

Love, Terence (2005) A unified basis for design research and theory, in *International Design Congress - IASDR 2005: New Design Paradigms*, Douliou, Taiwan, 2005. International Association of Societies of Design Research, Taiwan.

A Unified Basis for Design Research and Theory

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Abstract: An epistemologically fundamental problem in design research is contradiction between two opposing perspectives:

- Belief that design research will lead to the activity of design being completely understood.
- Belief that research into design will ultimately be limited because design activity is dependent on human creativity and human creativity cannot be deterministically modelled in the manner of simple physical research.

Both perspectives are strongly represented in the design literature. The contradiction between them has not been resolved, or addressed in an epistemologically conclusive manner.

This paper addresses this problem by outlining a proposal for a unified basis for design theory that builds on previous research by the author in integrating social, environmental, ethical and technical factors in design theory. There are significant advantages for addressing this contradiction to reduce the widely acknowledged epistemological problems found in the design research literature. Addressing the issue also forms the basis for a unified theory of design. The proposal draws on: epistemology and theory of knowledge; ethology and evolutionary development; systems; and organisational theory. The use of ethology in this context is new in the field of design research. The paper concludes by outlining the benefits of the proposed unified basis for design theory and its limitations.

Key words: *Design, unified theory, epistemology, ethology, systems*

Introduction

The aims of this research, the research goals, are to resolve a foundational theory problem reflected in contradictions between two conflicting perspectives central to the design research literature, and to explore the basis for a unified theory of design.

A review of the design literature [1, appendices 2 & 3] indicated that design research is dominated by two contradicting incompatible approaches:

- Scientific approaches that presume that design can be completely understood (Approach A).
- Interpretive approaches that regard design as an 'intuitive' activity, dependent on creativity, and scientifically inaccessible (Approach B)

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The approaches are epistemologically and practically contradictory in that scientific empiricism and interpretivistic exploration regard each other's central assumptions as invalid [2]. Empirical scientific research specifically excludes subjective reporting as reliable evidence. Interpretive approaches deny that the scientific empirical approach addresses the central target of design research – the human internal creative design activities (see, for example 'Dilnot's paradox' [3]).

Resolving the contradictions between these two central research perspectives is important. The literatures of design research are widely regarded as being confused, conflated and epistemologically flawed with partial theories that depend on uncritically accepted assumptions [4-7]. After 50 years, the body of knowledge from design research remains incoherent, poorly validated, and falls apart under critical review. Addressing the contradiction between the above two perspectives begins the building foundations for a coherent, integrated body of knowledge in the design arena.

This paper proposes a unified basis for design theory that bridges between these two incompatible approaches. The advantages of establishing a unified theory is that it provides a coherent epistemological basis for new theories and for recasting prior research and theory within a justified integrated framework with a clear epistemology and ontology. This in turn provides the basis for developing a design field.

The paper is unusual in that it draws on Ethology as the basis for this unifying foundation.

Epistemological contradiction: possibilities for resolution

The above two polarized approaches to design theory differ in several dimensions: in the concept of *design*, and in the associated discourses, research methods, and theory making approaches. Table 1 maps out several of these differences.

Table 1: Differences between approaches.

	Approach A	Approach B
Theoretical perspective	Scientific, usually based on physics	Interpretive, focusing on individuals' experiences, their construction of understanding, perceptions and interpretation of reality. Often centres on individual creativity and subjective perceptions relating to being creative.
Focus	Empirical realities of the design processes, design objects, design brief and contexts. The core concept of 'design' is defined in terms of these activities.	Focuses on experiences of designers and other design constituents. Tries to identify form of internal creative design activities from observation of externalities. Typically defines design in terms of creativity, art, individual genius and socio-cultural influences

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View of Design	Design is a process. May or may not include creativity.	Intuitive, involving hidden aspects of human subjective thinking and affective activity
View of creativity	‘Something, or a specification for something, is “created”’. Creation can be achieved mechanically, by automation or intuitively.	Human internal activity that results in ideas for new, unusual, highly valued, never before created things, emerging ‘magically’ from the genius of designers. Focus on ‘individual creativity’ attributed to specific ‘designers’ and socio-cultural influences.
Data collection	Similar to physics and natural sciences	Drawn from various qualitative traditions, e.g. anthropology, ethnography, history, includes self reporting data collection.
Analysis methods	Similar to physics and natural sciences	Drawn from various qualitative traditions, e.g. anthropology, ethnography, history, includes reflective analysis of self reports and self perception.
Knowledge focus	Discipline specific empirical information along with elicited representations of tacit information and data that designers <i>use</i> .	Tacit and embodied skills of designers and users. Culturally-determined knowledge. Embedded meanings.
Strengths	The strengths of scientific method and empiricism, i.e. techniques to investigate phenomena in ways that are transparent, repeatable, testable, and verifiable. Research methods are expressed in a formal language that enables precise critique of the data collection techniques, methods of analysis, processes that lead to abstractions, and the theory abstractions and conclusions. Correspondence between characteristics of phenomena and the formal defined symbolic language of concepts and operations in which mathematically theories and representations of the phenomena are expressed.	Focus on human considerations, such as the human creative aspects of design, and how users and other interpret designed outcomes. Interpretive methods give space for designers and users to explain, in their own words, and from their own perspectives, how they design and use designed outcomes and how they communicate with others about designs. Interpretive methods also allow exploration of opinions of users about cultural aspects of particular designs. The interpretive approach can be extended to draw strength from the use of large data sets by which correlations and measures of confidence in them can be established between individuals’ ‘stories’ and the phenomena being studied.
Weaknesses	Scientific empirical method does not adequately address human subjective, interpretive	Main weakness is lack of reliability of individuals’ evidence, perceptions and interpretations i.e. lack of correlation

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and experiential phenomena except via physiological substrates.

between what people say and reality. Evidence of this problem found in a wide variety of research areas, e.g. studies of: witness testimony, reliability of memory, relationships between reported thoughts and physiological evidence, influence of subconscious 'thinking', mental illusions and delusions in normal people. The problem of 'false consciousness' that peoples representations of themselves are inaccurate or simply wrong. This weakness extends to individuals descriptions of processes, and the social activities that they undertake.

<p>Contradictions There is an incompatibility between scientific modelling of design process and inclusion of subjective phenomenological aspects a process element 'create a new of human creative design activity and solution' as a subjective human activity.</p> <p>Claims that all sub-fields of design are incommensurate as they use different knowledge (and that the broader field of design is fundamentally fragmented) is at odds with scientific representation of designers working across disciplines and in multi-cross- and trans-disciplinary teams.</p>	<p>There is tension between interpretive approaches that focus on experiential aspects of design and creative activity that are more accessible empirically using a physical science approach.</p> <p>There is an epistemological inconsistency in claims that Design exists of itself as a phenomena capable of creative agency and action.</p>
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Initially, several possible foundations for a unified basis for design theory were identified that, potentially, at first glance, may have resolved the above contradiction and provided a basis for a unified design theory. These include:

- Designs (i.e. the specification for creating or doing something)
- Designed outcomes (after they are manufactured/actualised)
- Design activity
- Design processes
- The skills of designers
- The role of design activity
- Cognitive design processes
- Behaviour of designers as individuals and in social groups
- Combinations of the above

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For each of the above, however, it is possible to adopt either or both of the two contradictory positions. In addition, none of the above offers a comprehensive basis for design theory that span all 9 design theory levels [8]. This implies that none of the above in singular, or in combination, will be satisfactory as the basis for a unifying theory.

Resolution between the two positions requires a meta-perspective that focuses on the human aspects of design, because together these provide the only necessary and sufficient condition. Structurally, possibilities for resolution of the contradiction between the two approaches are located in two directions. The first is to make a bridge between the positions based on identifying a bridging terminology and concepts (effectively a suitable definition of design). This is problematic because there are already historically well-established definitions of design as a human activity.

The second is to find a research approach that has sufficient epistemological scope to be able to address adequately the theory territory of both the contradictory approaches. Examples of the second approach have been proposed by proposed by Coyne & Snodgrass [9] and Love [1], who in the mid-1990s identified that constructivist approaches bridged between the two positions. The constructivist position – that individuals construct their knowledge on the basis of their experiences, their environments, their memories and prior conceptualisations and their social interactions – has the necessary epistemological scope. It allows interpretive exploration of the ways that individuals construct their knowledge of past and future designs, and that individuals construct their knowledge and understanding on the basis of theory and information derived from scientific approaches, along with mathematically codified, empirically defined representations of reality, validated via formally-defined symbolic representations.

A significant problem of the constructivist approach, however, is that it is not very useful. To say that ‘designers construct their knowledge’ - including their knowledge of future design possibilities - is relatively meaningless. The aim of making theory about designing activity is to improve the efficiency and effectiveness of design activity or to improve the outcomes of design activity. To focus design theory on designers’ construction of knowledge requires a clear picture of the relationship between ‘knowledge’, ‘knowledge construction’ and ‘the activity of designing’. The conceptualisation of ‘knowledge’ used in the related literatures is ill-defined and too broad to be particularly useful [10], particularly when ‘construction of knowledge’ is conceptually extended towards organizational learning. In addition, to be useful, the idea of individuals constructing their knowledge requires an explanation of how this ‘constructing’ is done, in order to improve it.

Before the mid 90s, constructivist and similar mid range cognitive theories comprised best practice in theory, associated with speculative correlation-based psychological modelling of human functioning whose attempts to bridge the empiricist-interpretivist divide were limited because they pre-dated current radical insights from neuro-cognitive research. Significant developments from that era included e.g. models of learning cycles [11]; human reflection [12]; and hierarchies of human development [13] that provided pseudo-bridging of approaches A and B.

Ethology and Evolutionary Development

Bridging the two approaches by looking at human internal processes such as cognition, emotion, creativity and intuition is strongly informed by an understanding of *why* these internal processes are in place in humans [14; 15]. This is found in an understanding of the forces and factors that by evolutionary selection have given preference to particular physiological substrates enabling us to have the abilities to think, feel and act in the way that we do. It points to a need to understand the history of human development, particularly as this relates to evolutionary influences that occurred in pre-human development.

Herein is a problem. Much of the literature of design and design research is written from a limited human-centric point of view that assumes humans are a completely different sort of entity to animals, i.e. that somehow humans are categorically distinct from other fauna. This limited human-centric perspective is the basis for anthropomorphism, and human-centric statements such as 'human attributes are found in animals'. Reality is different: humans are a sub-group of animals and, like other animals, humans have development pathways and attributes.

The problem with the human-centric approach is that it excludes many aspects of human functioning relating to animal aspects of human functioning and development. This is an important issue because many of the core aspects of design ability are grounded in these animal aspects of human functioning. This implies it is more useful to ask 'what can we learn about how humans design when we regard humans as animals?' rather than 'how do humans design?' or 'how are animals similar to humans?'

It suggests there is significant advantage in using an Ethological meta-perspective that regards humans as fauna. Ethology is the study of animal behaviour, and applying an ethological perspective requires that humans are studied as animals rather than from a biased human-centric perspective. Applying the perspectives of ethology to humans offers the basis for gaining insights that researchers are otherwise blinded by the wall of human-centric literature [16].

Applying ethological perspective implies taking an evolutionary perspective on human development. It offers a way of understanding human internal processes, behaviours and ways of interacting with environments that are grounded in the selection pressures acting on the organisms that, in their different evolving forms, are part of the human evolutionary pathway. Another, perhaps more pressing reason for taking an ethological viewpoint is that the majority of human processes, internal and external activities, are outside the conscious control of the conscious sense of self that each of us presumptuously regards as our home or own. Given the strong evidence of false consciousness in its different forms, and recent neurological evidence that indicates that conscious awareness of events inside us happens very much as an afterthought, delayed some time after the real decision making has already been undertaken unconsciously, suggests individuals' beliefs in their sense of self and will is misguided, that sense of self is illusory, and that the concept of self is faulty or, more straightforwardly, wrong.

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This relocates the research perspective: to view humans as animals that have evolved in their physiology and functioning (perception, cognition, emotion, behaviour etc) via selection pressures over time. It grounds design theory on the practicality that humans, as animals, design changes to their environments to improve their local conditions and establish strength of opportunity for the future.

Taken together, this establishes an *ethological* and evolutionary basis for researching and theorising about human design activity. In conjunction with the new understandings emerging from research in the area of cognitive neuroscience, it offers a potential area of resolution between the two contradictory perspectives on design research and theory making because:

- Opens up areas of approach B that were previously regarded as scientifically inaccessible (e.g. intuition, tacit thought, gut-based judgement)
- It revokes the hegemonically defined reification of human experience, perception and 'sense of self'
- It brings under scrutiny the apparently random, subjective aspects of creativity previously attributed only to human skill or genius.

In this context, cognitive neuroscience provides a joining theme. It addresses the causal physiological processes that explain how and why humans construct knowledge, and make emotion and value laden judgements. It thus provides the conceptual bridge between previous constructivist integrating approaches and the application of ethological approaches to humans. In addition, it provides a bridge linking ethology with anthropology and ethnography: important design research perspectives. For ethology, cognitive neuro-science provides an understanding of why and how the physiological substrates needed by design, creative activity and other associated activities are actualized. It also provides an understanding of on one hand, the physiological foundations on which human culture is developed, and, on the other, understanding of how culturally-related behaviours shape humans' physiologically defined envelope of action possibilities.

Systems and Organisational Research

A practical aim of identifying a unified basis for design theory goes beyond addressing the contradiction to support improving the efficiency and effectiveness of human design activity. Using an ethological and evolutionary perspective helps by opening the scope of research and theory-making in a way that avoids culturally-based blockages to conceptualization caused by the prevalence of human-centric romantic literature that has limited the scope of design-focused inquiry. Opening up the scope of inquiry in this way opens up the scope of potential theory formulation. It also increases the theoretical complexity, and the need for an integrating structural theory framework.

Systems approaches offer epistemologically appropriate tools for addressing complexity in a structured way. They combine with the ethological / evolutionary perspective integrating theories about human design activity across scales: from the neurological substrates to process-level views of design and business activities

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involving complex social interactions. That is, together they address all nine levels design theory [5].

For example, ethology at its most primitive involves relationships between a simple organism and its environment. The organism has need for internal homeostatic regulation to maintain its life along with appropriate changes in its external characteristics, i.e. its emotional behaviour, to maximize its chances for survival and its opportunities for increasing its genetic variety at appropriate change rates to maintain its viability under selection pressures. System approaches offer a means to model this simple live organism-environment relationship at this micro-level.

Systems approaches also support theory making at all scales up to the largest and most complex levels of human-social-environment interactions, as demonstrated by, for example the work of Sterman and colleagues [17-19] with respect to organisational functions. Thus, they are well suited to representing understandings from ethological and evolutionary perspectives. The combination of ethology, evolutionary analysis and systems perspectives provides a means of modelling and representing human collaboration and cooperation processes in the arena of organisational behaviours associated with design.

The systems approach also aligns well with representing findings from cognitive neuroscience. Human physiology has developed in a piecemeal manner in which human physiology systems always contain and depend on elements of prior systems – a sort of recursive physiology of systems for which complex systems analysis offers a particularly appropriate way of simultaneously representing what is, and enabling modelling such that emergent properties are revealed. This addresses aspects of theory making that elude other forms of analysis typical of classical physics, correlatory analyses, or those simplistic analyses that attempt to superficially and heuristically establish predictive relationships of the inputs and outputs of an unknown black box (e.g. learning cycle models, models of multiple intelligences, cognitive systems theory etc).

Taken together, ethology, evolutionary analysis and systems perspectives combine to provide a unifying basis for design theory that integrates the two conflicting approaches by repositioning human-centric issues in a more objective and accessible theory framework.

Summary

The picture that emerges is a unified basis for design theory that addresses the contradiction between two core approaches to design theory making that extends across all scales and types of design theory. It does this by taking an ethological perspective that views humans as animals and thus expands on and avoids the limitations of human-centric viewpoints by drawing on understandings from observation of the consequences of selection factors impacting on the human animal and the physiological changes necessary to pass evolutionary selection constraints. The proposed approach also provides a basis for the adoption of recent advances in human biosciences into design research. Simultaneously, it maintains a focus on the

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creative aspects of human design activity and on the details of the design processes, information flows, and object and system properties. It aligns in many ways with the integrated design scenario described by Nelson and Stolterman [4] in the Design Way. It goes beyond it, in that it addresses the realities of human creative activity in ways that were assumed, but not described, by Nelson and Stolterman.

Addressing the problems and the dichotomy described in this research paper is also important as part of building bridges between Art and Design disciplines and the scientifically-based Design disciplines. It provides a theory perspective by which Art and Design disciplines can more easily draw on the advances made by the scientifically-based design disciplines over the last 50 years. In the obverse, it provides a basis for scientifically-focused design research to result in increased understanding of concepts and activities, such as intuition and creativity, regarded as central to Art and Design disciplines.

The limitations to the effectiveness of this proposal are associated with aspects of design research literature grounded in the perspectives of Humanities that derive from romantic externalist assumptions for foundations of theories about the human condition and functioning. These romantic externalist approaches are found in much of the literature about the human condition on which interpretivism, hermeneutics, phenomenology and experientially-based perceptions and human thinking are derived. Compared to disciplines at the boundaries of humanities and social sciences such as psychology, many areas of humanities have been relatively slow to build up a critique of their foundation literature in response to new physiological information about human functioning emerging from cognitive neuroscience. The limitation of the above proposal for a unified basis for design theory is that the bridge developed here, though epistemologically robust, may not be culturally satisfactory to many design research constituents who wish to retain 'older' speculative approaches to conceptualizing and modelling human behaviour, or those who for religious or other reasons wish to continue to reify the 'human animal' above and distinct from other related animal forms.

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