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Science, Design, and Design Science: Seeking Clarity to Move Design Science Research Forward in Information Systems

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Abstract

This paper examines the fundamental nature of science, design, hence design science and design research, with a view to determining a conceptualisation of design science that is useful in the discipline of information systems (IS). After reviewing several notions of design, the paper recommends a conceptualisation that involves a broad practice-based view of design, an inclusive conceptualisation of design science, and a diverse and multi-paradigmatic approach to design research. The paper recommends that the design task in IS be conceived as one that includes rather than strips away the social and organizational context of the IT artifact, and this impacts the breadth of topics embraced by design science, and the types of methods employed to further enquiry in the field.

Keywords

Design, science design science, design science research, paradigm

Introduction

In modern organisations, IT (here defined to include hardware, software, databases, and communications technologies) is often implemented across multiple sites in multiple countries, and results in work systems intended to service the requirements of many different professionals and workers performing a diverse range of activities often collaboratively. Far from resulting in purely technical systems or technical artifacts when thus deliberately designed, structured and implemented, the resultant information systems (IS) have clear human (social, cultural, political and organisational) dimensions inextricably linked to the technical dimensions. Ignoring these soft factors in the design of IS is a known contributor to IS failure (Montealegre and Keil 2000). The IS discipline therefore could be viewed as being concerned with the increasingly complex web of relationships and interactions between the various elements listed above. In addition, considered holistically, IS should be regarded as historically and contextually situated (Mitev 2003), in the sense that they are designed and acquired in a context with social, cultural and political dimension which are inextricably linked to the history of that context and the actors in that context (McKay and Marshall 2007).

Much of what we do in IS is thus concerned with design: depending on one's perspective, the IS discipline is concerned with designing technical systems or is about designing technologically-enabled social systems. However, continuing to ignore these 'soft' factors, and placing excessive emphasis on the technical factors increases the risk that we make poor design choices which result in sub-optimal sociotechnical systems (Mumford 1995). Developing a research agenda around design in IS, and building a design science relevant to information systems, therefore seems an important and relevant thing to do: indeed, much of what we have historically taught and researched has been concerned with the design of IS (Mathiassen 2002). However, of late there have been concerns voiced within the IS discipline (Carlsson 2006, McKay and Marshall 2005) that there is a lack of discussion about what is (or should be) and what is not included within design science in IS, and on the absence of debate or development of the underlying philosophical foundations of this important field (Carlsson 2006). It thus seems important that as a research community, we attempt to better understand design science and its fundamental nature and scope, given its importance to developing and contributing to our understanding and practices in IS. This paper will attempt to lay a foundation for future discussion relating to design science in IS. It will not provide all the answers, but hopefully it will advocate a broader perspective for

design science and spark debate from all quarters of our scholarly community, thus resulting in a more embracing understanding of design science. We intend to start this paper with a discussion of what constitutes 'science', and this inevitably will involve a discussion of the notion of a 'paradigm'. From there we will consider what is meant by design, and think what this means in an IS context. We will then consider what design science is in IS, and hence the nature of investigation in design science research. The paper will conclude with a discussion on our concerns associated with the claims of paradigmatic status for design science in IS, and what we regard as an overly narrow and unhelpful delineation of what constitutes design and hence design science in IS.

What is Science?

If one consults dictionaries for a definition of the term 'science', there appears to be a consensus around two broad meaning of this word. The first is exemplified in definitions which basically describe science as an *"intellectual and practical activity encompassing the systematic study of the structure and behavior of the physical and natural world through observation and experiment"* (The New Oxford American Dictionary 2007), and as a *"branch of knowledge conducted on objective principles involving the systematised observation of and experiment with phenomena, esp. concerned with the material and functions of the physical universe"* (The New Zealand Oxford Dictionary 2007). Particular subsets or branches of science, such as Physical Science, or Agricultural Science are thus acknowledged. Implicit in these definitions is the concern for the approach to building knowledge. In using phrases such as 'observation' and 'experiment', science is being defined or characterized by the methods, formalisms, approaches to building knowledge rather than the content matter of that knowledge. In short, science is defined through methods for determining knowledge about the world, not a body of facts. Scientists study any phenomena: what distinguishes it as science is the use of intellectual procedures such as observation, experimentation, measurement, theorizing and testing, not the object(s) of study (Archer 1979b, Glanville 1999). Branches of science, such as physics or biology are thus defined by the part of the world that is investigated by the scientific method – matter, space and time in the case of physics and living systems in the case of biology. (This concern with method brings us close to a discussion on the notion of 'paradigm', to which we will return below.) We call this meaning of science 'science$_1$' or S_1.

The second meaning of the word 'science' is a much broader one, and possibly stems more directly from the Latin roots of the word, *scientia*, meaning knowledge or skill (http://sunsite.ubc.ca/LatinDictionary/HyperText/s.html). Science in this second sense refers more generally to the systematic and disciplined accumulation of a coherent body of knowledge, or knowledge itself, and does not necessarily imply any specific methodological requirement in the accumulation of that knowledge. For example, in recognizing these dual meanings of science, it is noted that *"science often describes any systematic field of study or the knowledge gained from it"* (www.sciencemadesimple.com/sciencedefinition.html). We call this 'science$_2$' or S_2. Thus whereas S_1 has a very express requirement that knowledge must be accumulated by the methods of science (justified and explained by the associated worldview of positivism), S_2 does not impose this requirement, only that the knowledge must be systematically acquired. From an S_2 perspective, research may be deemed to be scientific if it is deemed to be systematic and rigorous in its conduct and its claims to knowledge generation (Roth 1999).

There is direct relevance to our understanding of design science in this distinction: are we in IS, when we talk about design science, referring to S_1 (only that knowledge of design generated through research involving the application of the scientific method) or S_2 (knowledge systematically generated and accumulated both through the application of the scientific method, and through the application of other research approaches such as constructivist methods and critical methods, and the like)? In this regard, differences clearly emerge. While some major writers, notably those in the US (e.g. March and Smith 1995, Hevner et al. 2004, Cao et al. 2006, and the like) would appear to subscribe to an S_1 view of design science, those from Europe (i.e. Carlsson 2006) and Australia (McKay and Marshall 2005, Venable 2006) for example, tend to be understanding the term design science from an S_2 perspective.

Distinguishing the Sciences

Natural science is usually used to describe those branches of science which deal with the study of the physical world (including the universe), and typically embraces the physical sciences, fields such as physics, astronomy, chemistry, earth and biological sciences (Concise Oxford Dictionary 2006). Natural science is described in rational terms, and is identified by its use of the scientific method to study its subject matter, and in this sense, is as much about the manner of accumulating knowledge of these sciences, as it is about the content (Archer 1979b). In contrast, behavioural science is most often defined as the systematic analysis and investigation of human and animal behaviours (Concise Oxford Dictionary 2006). It would normally be seen to embrace disciplines such as psychology, anthropology, and behavioural zoology (Dictionary of Psychology 2006).

Whereas some categorise sociology as part of behavioural science (Dictionary of Psychology 2006), others create a separate classification of social science, embracing sociology, economics, and political science (Graaff 2002). A critical disagreement however occurs with respect to the methods by which knowledge in the behavioural and social sciences is accumulated. While some suggest that as in the natural sciences, human and animal behaviour should be investigated scientifically (in the sense of S_1) through controlled and naturalistic experimentation and observation (Dictionary of Psychology 2006), others have adopted a more liberal stance and it is now acknowledged that scientific (in the sense of S_2, systematic) research using a variety of methods (such as those based on interpretive and critical perspectives) in addition to the scientific method can be employed to legitimately build knowledge in the behavioural and social sciences (Haralambos et al. 2004, Alvesson and Skoldberg 2000).

A diagram may help to clarify (see Figure 1). Natural science knowledge is accumulated through the application of the scientific method, which we here equate with the positivist paradigm (see shaded area). The same can also be said for behavioural science and social science if one is adopting the S_1 perspective. However, S_2 offers greater possibilities to accumulate behavioural science and social science knowledge, through recognising the scientific (S_2) contribution of interpretive and critical research in some branches of behavioural and social sciences in addition to that of positivist research. We will return to a consideration of design science in relation to these other sciences later in the paper.

		Positivist	Interpretivist	Critical
Natural Science	S_1			
Behavioural Science	S_1			
	S_2			
Social Science	S_1			
	S_2			

Figure 1: Mapping scientific perspective against paradigm

What is a Paradigm?

March and Smith (1995:253) use the term 'species' of science when referring to natural and design science, but do not offer a definition. Thus we assume it was meant to refer to a type, or category or grouping. In assigning paradigmatic status to this division by referring to the behavioural science paradigm and the design science paradigm, Hevner et al. (2004) have seemingly elevated the discussion to a different plane. It is essential to our argument that we understand what is meant by the term 'paradigm', and hence, whether it is appropriate to assign paradigmatic status to both behavioural and design sciences, for example, both of which, we would argue, are essentially bodies of knowledge generated through rigorous, scientific (both S_1 and S_2) research. Is a paradigm the same as a body of knowledge?

In common usage, a paradigm refers to a typical pattern to be followed, or model, or exemplar (Dictionary of Sociology 2005). The application of this connotation into academic circles is attributed to Kuhn (1962) in his seminal publication "*The Structure of Scientific Revolutions*". Paradigm thus becomes associated with terms such as theoretical perspective (Crotty1998), worldview (Deshpande 1983), research tradition or orientation (Deetz 1996), ontological and epistemological assumptions (Schultz and Hatch 1996, Guba and Lincoln 1994), and implies a conceptual and philosophical framework incorporating the methods and tools by which researchers conduct investigations into areas of interest, the problems of interest, and the means by which research is evaluated (Dictionary of Sociology 2005, Burrell and Morgan 1979). Note that a paradigm is thus not the same as an accumulated body of knowledge within a discipline. A paradigm is not a conflation of knowledge and method, but refers to the epistemological, ontological, and methodological set of assumptions through which knowledge can legitimately be derived through rigorous, scientific (S_2) research (Guba and Lincoln 1994).

We earlier noted that the natural sciences were broadly investigated through the application of the scientific method to fields under investigation, and thus to abbreviate the statement "the natural sciences which have been investigated through the application of the scientific method as defined by the positivist paradigm" to "the natural sciences paradigm" is not totally inaccurate as the natural sciences have traditionally and remain the

province of the positivist paradigm[1]. In other words, the bodies of knowledge accumulated in the natural sciences were all achieved through the application of positivist assumptions and what became known as the scientific method, and therefore, there is convergence of body of knowledge (*content*) and conceptual and philosophical framework which guides and informs the method by which that knowledge was derived (*paradigm*). Only in the natural sciences is this an unproblematic thing to do, as natural science is that knowledge derived through the application of the methods of the positivist paradigm and hence the conflation of body of knowledge and method.

When applied to human behaviours and societies, the assumptions and methods of science (S_1) do not always serve us as well as they do in the physical sciences (Glanville 1999, Alvesson and Skoldberg 2000), and this resulted in alternate paradigms being articulated, recognised, and applied. Many of the human- and organisationally-oriented disciplines have gone through times of upheaval as alternative paradigms embracing new methods of investigation are proffered, gain traction and became more and more accepted as legitimate ways of building and contributing to a coherent body of knowledge (Lincoln and Guba 2003). However, to ascribe something paradigmatic status such as declaring design science to be a paradigm (Hevner et al. 2004, Vaishnavi and Kuechler 2007) without clarifying the meaning nor articulating the justification for and implications of such a claim may hamper efforts to conduct good research and build a strong knowledge base for our discipline, a point noted by Behling (1978) in his commentary over the state of organisational studies research. Proponents of the multi-paradigmatic position from many different disciplines exhibit considerable convergence in their views on paradigms, and what constitutes different paradigms in their disciplines. For example, Filstead (1979:34) defines a paradigm as a *'set of interrelated assumptions about the social world which provides a philosophical and conceptual framework for the organized study of that world'*. Guba and Lincoln (1994:107) add that a paradigm *'represents a worldview that defines, for its holder, the nature of the "world", the individual's place in it, and the range of possible relationships to that world and its parts'*. Burrell and Morgan (1979:24) argue that paradigms represent the *'taken-for-grated assumptions, the frames of reference, the mode of theorizing and the methods of researching and building knowledge…Each paradigm represents different 'meta-theoretical assumptions with regard to the nature of science and of society'*. Guba and Lincoln (1994) acknowledge that ultimately paradigms must be accepted in faith, as there is no way of establishing the rightness or truth of a paradigm. While we do not argue for paradigms to be regarded as unchanging and perfectly articulated constructs, neither can we accept that any difference in opinion or divergence from current paradigmatic orthodoxy in a discipline should be ascribed the status of a new paradigm. Difference of opinion, world view and research practice does not necessarily need to be viewed as a paradigmatic difference, or as representing a new paradigm (Bostrom 2004).

We conclude that a paradigm is not the same as a body of knowledge: this is the case irrespective of discipline or field of study. In talking about the natural sciences, there can appear to be a convergence between accumulated bodies of knowledge in disciplines and the paradigm of positivism, because natural science is defined by the positivist worldview enshrined in the scientific method, rather than by an object or field of study. This is not the case in the behavioural and social sciences. We will return to this point later when we discuss the paradigmatic status of design science.

What is Design?

Establishing what we mean by 'design' intrigues, in the sense that most of us have a strong intuitive sense of its meaning, yet there is substantial diversity and breadth in its formal definition when a dictionary or thesaurus is consulted (Buchanan 2005) (see www.thefreedictionary.com/design for examples of this diversity in definitions and synonyms). This position is essentially confirmed by Blevis (2004:1) who writes that: *"From the literature on design, one learns that there are a number of competing notions of what design is. To some, it is an art, to others, it is a science, and to others it is a reflective practice."*

Design generally refers to some object, entity or artifact, and this serves to emphasise that the design is a human creation, is generally of utility, and the result of intentional activity (Dipert 1995, Hilpinen 1995). This type of definition, where the focus is clearly on the designed artifact has been called the '*product view of design*' (Marxt and Hacklin 2005:414). Definitions of this type, however, causes angst in some circles, where there is a tension perceived between the *product* of creation and the *activity* of creation. For example, Miller (2004) asserts that the product of creation is an entity, an output of design, but is not design itself. Thus, from this perspective, a chair is a chair, an output of designing a chair, but a chair is not itself a design. Thus, in contradistinction to the product view of design is what could be called the process view of design: design is a process, a series of thoughts and activities by which an artifact is created and realized (Andreasen et al. 2002, Miller 2004). Miller

[1] We note some variants within the positivist paradigm, but would assert these still embrace the broad understanding of the scientific method.

(2004) emphasises the importance of broad thought processes in design activity, including insight by which a designer is able to see connections between problem (challenge) and possibilities, intuition and hunches, and reasoned problem solving, which are synthesized throughout the design process. Close to the process view of design would be design as a practice delimited by the design task (Hooker 2004), or engagement directly in a specific design activity (Fallman 2003). This view of design emphasises the situatedness of the designer in a real-world context involving uncertainty, ambiguity and value conflict (Fallman 2003, citing Schon 1983), and appears akin to the notion of design as professional practice (Friedman 2003). For the purposes of this paper, the definition of design adopted is that of Buchanan (2005:504) who argues that *"Design is the human power of conceiving, planning, and bringing to reality all of the products that serve human beings in the accomplishment of their individual and collective purposes"*. This view of design supports both the product, process and practice view of design.

Design Problems and Solutions

In writing about the nature of design problems, Archer (1979a) argues that a design problem is not the same as a statement of requirements. Rather the problem that underpins the design process can be conceptualised as the obscurity that surrounds requirements, the practicality of envisageable "provisions" (a term used by Archer (1979a) to refer to possible part, or emergent solutions or designs, or what Cross (1992:5) refers to as '*solution conjectures*') , and the misfit that may occur between requirements as perceived and articulated provisions. The solution that emerges is ultimately the provision that offers an acceptably small residual misfit (see (a) in Figure 2), and an acceptably small degree of residual obscurity of requirements (see (b) in Figure 2).

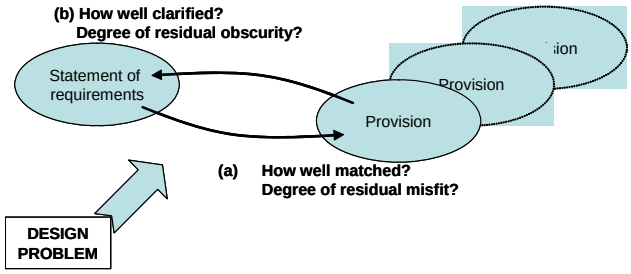

Figure 2: Conceptualising the design problem

Thus design as an activity gets conceptualized as an oscillating conceptual and practical activity, with thinking and activity swinging between clarifying requirements (reducing obscurity) and articulating provisions that match the requirements to varying degrees, until a solution that satisfices the problem owner emerges (Archer 1979a) (see Figure 3).

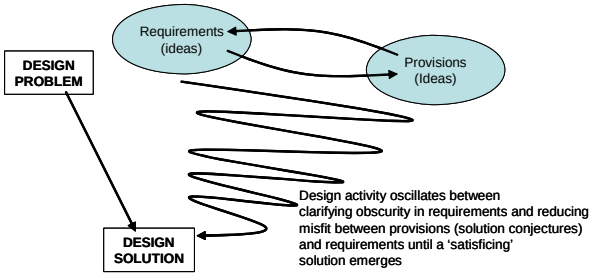

Figure 3: The oscillating nature of the design process

The implications of conceptualising design and the design process in this way in a specifically IS context will be discussed subsequently.

What is Design Science?

Design as we have defined it is thus not delimited to a single discipline or field of study, but is interdisciplinary (Blevis 2004), integrative in nature (Friedman 2003), and can be regarded as a domain-independent, meta-discipline which subsumes domain specific knowledge of design and design practice. This is described by Gasparski and Strzalecki (1990, in Cross 1992:3) as *"a federation of sub-disciplines having design as the subject of their cognitive interests"*. For clarity we describe this as design as an area of scholarship and acknowledge that this is a fundamentally different conception of design. Indeed, as an area of scholarship, design is placed alongside in type to Science and the Humanities as two other distinct areas of scholarship (see

Figure 4). It is not our intention to re-ignite the Science-Humanities debate here, nor to comment on how clear cut a distinction there exists between them, but rather to argue that design can be thought of at a high level as knowledge of the material culture or artificial world, counterbalanced by knowledge of science and knowledge of humanities (Archer 1979b).

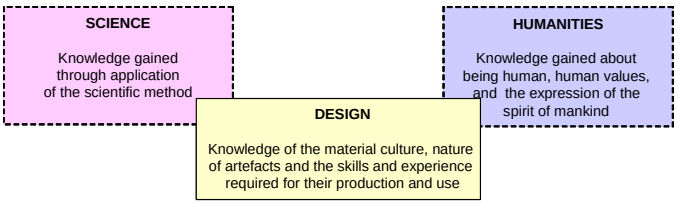

Figure 4: Design as an area of scholarship (from Archer 1979b)

From this perspective, design science can thus be defined as the science of the material culture (Archer 1979b) or artificial world (Cross 2001), the study of the skills, experience, expertise, values, technologies and knowledge involved in design. An immediate question that arises is the nature of this 'science': are we referring to design science$_1$ (DS_1), a body of knowledge that has grown through application of the scientific method to design-type problems, or DS_2, a systematically and rigorously generated body of knowledge built from multi-paradigmatic enquiry? Cross (2001)[2] draws a clear distinction between DS_1 and DS_2. Cross (2001:52-53) argues that the DS_1 perspective has been concerned with the articulation of a *"design method"*, a rationalized version, with possible slight variances, of the scientific method for the context of design, and concludes from this S_1 perspective that *"design science refers to an explicitly organized, rational, and wholly systematic approach to design; not just the utilization of scientific knowledge of artifacts, but design in some sense as a scientific activity itself."* However, Cross (2007) bemoans such attempts to 'scientise' design, supporting Grant's (1979) view that *"the act of designing itself is not and will not ever be a scientific activity"*. Cross (2001:53) goes on to discuss DS_2, suggesting that the science of design *"refers to that body of work which attempts to improve our understanding of design through "scientific" (i.e. systematic, reliable) methods of investigation…the study of the principles, practices, and procedures of design…includes the study of how designers work and think, the establishment of appropriate structures for the design process, the development and application of new design methods, techniques and procedures, and reflection on the nature and extent of design knowledge and its application to design problems"*.

Design Science in Information Systems

The preceding discussions have some critical implications for IS: should we promote DS_1, or argue that DS_2 offers greater scope to progress the discipline? Should we focus on design as product, process, or practice, or on all of these? Previously, it has been argued that the prevailing orthodoxy currently in IS is promoting a DS_1 perspective as its agenda (McKay and Marshall 2005, Carlsson 2006), and it was earlier argued in this paper that DS_2 offers greater scope and diversity, with Roth (1999:20) noting that *"for a relatively new profession, diversity of opinion and approach could be a productive state if it leads to further explanation and new ways of thinking"*. Given this sentiment, it seems critical to encourage a DS_2 body of knowledge to grow that helps build our understanding and knowledge of design product, process and practice in IS.

What emerges for the IS design science research community to consider are at least three things. First, we need to acknowledge and embrace the sociotechnical nature of design in IS. Second, we need to broaden our horizons from a primary, indeed an almost exclusive focus on technical artifacts, to the range of human activities involved in the production, implementation, and acceptance (use) of technical artifacts embedded in sociotechnical systems. The organisational context for IT is not merely the situation in which the IT is finally implemented and used, but it is the primary guiding influence on shaping and informing the design activity (Roth 1999). Third, we need to recognise the importance of relationships between designers (or actors in the design process), designed artifacts, and the contexts in which those artifacts are deployed and adopted. The designer in an IS context occupies many roles requiring many attributes (see Figure 5), and must build relationships with a variety of other actors (including users, clients, consultants, and the like) who are likely to have different experiences, backgrounds and cultures to the designer. What an IS designer is and does, we would argue, give insights into aspects of design worthy of rigorous enquiry.

[2] Cross (2001, 2006) uses the term 'Design Science' to refer to what we call DS_1, and 'Science of Design' to refer to what we call DS_2.

Figure 5: Roles of IS designer

The process of design in IS may be illustrated in two stages (see Figure 6). We can conceptualise design as arising from a problem, an idea, a need, or an opportunity, for example. There follows an intentional process of conceptually designing a system artifact, which results in some sort of plan, model, and/or specification. Following that, there is some sort of realisation process, in which the conceptual design is transformed into an artifact of utility.

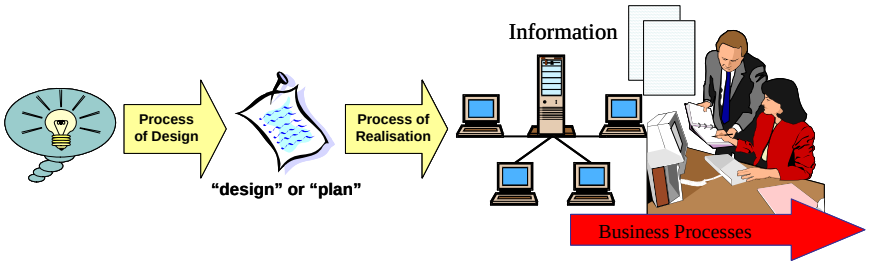

Figure 6: The process of design in IS

From an IS perspective however, this view is perhaps a little simplistic, and other key concerns need also to come under the rubric of design. These could be called 'design-process design' (van Aken 2005), or the design of the entire process of design, which we would equate with the concept of systems development or acquisition methods. Such methods are in fact ways of scoping or structuring or designing the overall process by which we design & construct IS artifacts. Of note also is the fact that throughout this overall process, several different artifacts are designed and used for different purpose by different people. Furthermore there is a complex set of relevant relationships that need to be considered (see Figure 7). For example, the person or organisation that 'owns' a problem that needs to solved, may well, as a client, engage the services of a business analyst. The business analyst may be an employee of the same organisation as the client, or may be external to the organisation. The proposed solution to the problem may involve some organisational restructuring, some reskilling, and the like, together with the development and implementation of an information system. Both the developer of the proposed solution and the end-user of the resultant IS may or may not be in the same organisation as either the client or the analyst. This chain of interacting people and design activities can be quite complex, involving a number of different artifacts, each of which must be interpreted and understood and related to its purpose at each stage. All of these are integral parts of the overall design activity, a position supported by Mumford (1995:4) who notes that "*technical design is only one part of a large, complex, design process which includes everything that both interacts with the technical system and surrounds it in the total design task*".

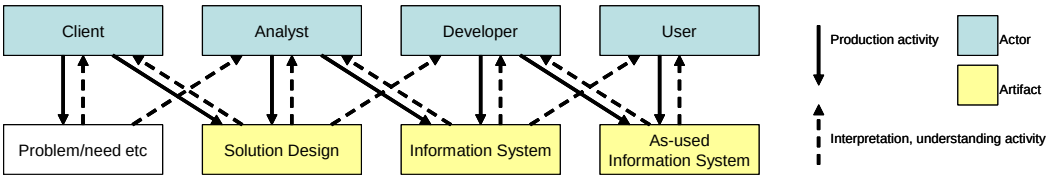

Figure 7: Complex interconnections between actors and artifacts in IS design (adapted from Galle 1999)

In sum, we view the focus on a technical artifact, stripping away context, as unhelpful in advancing the IS discipline, and particularly worrying when this becomes construed as design science research. Rather we suggest that a much broader view of design science in IS, drawn from the perspectives of Boland (2004), and Boland and Lyytinen (2004), which firmly positions design activity in IS in a sociotechnical context, and argues that misguided attempts to split out the technical artifact fundamentally impacts and alters the sociotechnical system. Further we would argue that design research should embrace research efforts involving researchers,

practitioners and users, and to this extent, can be viewed within the realm of action research and collaborative practice research (Mathiassen 2002).

Design Science Research in Information Systems

In many disciplines with arguably greater maturity in design science, there has been a notable trail in which early design science research efforts were grounded in the scientific traditions of the natural sciences, with positivist values and approaches. Over time however, there appears to grow an increasing recognition that other research traditions offer possibilities to better understand the full gamut of issues and concerns confronting designers and design researchers within particular disciplines. This phenomenon is well documented in the diverse literature of Engineering (Marxt and Hacklin 2005, Andreasen et al, 2002), Management (Friedman 2003, Van Aken 2005), Industrial Science (Cross 2001, 2007, Roth 1999), and Management Science/Operational Research (Avenier and Nourry 1999, Cross 2007), for example.

IS thus seems poised at the crossroads. Do we continue with the predominance of the DS_1 perspective investigating primarily the technical artifact, or do we recognise the sociotechnical core of our discipline and embrace the more inclusive DS_2 traditions? From our perspective the latter is preferred, not just because it offers greater inclusivity and diversity which we regard as important. Rather, the designer is an inextricable part of a design, irrespective of whether the interpretation of design is as product, process or practice. Designers are not objective and value-free – to quote Buchanan (2005:504) designers *"possess values and preferences, beliefs about what is good and bad for human beings, and an array of intellectual and moral virtues and vices that constitute personal character"*. If as researchers we intend to understand the oscillation (practice) of design activity, the interactions between various actors, between artifacts and between actors and artifacts in the design and realisation processes, the roles played and the attributes required of designers, and the impacts that IS design artifacts have on their contexts of their use, then it seems reasonable that DS_2 will enable a broader spectrum of enquiry to flourish, and will require the articulation of new methods of rigorous enquiry. Incorporating human-centered approaches may also, however, result in more successful and compelling research outcomes (Roth 1999).

In other disciplines, a range of methods are adopted in DS_2 research (see Table 1). These different approaches reflect differing philosophical views about the nature of the world and how knowledge of that world can be built, and methodological issues are somewhat secondary to issues of paradigm. Adopting a DS_2 view acknowledges that the existing positivist, interpretivist/constructivist and critical paradigms offer multiple methods (and the inevitable new variants) suited for research into design science in IS. Further, it clearly implies recognition that design science itself is not a paradigm, but a body of knowledge, most usefully built through the application of a variety of methods.

Table 1: Examples of research methods in design science research (from Cross 1992, Glanville 1999, Roth 1999)

Positivist	**Interpretivist/Constructivist & Critical**
Lab experiment	Interview
Simulation	Participant and non-participant observation
Survey	Case study
Observation	Protocol analysis
	Participatory research
	Ethnography
	Action research

Conclusion

This paper has examined various conceptualisations of design, design science and design science research, with a particular focus on what would constitute useful perspectives for the IS discipline. Design was examined from the product, process and practice-based viewpoints. A combination of these viewpoints was argued to be the most suitable for the IS discipline. In reaching this conclusion, it was noted that design in IS is a complex social task involving several roles or actors, including client, analyst, developer and user, and further, involving a number of possibly complex relationships between these actors and between the actors and the artifacts designed and produced. In IS, design as product, process or practice should be viewed as embedded within an organizational setting, and thus may have many psychological, social, cultural, political and value-based dimensions.

Design science, it was argued, is best viewed not as a rigorous practice based on the strict application of the traditional scientific method, but as a broad and encompassing body of knowledge. Further, because of the fact that design, and in particular design in IS, has diverse human and organisational aspects, it was argued that this

body of knowledge must be built through a design science research approach that employs a diverse set of methods including those from the paradigms of positivism, interpretivism and critical theory. Thus, design science, is not, as argued in several prominent papers, a paradigm with a guiding philosophy and methodology, but is a multi-paradigmatic area of scholarship that offers a useful lens on the study of information systems.

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