Values role in computer assisted designing

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Abstract

This paper is a contribution to the area of design research concerned with providing computer assistance to designers such as, engineers, architects, and industrial designers. The paper sketches out some features of the roles of human values in the ontological, epistemological and methodological perspectives which underpin the development of theories about designing used in the development of computerised assistance for designers.

Introduction

Human value is central to research into design, especially in research into providing computer assistance for designers, because designing is fundamentally a human activity rather than an ahuman process (Nakata 1996; Bieniawski 1993; Lawson 1993; Konda et al 1992; Petroski 1992; Piela, Katzenberg and McKelvey 1992; Ullman 1992; Cross 1984, 1990; Ward 1984; Wilde 1983; Abel 1981; Thomas and Carroll 1979). Human values underpin most, if not all, human action, thought and decision making because the cognition and being of an individual is shaped by their values and beliefs. Evidence for this position is found in the hermeneutic basis for philosophy that evolved from Husserl, Heidegger and Gadamer, and the deconstructivist perspective of Derrida (Coyne, 1991; Flood, 1990). It underpins Berger and Luckman’s (1987) social constructivist argument that an individual’s construction of reality is more dependent on social interaction than objective concepts, and Giddens (1987) claim that many matters that were previously considered to be epistemological are dependent on social conventions and human values. It is found in the critical theory of Habermas which extended and elaborated Berger and Luckman’s social constructivism into the realms of politics, power and hegemony (Giddens, 1987). Finally, it is clearly stated in the constructivist perspective of Guba (1990) and Lincoln (1990) in which individual realities are constructed on the basis of individuals’ unique personal experiences and histories.

Including human values into design theory and research into designing is important because it is foundational to any attempt to produce a coherent design theory that includes humans and their condition (Coyne and Snodgrass 1993; Dilnot 1982; Franz 1994; Reich 1994a,1994b, 1995). In addition, the qualitative issues that lie at the heart of any theory of creative cognition based on human values provide the human value-laden context within which designed artefacts are intended to be used, and which design theories must include in the way they address the evaluation of emerging partial and completed designs (Hamlyn 1990; Petroski 1992; Oxman 1996; Soufi and Edmonds 1996).

Design research in technological domains has, with few exceptions, neglected issues concerning human values in designing, and focused on the physical aspects of designing .Most design research has been aimed at automating designing and has concentrated on the physical features of design circumstance (i.e., the problem, solution, and the relationships between them), and on gathering information from individual designers about the ways that they conceive design problems and develop solutions. Implicit in both of these avenues of research is the assumption that designing can be adequately represented by an objectively-based problem-solving process. The epistemological assumptions that underlie the methodological perspectives of the above two research paths are essentially those of logical positivism. This positivist approach to design research has been attractive on several counts. First, it has a history of success in the natural sciences. Second, it cohorts amicably with well developed conceptual and physical habits (in mathematics and computing) that are based on logic and analysis of physical phenomena. Third, the majority of design researchers have prior training in scientific or mathematically-based disciplines. Fourth, the positivist perspective on designing parallels the currently most authoritative theoretical perspective of Cognitive Science. Fifth, funding for research into designing that is undertaken from a positivist perspective is more easily obtained from scientific research funding bodies. These reasons have resulted in the positivist perspective becoming the default theoretical perspective of design research, particularly in engineering, regardless of its suitability or validity (Dilnot 1982; Love 1998, 1995; Reich 1994a).

The purpose of positivism's earliest proponents was to dislodge metaphysics from philosophy, leaving only those aspects of existence which could be perceived directly, measured, or proven from perception or measurement (Giddens 1987; Guba 1990; Harre 1981). The logical positivist, view of reality is, however, intrinsically incomplete has restricted the way that the human aspects of designing have been included in theories of design (Coyne and Snodgrass 1993; Dilnot 1982; Love 1998). Logical positivism is the universal application of the theoretical perspective of the natural sciences, a theoretical perspective that was developed specifically for objects whose behaviour is best viewed as purely physical phenomena. That is, the objects must have inanimate physical properties, in particular, that their behaviour is independent of observation and repeats identically in identical circumstances, and that the objects properties and behaviour are available and identical for all observers. Many research situations and subjects, such as designing, do not conform to these requirements, and, for these cases, the theoretical framework of the natural sciences is insufficient because it does not contain the necessary additional ontological and epistemological attributes.

Essentially, positivism, and scientism offer a logical and efficient way of modelling reality, but the model of reality that they create is a restricted representation of a subset of existence. The assumption that science is the most appropriate theoretical framework for design research has resulted in the epistemologically under-justified application of quantitative scientific methods to qualitative issues and has ignored the philosophical difficulties presented by the application of the scientific method outside the physical domain. It has not been widely appreciated in the design research field that positivism presents these difficulties, that in Philosophy the positivist position has been refuted for some time; that there are intrinsic problems concerning the objectivity that underpins the theoretical models of design research derived via scientism; that there are fundamental problems concerning the theoretical status of objects when a positivist perspective is applied to design research; and that, by definition, positivist epistemologies do not address qualitative matters and issues involving human values (Coyne 1991; Coyne and Snodgrass 1992, 1993; Crane 1989; Daley 1982; Guba 1990; Harre 1981; Phillips 1987; Reich 1994a, 1994b). These arguments do not negate the use of the scientific perspective in design research. Rather, they change the theoretical role of science from an overarching world view—an all encompassing ontology, epistemology and research methodology—to a research tool that is appropriate in some areas of human inquiry relating to situations where a mechanistic, deterministic objectivised view of reality is acceptable.

Human value is the most significant of the subjective aspects of reality that lie outside the objective domain. This is because human value is an essential aspect of the ontological foundation that determines the appropriate choices of epistemological and methodological framework for research and theory-making. To include human value into research into and theories about designing requires further clarity in the area that would, in line with other disciplines, be called *Philosophy of Design.* That is, more attention to human value is needed in the areas of research methodology, epistemology, ontology and terminology (Dilnot 1982; Love 1998, 1995; Konda et al 1992; Reich 1994b; Ullman 1992). The following sections of this paper outline some of the issues involved in including human value into research aimed at providing computer assistance for designing.

Terminology

In the design research literature, most definitions describe design as some sort of process that relates what went on before the act of designing to the situation afterwards. Dilnot (1982) pointed out that, when this basis for defining 'design' is used in design research, the activity of designing disappears from the theoretical scene. That is, the perspective changes from design research being *research about the activity of designing* to some other research perspective, for example, engineering research, research into information processes, research into artificial intelligence, or applied physical research. One implication of the details of Dilnot's argument is that, in a general theory of design, 'design as human activity' should have precedence over other design research outlooks, because the latter can be subsumed within the former but not vice versa. In this paper, design research refers to research into the activity of designing, rather than research into the physical or informatic attributes of a design problem, its solution, or the relationship between them.

The role of social, environmental and ethical factors in design research

The inclusion of social, environmental and ethical factors in design theory particularly depends on human values because:

- Decisions about what is socially and environmentally important and what is ethically good are intimately linked to human values.

- Human values are a necessary aspect of explaining cognition.
- Human values underpin explanations of the socio-cultural aspects of designing.

The role of social, environmental and ethical factors in design research goes, however, beyond them being context for the activity of designing. Social, environmental and ethical factors, like *technical factors* or *economic factors* are influences on designing, and therefore, part of design cognition. Taken further, because designing is a activity undertaken by humans that is intended to have social and environmental effects (with ethical implications), then these social, environmental and ethical factors with their associated human values are epistemologically central to research into designing.

Court (1995) has argued that the most crucial aspect of understanding designing and designers' behaviour is understanding how a designer uses information. Social, environmental and ethical factors influence designers' thoughts and behaviour in a similar way to technical factors, which implies that social, environmental and ethical factors, like technical factors, should be seen as information. This position would fit well with the established quantitatively informatic view of design and with the design research literature that depends on the paradigms of Artificial Intelligence and Cognitive Science. To follow this direction, however, would be to go uncritically against the arguments that have been established earlier in this paper that a positivist outlook on engineering design research is inadequate for addressing matters of design cognition. If social, environmental and ethical factors are to be satisfactorily included in design theory, it is necessary to identify pertinent abstract characteristics about these factors that include human value. This argument is supported by Court (1995) who emphasised the extensive use of individual memory, knowledge and experience by engineering designers, and concluded that 'future research should also be directed to study the processes and developments involved in creating the memory/knowledge and experience of engineering designers'.

Theoretical perspective of design research incorporating human values

The theoretical perspective that informs any research has three aspects to it:

Theoretical Perspective	
Ontological Perspective	Assumptions about reality. 'World View', value basis
Epistemological Perspective	Assumptions about the relationship between the 'world' (ontologically defined reality) and theory
Methodological Perspective	Assumptions that guide the choice of methodology including the particular way of seeing the object of research.

The most important criteria for the choice of theoretical perspective and framework for research into designing are:

- The 'world view' must be broad enough to include the human aspects of designing alongside the spread of existing perspectives of design research that range from scientific determinism to romantic assumptions about 'human genius'.
- Sufficient conceptual and analytical means must be available for reviewing and critiquing epistemological, ontological and theoretical issues in design research.
- The theoretical perspective and framework must provide the means of including subjective human experiencing and human values into design theory.

It is clear that a positivist or scientistic perspective is insufficient from the arguments presented earlier. Many post-positivist perspectives can satisfy one or more of the above criteria but some are less appropriate than others because their primary focus is less well matched to the research circumstance. For example, the social constructivism of Berger and Luckman (1987) addresses the research issues through the social context of designing rather than focusing on the designer.

The most appropriate ontological and epistemological perspective for addressing how human values influence how designers view the world and construct designs in their consciousness is individual constructivism (Guba 1990; Lincoln 1990) because this constructive perspective focuses on how an individual interprets and constructs their own internal worlds. Constructivism includes all and any epistemological and methodological details that help address its central concerns, and therefore is able to encompass the scientific perspectives of existing design research. In addition, the use of constructivism also alleviates the concerns of some researchers about the implications that *any* theory-making and theory depends fundamentally on human values (Guba 1990; Rosen 1980; Stegmuller 1976). Using a constructivist basis for design research also assists with addressing the problems of terminological confusion and theoretical under-justification in some areas of design research because the constructivist position is accompanied by an appreciation of the need to address semantic difficulties due to its assumption that theory and abstraction are based on knowledge that is relative and interpreted. Consequently, constructivism contains the necessary analytical basis for dealing with terminological and conceptual confusion (Guba 1990). In addition, constructivism provides a means of addressing the lack of ontological and epistemological justification of research into designing because of its close relationship with the critical perspectives and methodologies (Reich 1994a, 1994b; Franz 1994; Guba 1990). The use of a constructivist ontological perspective implies that knowledge and theory are also constructed and, hence, the epistemology of that knowledge must also be constructivist (Guba 1990b). The position taken here is that all theory is relative: that theory and 'truth' may coexist but the search for a 'true' theory must be fruitless. It is still necessary, however, to be able to differentiate between 'good' theory and 'poor' theory, and to compare and contrast theories. That is, it is necessary to address matters of 'meaning' and 'correctness' between and across theories. A critical methodological perspective is regarded by many researchers as the best choice in these circumstances because critical analysis is the most appropriate methodology for analysing theoretical issues particularly those involving analysis of research methodologies (Reich 1994; Franz 1994; Flood, 1990; Rowan & Reason 1981). Systems research provides a role model for changing the 'default' theoretical perspective of design research. During the last decade or so, systems researchers have looked to other ontological and epistemological foundations than positivism and scientism because these had led to problems of philosophical justification, lack of theoretical integrity, and poor practical applicability of theories, research methods and practice (Flood, 1995; Ellis, 1995; Flood and Jackson, 1991; Flood, 1990; Flood and Carson, 1988)). Over the last few years, several systems disciplines have absorbed post-positivist and constructivist outlooks, and as a result epistemological and ontological changes have been made, and theories developed, that reflect these changes (Hutchinson 1997). Over the last 30 or so years, design research has frequently been implicitly and explicitly dependent on systems outlooks, models and theories. The philosophical changes to the basis of Systems research implies that a review of the theoretical and philosophical foundations of design theory and research is also indicated (Holt, Radcliffe and Schoorl 1990; Love 1998, 1995).

The role of human values in theories of design cognition

There is substantial agreement between design researchers about the human attributes that are important or essential for design cognition, and what emerges is a picture of human design cognition that is partly rational, partly intuitive, and dependent upon designers' feelings (see, for example, the lists of characteristics and skills of Cross 1989; Eder 1995; Glegg 1971 and Neville and Crowe 1974). There are many differences, however, between this human picture of designing and underlying assumptions of research into artificial intelligence as it relates to automating designing.

Epistemologically, the study of human designing and the study of artificial design processes are different. One is the study of a human activity which has objectively observable and subjectively hidden aspects. The other is the study of a theoretical structure. In Popper's (1976) terms they lie in different 'worlds' of research and theory-making. The main intention of models of artificial design process is to formalise the links between problem definitions and designed outcomes. During the research and theory-making that is necessary to achieve his end, the activity under study, *design cognition*, is opaquely reconceptualised from the realm of designing to the realm of the mechanical. This leads to an epistemological impasse because this reconceptualisation means that designing, in this sense, cannot be automated because what is then referred to as 'designing' has become a determinable mechanical process. Mechanistic theories about automatic or routine design processes are not theories about *designing*, regardless of whether they are based on the techniques of artificial intelligence or any other body of knowledge.

Identifying the activity of designing, therefore, may be best viewed as attempting to catalogue a continuously changing target. That is, researching the designing that happens *now* results in the development of *automated decision-making processes* that solve the same problems as human designers, but are no longer *designing*. In the future, the same activity as the *designing that has happened now* and has been automated or formalised will no be longer designing, but the future will have its own activities of designing that is not yet automated. In other words, designing is the human response to situations for which we do not yet have a satisfactory, rational and-well defined process. This outlook, that the activity of designing is that which is done whilst being in a state of unknowing was proposed by Thomas and Carroll in 1979 (and, from memory, echoes the 'state of agnosia' of St. Dionysius' writings).

Value judgements and other human aspects of design cognition are excluded from the logical analysis that underpins many theories of artificial design cognition and creativity (see, for example, Alexander 1964; Altshuller 1984; Coyne, Newton and Sudweeks 1993; Hertz 1992; Liu 1996; Mitchell 1993). This exclusion of the human aspects of cognition gives rise to the problem of representation. Briefly, the problem of representation is the difficulty in establishing an adequate epistemology for theories that insist on objectivity and contain a circularity due to knowledge being derived from representation, and knowledge in its turn existing as a further representation. This issue of representation presents potentially insurmountable difficulties relating to the validation of core theories and concepts. Newell (1982) identified the importance of the representation problem in the first presidential address of the American Association for Artificial Intelligence and it emerged again in Newell's later attempt to establish a comprehensive framework for a unified theory of artificial cognition (Newell 1990). This means that the theoretical foundation of theories of design information and knowledge are challenged because they depend on a satisfactory theory of representation that cannot be construed using the same epistemological perspective. The problem of representation arises due to attempts to locate 'meaning' independently of individual human conceptualisation. Theories of human design cognition that allow subjectivity and human values into the semantic aspect of cognition, such as those based on individual constructivism, avoid those aspects of the representation problem that are present in theories of artificial cognition.

Rosen's (1980) focus on the underlying assumptions and 'bounds' of analysis raised two other issues relevant to theory-making about artificial and human design cognition. Rosen pointed to *intuition* as being epistemologically foundational in any explanation of creativity and synthesis, and he implicated intuition, creativity and synthesis in activities which are commonly regarded as being purely rational or non-intuitive. He concluded that intuition was fundamentally to rational analysis, judgement and other apparently non-intuitive activities because of its roles in:

- Justifying the closure which is necessary for validating theory (see also Walton 1996).
- Differentiating between creative activities and processes that can be routinised or formalised.
- Explaining activity which is not routine.

According to Rosen, intuition is dependent on individual human values, and this implies that human values must be included in explanations and theories of analysis, synthesis and human judgement. Rosen's inclusion of intuition and human values as essential aspects of theories of analysis and creativity is directly and indirectly supported by a variety of viewpoints. For example:

- Hamlyn (1990) critically analysed the foundations of theories of cognition and concluded that intuition was an essential aspect of theories of design cognition, and that it is neither explained nor explicable in the rational and bounded rational views of cognition (see also, Newell 1990; Simon 1981, 1982).
- Lai (1989) claimed that humans use an interpretive 'investigative strategy' for analytical problem solving.
- Rittel and Webber (1974) brought human values and intuition into design by arguing that the information needed to *understand* a problem depended upon one's idea for *solving* it.
- Dym (1994) included human values and intuition by arguing that design is a human activity or process with all that that entails about context and language.
- Stolterman (1994) claimed that there is objective evidence that designer's do not function rationally, and that it is the ideals and values of the designer that give a 'hidden rationality' to the design process.

Summary

Human values have a variety of roles in research and theory-making related to the provision of computer assistance for designing. These roles cannot be adequately addressed via logical positivism or the sole application of the theoretical perspectives of the natural sciences: they require the use of a post-positivist theoretical perspective. Of the wide variety of post-positivist theoretical perspectives, the individual constructivism of Guba (1990) and Lincoln(1990) seem the most promising. From this critical constructivist perspective, it is clear that the role of human values and their associated subjectively based phenomena extend into areas of theory-making and cognition that have previously been regarded as purely rational and independent of subjectivity. Finally, human values are part and parcel of social, environmental and ethical factors, and, when the research focus is on *designing,* rather than designed objects, then social, environmental and ethical factors (and their associated human values), become the central issue of design research.

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