artifact / system) at best. Maybe we are a discipline of professional diletantism. And maybe we should stop complaining about that...

P.S.:

I wrote several paper on this subject, e.g.: - Viable Structures and Generative Tools - an approach towards "designing designing" in: "contextual design - design in contexts" the european academy of design, Stockholm 23, 24 and 25 April 1997 (accessible via my homepage) - "A Scenario for Design - or how to become a discipline?" to be published in Design Issues - "On the Foundations of a "Science of the Artificial"" to be presented at the Helsinki conference, Sept. 99

So much for now,

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Towards an epistemologically more coherent view of design

Terrance Love - Eco-Design

For brevity and ease of reading in what follows, I have omitted references, data sources, and the detail of many arguments. If any reader wishes for more detail I am happy to provide it.

Recent postings have returned to definitions of design and the associated problems in design theory. This is not a new issue - it dates back at least to the mid 1960s. The underlying problem seems to be that, for a variety of reasons, design researchers have not paid sufficient attention to terminology and epistemology. Most approaches to defining design have been epistemologically inappropriate, and this lack of epistemological clarity about fundamental concepts of design research is a major weakness. It causes confusion and unnecessary work for each researcher who must tread a path round terminological and conceptual double-speak. The scale of the problem is that now - as in the 1960s - the term 'design' has been used for so many different things that it has lost any real meaning. It is a reasonable claim that some kind of creative actions are a part of all human endeavour, but bundling all action and objects as 'design', however, is overly broad. Theoretically, this is similar to, for example, maintaining that all physics is best expressed in terms of philosophy, or that all things concerning art are best expressed as physics. Certainly, there are many connections between concepts and subject disciplines but to blur these connections produces a sloppiness of analysis that is unhelpful to all researchers. In short, what is needed is a conceptualisation and definition of design that is well-bounded and appropriate to its theoretical 'purpose'. Some key analyses and conceptual structures that might help with this task already exist. I offer the following as some touchstones for moving towards an epistemologically, con-

ceptually and terminologically more coherent basis for design research.

1. There are two main factors that characterise how design is defined. Most definitions of design are influenced by the cultural and conceptual norms of the particular discipline in which the author is writing. In the domain of Mechanical Engineering, for example, design theory and the definition of design are addressed in a similar manner to mechanical objects and processes. Similarly, in Architecture, design is often defined in terms of individual genius and project management. The text of the discourse of design research in most cases follows the discourse of the background discipline. More importantly, however, most definitions of the theoretical concepts of design research do not fulfil the philosophical requirements for adequacy of a definition - an adequate definition is one that sets bounds that include all those members of the set being defined, AND exclude all those things that are not. In the case of design, because of its intimate relationship with cognition, it is also important that these criteria are epistemologically and ontologically well justified. These weaknesses in the definition of design act against coherence of design theory. Resolving these problems requires that 'design' should be defined at a meta-theoretically higher level - a higher level of abstraction - than commonly undertaken.

2. Underlying the above issue is that of 'where to stand' in revisiting or re-conceptualising design. Meta-abstraction analysis of the underlying concepts of design research requires concepts and analyses from research domains concerned with 'the structure and dynamics of theories', epistemology, and ontology. In philo-

sophical terms, these issues are aspects of the study of the theory of knowledge and exist at an higher level of abstraction than the philosophies of, for example, art, science, social science, literature or the philosophy of design. The domains associated with design practice, such as science, mathematics, engineering, graphic design, design critique, have a different purpose and are aimed at a different and lower level of abstraction. Philip Sargent pointed to this issue in engineering design research when he said something along the lines of 'Engineering designers think they are the experts in design. They are not - they are the subjects of research'. In other words, the theoretical positions from which design has commonly been defined do not contain the necessary conceptual tools for the purpose. Much of the confusion about design occurs because attempts have been made to define design through a variety of discourses that are neither at the appropriate levels of abstraction, nor contain the appropriate conceptual and analytical tools. The corollary of this argument implies that further analyses and discussion via the same conceptual levels will also fail.

3. There is a fundamental epistemological difference between 'design' as a noun and 'design' as a verb. Design (noun) refers exclusively to the world of objects and information. Design (verb) refers to the world of human actions. Human action includes subjective issues. Epistemologically and terminologically separating these two meanings is a major aspect of clarifying design theory for several reasons. The most appropriate theoretical approaches relating to design (noun) are essentially positivist, materialist and scientific. The most appropriate theoretical approaches relating to design (verb) are post-positivist. Positivist approaches are conceptually insufficient for addressing 'designing' because they specifically exclude many of the issues, such as human subjective functioning, that necessarily must be addressed. Confusion between design (noun) and design (verb) is common and the problems

associated with this confusion reach deep to the heart of the discipline of design research. To resolve some of the epistemological and theoretical problems raised by this terminological duplication, members of the design research discipline must find satisfactory answers to the following questions: 'Is design research about researching the human activity of 'designing' (verb form of design)?' / 'Is design research about researching the properties and behaviours of objects (noun form of design)?' / 'Is it possible for a definition to satisfactorily span both meanings of design?'

4. Dilnot identified the problem of the 'disappearing subject of design' - perhaps best referred to as 'Dilnot's paradox'. Dilnot observed that when design is researched via the design problem, its solutions and the relationships between them, then the subject of research 'designing' disappears. This is largely a practical observation of the consequences of the adverse aspects of points one to three above. Its implication is that research that focuses on design problems, solutions and the relationships between them, does not completely address the situation - implying that building a conceptual basis for design research and design theory on designing (verb form) is epistemologically more sensible than focusing on design (noun form).

5. There are the issues of simplicity, coherence and elegance. Where competing theories or definitions appear to satisfactorily explain or define a phenomenon then the application of Ockham's razor demands that we choose the option with the least exemptions, qualifications and 'special pleading. (Ockham argued through his law of parsimony that terms, concepts and assumptions must not be multiplied beyond necessity.) By this measure, the best choice of conceptual and theoretical definition of design is the one that is most coherent and makes the conceptual landscape less complex and more straightforward. Applying Ockham's razor in the instance of design research means that the concepts and definitions of design theory should

sit well with well-established concepts and theories in other disciplines, and should avoid unnecessary duplication.

6. Design researchers have spread into other disciplines. Clarifying the definition of design requires questioning whether it is best for design research to encompass many of these topics. It must be asked whether these research topics are fundamentally 'design' related, or are more appropriately viewed as the subject matter of other disciplines. For example, 'Is "design management" an essential aspect of research into designing, or is it better viewed as a part of Management Research?' These issues must be carefully addressed so that the scope of design research as discipline may be defined coherently with whatever are the most appropriate conceptual choices that shape a definition of design. Conceptual simplicity, and epistemological coherence would indicate that for many of these issues it is better to remove the design prefixes that have been applied to many topics in the last three decades. This is not to say that researchers involved in researching design should shun these topics, but because the term 'design' has been over-widely used it implies that they should be parsimonious, using it only when it is clearly epistemologically beneficial.

7. Similarly, greater clarity is needed about which aspects of an individual designer's activities are 'design,' and which are associated activities that are better viewed as activities that are a part of other domains. Questioning whether some of these activities should be viewed as design is likely to be contentious, for example, 'Should engineering drawing be considered to be 'design'?', 'Are calculations best viewed as 'design' - or better viewed as being engineering, or mathematics, or perhaps physics?', 'Should data gathering be considered a design activity?', 'Which aspects of participatory design processes are designing, and which are other activities such as organising, social skills, or group management?', 'Should the banking of project payment cheques be viewed as a design

activity?'. These issues have an important role similar to bounding the scope of the discipline in that they must be coherent with the underlying conceptual foundations of a definition of design. It seems clear to me that many activities are 'tools' which the designer uses, rather than designing per se.

8. The conceptual structure that underlies a better definition of design should also be coherent with the conceptual and epistemological foundations necessary for a detailed exploration of the intuitive, insightful creative processes that many view as an essential aspect of designing.

9. It is necessary to take account of those epistemological, ontological and theoretical concepts that must be included in order to address issues that lie beyond the bounds of analysis. Rosen and others have pointed to the limits of analysis - these limits are relevant to design research and defining design because much of what is related to creative activity and thinking lies beyond these limits. More importantly, however, Rosen's arguments draw attention to the epistemological issues related to the use of analysis in the research processes involved in investigating and theorising about designing. Again the implication is that theory-making in design research must be based on post-positivist epistemologies and ontologies.

10. Following on from the need to address those matters that lie beyond analysis, the conceptual structures that relate to a definition of design must also satisfactorily include Affect because of its roles in creative thinking, logical analysis, information gathering, problem formulation, solution identification, identifying and theorising about the properties of objects, theory-making and closure. The embodiment of affect into such theoretical scenarios also requires the use of appropriate post-positivist epistemologies.

11. Any definition of design that is to be useful in the future must allow an appropriate conceptual pathway to facilitate the inclusion of find-

ings about human cognitive functioning emerging from psycho-neuro-physiological research. Many of these recent findings tie down firmly what previously were speculative assumptions about the human functioning on which theories about designing have been based.

12. Defining design must be located at the appropriate level of abstraction. All design concepts and theories can be viewed as abstractions and categorised into a meta-theoretical hierarchy. The higher levels describe patterns in abstractions at lower levels, and provide the assumptions on which lower level abstractions are based. At the higher levels are abstractions relating to ontology, epistemology and general theories of design. At the lower levels are abstractions concerning the initial conception and labeling of reality, and theories about the behaviour and properties of objects. In the middle are the sundry abstractions about the internal processes of designers, mechanisms of choice, design methods and the structure of design processes. Currently, most definitions of design have design as a process and are closely tied to the behaviour and properties of objects. In terms of the structure and dynamic of theory-building, these definitions at lower levels of abstraction have not commonly identified and clarified their relationships with appropriate abstractions and assumptions at higher abstraction levels. This has led to a lack of coherence and unnecessary confusion, complexity and conflation. What is needed is more attention to the higher levels of abstraction.

Defining design as a human activity appears to offer advantages that bring greater epistemological and theoretical integrity than basing design theory on objects. It points towards a definition of designing as a human activity of 'addressing situations for which there is not a routine or logical way of deriving a solution'. This definition is too broad, however, because it also includes other activities that are already well defined, and it would be epistemologically unhelpful to create duplication. The definition

can be sharpened further on two sides. First, by extending it to include designing by 'acting as if there is no routine approach' - a point that was raised some time ago by Thomas and Carroll who noted that many new designs came about by designers 'acting as if they didn't know about existing ways of getting to outcomes'. Second, the definition of design(ing) can be sharpened by excluding those activities that are routine or already well-defined because for routine and logical ways of solving problems we already have adequate and well established terminology and concepts - engineering, analysis, logic, science, calculation - so there is no need to worry about including this side of human activity under the definition. This latter proposal provides great increases in epistemological clarity, although I guess it is likely to be strongly resisted from the field. In addition, it opens up a definition of a role of design research as 'converting "wicked" problems into routine processes'.

In epistemological terms, the above proposals allow 'designing' to be defined as a Primary human cognitive process alongside 'rational thinking' and 'feeling'. This move also offers some epistemological support for the 'Art/ Science/Design' trilogy of human endeavour. The problem of how to include the other activities that designers do - calculating, drawing, taking their fees, sweeping the studio and the like - can be resolved by appropriately defining the term 'design process' to include them. For example, by defining design process as 'any process that includes at least one human act of designing'. This way associated activities such as calculating, information gathering, analysing the details of the problem brief, etc. are not 'designing' but remain 'part of the design process'.

In conclusion, the above approach offers a powerful means of clarifying many problematic aspects of design theory, and provides a means of resolving most of the issues of confusion, conflation and confabulation of design theory

and design research.

The benefits and clarity that the above approach brings can be explored by consciously using the term 'designing' instead of 'design' in discussion and analyses.

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