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A Review of Design Science in Information Systems

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Abstract

This paper gives an appraisal of recent writings on design science in the information systems discipline. The authors believe that the new emphasis on design could be an insightful way to look at the discipline as long as the focus and emphasis of design science is broadened from a technical software engineering perspective to include and embrace the necessary social and organizational considerations. In addition, some potential confusions that surface in the recent design science publications are discussed, including conflating design activity with research. We argue that a reappraisal of some issues of concern may be required to ensure that design science fulfills its promise of building knowledge of design and improving practice in information systems.

Key Words

Design science, design research, research paradigms

INTRODUCTION

In recent years, there has been a rise in interest in topics such as design science, design research, and the like amongst the Information Systems (IS) fraternity. This is evidenced through the appearance of recent publications in the prestigious *MIS Quarterly* (Hevner et al. 2004, Markus et al. 2002), a number of papers in a recent special issue of *Journal of Information Technology Theory and Applications* (Walls et al. 2004, Goldkuhl 2004, Hooker 2004), the appearance of a page IS World devoted to this topic edited by Vaishnavi and Kuechler (http://www.isworld.org/Researchdesign/drisISworld.htm), a keynote address by Lee at the 11th International Conference on Information Management in 2000 (http://www.people.vcu.edu/~aslee/ICIM-keynote-2000/ICIM-keynote-2000.htm), together with a smattering of other papers appearing in various reputable IS publications (for example, Gregor 2002, March and Smith 1995). In an applied discipline such as IS, such increasing interest in aspects of design is encouraging, given our research domain involving the design, development and/or acquisition, implementation and use of sociotechnical systems in organisational contexts and business environments. It thus seems important that as a research community, we attempt to better understand design science and its fundamental nature and scope. This would also imply a requirement that we attempt to determine also how best one conducts enquiry in design science, and from this, articulate what might be regarded as constituting sound research in design science.

Of concern however, and hence the motivation for this paper, is that as interest in design science and design science research grows in IS, there is evidence of a lack of clarity in our understandings and endeavours. We feel that a discussion on some of these differences in perspective is warranted, not to put design science in a positivistic 'box' in which all elements of interest are perfectly and immutably defined and prescribed, but rather, through initiating dialogue via this paper, to bring about greater understanding, robustness and credibility in the outcomes of our research

in this field. The aim of this paper is thus to disturb and challenge some of the orthodoxy about design science and design research which appears to be taking hold in the emerging literature, and hopefully to thus spark a debate in which a broader range of perspectives and positions can be aired and debated. Our major concern is the overly narrow framing of design science research and interests currently, and an objective here is to challenge that framing, and argue that a different perspective is required.

In this paper, we intend to build an argument which will suggest the need for a reappraisal of design science in IS, if this is to become a sound, valuable addition to the knowledge base and research activity in the IS discipline. The paper is organised as follows. In the first section, we discuss some of our concerns. Specifically, these concerns relate to whether design science is currently conceptualised adequately in terms of its scope, whether design science can fairly be called a paradigm, whether current writing in design science is in danger of perpetuating an impoverished view of IS in organisations, whether there is a risk of confusing design as problem solving with design science research, and whether research approaches in design science are being adequately conceptualised. The paper concludes with a brief discussion of how thinking about design science might be expanded and thus become an important frame through which we build knowledge and improve practice in information systems.

POINTS OF CONCERN

Understanding the Scope of the Design Science

A number of early scholarly debates in IS often focussed on paradigmatic indignation and called for a softening of the positivist grip on IS research (Fitzgerald et al. 1985), an acceptance of pluralism in IS research (Landry and Banville 1992), and these were often accompanied by discussion of how legitimate IS research could and should be conducted, and thus, on research methods appropriate to advance the knowledge base of the discipline (Galliers 1991). Boland and Lyytinen (2004) note that the polarization around paradigms has largely diminished, with the discipline now challenged and possibly struggling with the diversity of perspectives, modes of enquiry and approaches to data collection and analysis. Boland and Lyytinen (2004) assert that such diversity results in a loss of identity or certainty as to what exactly constitutes IS as a discipline. This is evidenced in the more recent interest in defining the core of IS (Rowe et al. 2004), calls for attention and prominence to be given to the IT artifact (Weber 1987, Orlikowski and Iacono 2001), and concerns about the lack of a unifying theory of IS (Hamilton 2004). Accompanying this discussion has been an increasing recognition that IS is concerned with design: much of what we have historically taught and researched has been on the design of IS (Walls et al. 1992, Mathiassen 2002), and thus there have been calls for more research into design, and thus for the articulation of design theories and the building of a design science (Hevner et al. 2004).

Design science is often acknowledged of having its origins in architecture and engineering (Au 2001, Power 2004). In engineering, for example, design science is defined as *"a problem solving approach which entails a rigorous, systematic study of the deliberate ordering of components in our Universe"* (www.bfi.org). In contrast to this, Hubka and Eder (2005) write that the goal of design science is to explore the design process with the ultimate aim of creating a taxonomy organising, storing and referencing knowledge about both the design process and the designed object. For Hubka and Eder (2005), design science was seen as clearly residing in the positivist paradigm, with the requirements of 'good' natural science informing the practice of research into either the design processes or the design object. These sorts of origins seem to have been influential in IS, where we read that *'design science is technology-oriented'* (Au 2001), and *'design science research is about building innovative technology systems'* (Power 2004), and also that '*design science attempts to create things'* (March and Smith 1995). Thus we encounter a pervasive view that design science is about 'things' and the things or artifacts of interest in IS are technical systems (such as DSS or GDSS (Hevner et al. 2004)) or aspects of these technical systems, such as data models and CASE tools (March and Smith 1995).

If however, one turns to design science and design research as promulgated in the arts, one detects an attitudinal difference in definition. For example, Lunenfeld (2003:11) writes that '*design research regularly participates in the redefinition of the design process away from the stand-alone object and into the integrated system…By moving away from "mere styling" of the product itself and into the interlocking systems that manifest, support, constrain and envelop products, designers can rightfully lay claim to a much farther-reaching contribution*'. Of interest for the IS discipline is the determination to clearly embed or situate the designed object or artifact into its surrounding context, and acknowledgement of the 'irremovability' of that context. Lunenfeld (2003:13) goes on to argue that '*very often*

it is the sensitivity to social context and cultural moment that makes the results of the design research resonate with a public or a market'. We urge you to contrast that position with the perspective articulated by Hevner et al. (2004:82-83) who openly state that *'we do not include people or elements of organizations in our definition [of the IT artifact]…artifacts constructed in design science research are rarely full-grown information systems that are used in practice'*. In other words, the IS perspective on design science is perilously close to removing the 'socio' from the sociotechnical system, so we can engage our fascination with the purely technical (while occasionally acknowledging a context somewhere out there in which we have little other than a cursory interest).

In contrast, we support those proponents of the view that IS is a sociotechnical discipline (Hirschheim 1985), and feel discomfort when this is conveniently subdivided into two separate components, a knowledge of machines or technology or artifacts separate from a knowledge of organisations or human societies and behaviour, with the notion that IS is somehow at the 'intersection' of these two domains of knowledge (Gregor 2002). Surely what separates IS from say, computer science (which sits firmly in the machine domain), and psychology (which sits firmly in the human behaviour domain) is the 'situatedness' of the machine in the social system. It may be conceptually handy to pull these domains apart and examine each bit in isolation, but we would assert that the essence of IS lies in the contextualisation of the machine in the social system.

Often the proponents of design science draw inspiration from the work of Simon (1996, originally published in 1969), and his espoused ideas on the designed artifact. An artifact may be defined as *'any object made by humans with a view to subsequent use'* (Macquarie Concise Dictionary 1998:54). This definition emphasises two important aspects of artifacts: that they are creations of humans and therefore not naturally occurring, and that they have utility. If IS is agreed to be a sociotechnical discipline, and thus differentiated from computer science and software engineering (for example) through a focus on sociotechnical (or system) artifacts, this encourages us to consider and research not just the technical artifact, but the system artifact and its situated utilisation in a particular wider sociotechnical context. Arguably then, the task of IS researchers is not to seek ultimate truths or grand theories or universal laws, but to recognise, understand and elucidate practices with respect to transforming situations (by the responsible application of artifacts) into more desired states, taking account of context and the uses for which people may appropriate such systems. Indeed, this argument parallels that of Simon with regard to organisations and management: managers, in creating structures, writing plans, developing processes, policies and procedures and the like, are designing – they are creating designed artifacts: they are (hopefully) responsibly construing and shaping problem spaces and designing artifacts in response to that problem construction (Boland 2004). These designed artifacts, when implemented in the target organisation, form part of the improvement of the problem space or situation. There are almost always other concomitant people, process and organisational structural changes that are just as important and relevant to improving the problem situation as the designed technical artifact. For IS researchers and practitioners, this emphasises the need for broad interest and involvement in design, and the need also to identify the assumptions, values and perspectives of designers as they work to ameliorate problems. How problems are formulated, structured and represented ultimately shapes and influences how a designed artifact may address the perceived problem (Boland 2004, Rosenhead and Mingers 2001). Thus, analyzing and defining problems from multiple perspectives needs to be regarded as a critical and inseparable part of designing (Mitroff 2004), and therefore of design science. It is interesting to note that research and practice of this nature has been conducted in IS for some time, particularly in Scandinavia, as collaborative practice research exemplified through reflective systems development (Mathiassen 2002).

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, informed from the arts rather than engineering, and drawn from the perspectives of Simon (1996), 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 as a Paradigm or Discipline or What?

Design science is sometimes acclaimed as a paradigm in IS. For example, Hevner et al. (2004:75) write: *'Two paradigms characterize much of the research in the Information Systems discipline: behavioral science and design science. The behavioral-science paradigm seeks to develop and verify theories that explain or predict human or organizational behavior. The design-science paradigm seeks to extend the boundaries of human and organizational*

capabilities by creating new and innovative artifacts…In the design-science paradigm, knowledge and understanding of a problem domain are achieved in the building and application of the designed artifact.' Following this assertion that design science is a paradigm, there is little discussion or justification provided for such a claim, other than to suggest that the design science paradigm owes its origins to engineering and Simon's influential work and that it is in essence a problem solving paradigm. Vaishnavi and Kuechler (2005) draw on their collective personal experiences to describe design research as a *'research perspective'*, and place it alongside other research perspectives, positivism and interpretivism. We thus interpret their use of the words 'research perspective' to equate with others' use of the word 'paradigm', but note that there is little justification for this claim.

Adequately understanding what is meant by the word 'paradigm' is not a simple matter. Arguably to ascribe something paradigmatic status 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. 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), although we note the tendency in social research for there to be a slight blurring of paradigmatic boundaries and some interweaving of perspectives (Lincoln and Guba 2003).

In selecting a paradigm to set the context for enquiry, researchers are guided in terms of philosophical assumptions about enquiry (research) into items of interest in the world and in the methods, research instruments and tools appropriate for use in a particular study. In addition, guidance is also offered in terms of notions of quality or rigour or appropriateness of approaches to enquiry and hence the validity of research outcomes and findings (Denzin and Lincoln 2000). IS research is often characterized as being constituted by three paradigms: positivist, interpretivist and critical (Orlikowski and Baroudi 1991). More recently, a participatory paradigm has been proposed (Breu and Peppard 2003). These generally bear striking resemblance to the paradigms proposed in psychology (Ponterotto 2005), organisation studies (Burrell and Morgan 1979), and social science (Lincoln and Guba 2003). It is not proposed to delve into lengthy descriptions of these categories here other than to note that there are striking parallels across disciplines in framing paradigms. None of these paradigms approach what Vaishnavi and Kuechler (2005) are describing as the design science or design research paradigm.

Analysis of proponents of the design science paradigm reveals some concerns with their arguments. For example, Vaishnavi and Kuechler (2005) argue that design research produces understanding, which is *'knowledge that allows prediction of the behaviors of some aspect of the phenomenon'*. Thus we seem to have potentially a mix of an interpretivist perspective (understanding and insight) with the positivist (prediction and control). Vaishnavi and Kuechler (2005) also fail to adequately justify the theoretical assumptions with regard to the nature of science and of society in their assertion of design research as a paradigm. If design science enjoys paradigmatic status, then this would imply attendant types of enquiry and research methods by which knowledge is acquired and theory constructed. However, as we seriously doubt its paradigmatic claims, we would prefer to assert that design science can be progressed through enquiry informed by positivist, interpretivist, critical and participatory paradigms, and thus a broad range of research methods are potentially available to be employed. March and Smith (1995) and Hevner et al. (2004) appear representative of the prevailing view in design science in promoting a positivistic approach to the evaluation of design artifacts through mathematical formalisms or experimentation (reliance on subject groups using a design artifact within semi-controlled environments). However, it is conceivable that interpretivist researchers could also engage in rigorous research to better understand the impacts of design artifacts in real world contexts, while critical researchers might be interested in considering and changing the impact on power relations following changes to sociotechnical systems caused by the introduction of a design artifact, and so on.

We conclude that design science is not a paradigm, but a body of knowledge of great interest and relevance to IS. We would argue that this body of knowledge can be advanced through a range of different modes of enquiry, thus contributing to the diversity that is currently embraced within the IS discipline (Boland and Lyytinen 2004).

Perpetuating an Impoverished View of Information Systems and Contexts

The functionalist paradigm has long dominated research and thinking in the IS discipline, and despite calls for broader perspectives (Lee 1999) and more industry-relevant research to be undertaken (Applegate 1999), and suggestions that IS is inclusive of a variety of research traditions and approaches (Boland and Lyytinen 2004), rational and mechanistic views of and assumptions about organisations, people, information and technology are still overwhelming in much IS research and practice. This pervades despite concerns expressed about the high rates of failure and disappointment with implemented systems in organisations (Monteleagre and Keil 2000), and identification of contradictory and at times antagonistic goals enshrined in information systems artifacts in organisations (Ngwenyama and Nielsen 2003). Our concern is that by narrowly conceiving of design science and design science research as being about 'the box', and approaches to building 'the box', we are once again falling into the traps that have beset IS for decades, and are in danger of enshrining an impoverished and excessively narrow view of systems in our research agendas. We would argue that design science and the research that builds that body of knowledge must acknowledge that IS is fundamentally about human activity systems which are usually technologically enabled, implying that the ***context*** of design and ***use*** is critical, and that research paradigms, practices and activities must embrace such a worldview. Thus we would assert that the position of Hevner et al. (2004:83) is worrying, in that it implies that one can separate the technological artifact from the people and the organisational context for which it is being designed. Further they go on to argue that *'artifacts…are rarely full-grown information systems that are used in practice'* but suggest that one is still able to prove feasibility of both the product and the design process. This again suggests a view that it is possible to separate out the technical artifact from the organisational context which gives rise to the need for the artifact, and one wonders how indeed feasibility can be fully established without the need for deployment in the context for which the artifact was designed to be used. The context of use must inform the design, and thus must also form part of any evaluation of either the technical artifact or the process by which that artifact was designed and built. Failure to acknowledge this critical point is a failure to learn from sociotechnical systems theory which can inform our thinking in two important ways. One is that any intervention in a system should consider the entire system. The second is that any attempt to optimize the technical subsystem without considering the larger human activity system may result either in a suboptimal solution or an infeasible outcome (or artifact) (Lee 2000). The situation is not helped by Markus et al.'s (2002) claim that IS design research is not a 'radical departure' from established practice and research into IS development, but simply formalizes, justifies and extends the practice of prescribing development approaches for various system types. This is because without a radical departure, the existing, impoverished, excessively technical orientation of much ISD research will continue, and will not be made better by being re-badged as design science research.

Another concern about design science research stems from its apparent failure to respond to changing organisational realities with respect to IS. Recent decades have seen increasing commoditisation of hardware and software in organisations, with attendant increases in the practice of purchasing software packages and implementing them in organisations. Associated with these implementations are thus questions about the efficacy and suitability of business processes embedded in the software for the particular organisational context and business environment, with much IS activity focussed now on issues of configuration, customisation and integration of software packages with the business and technical architecture of an organisation (Shanks et al. 2003). Much less bespoke software is being developed from 'first principles'. Accompanying these sorts of changes to the way we acquire IS has been an increased trend to outsourcing and offshoring of IS services, where IS managers in organisations must make increasingly complex decisions about the appropriate mix of internal, outsourced and offshored service provision and delivery, driven both by cost concerns and the need to be overtly seen to deliver business value to the organisation and its key stakeholders (Benson et al. 2004). Thus, the design activity that typifies the work of many modern IS professionals involves decisions about IS architectures and infrastructures that support and enable the business, about developing appropriate IS structures and relationships in an organisation to enhance the likelihood of achievement of business goals and objectives, and decisions about sourcing strategies with respect to obtaining and delivering the required IS solutions and services to support the implementation of business strategy and business operations, such that value is clearly captured and delivered from investments in IS (Marshall et al. 2005). These design activities also need to be acknowledged as rightly finding a place in the research activities undertaken and supported in IS.

If we are to avoid perpetuating an impoverished view of organisations and people in IS research, then we would argue that it is critical that design research is seen as embracing the full range design activities demanded of the modern IS professional, and does not fall into the trap of perpetuating the view of the computer nerds in dark rooms with pizza and coke being pushed under the door as they feverishly design technically-complex and challenging technological artifacts while paying little or no attention to organisational context and use by humans.

Confusing Research Method with Problem Solving Method

Hevner and March (2004:109) write that the goal of design science research is *'the development and evaluation of technologies'*. A similar stance is adopted by Power (2004:2) who argues that design science research is *'about building innovative technology systems…and evaluating them'*. This seems profoundly confusing. These authors are asserting that the goal of research is to develop, or build, or evaluate, for example, whereas we would assert that the goal of research must be to conduct research into something. If we read that the goal of design science research was to undertake *research* into the development and evaluation of technologies, or *research* into building innovative technology systems, then this would seem reasonable.

This is not the first occasion in IS when we witness this type of confusion. What is occurring here is confusion between an interest in conducting research into an area or object of interest on the one hand, and an interest in what we will call broadly 'solving a problem'. Design science, as we have discussed, has as its aim a focus on designing, building and/or developing an artifact. It is thus concerned with the conceptual design, the process of building, and the emergent artifact in response to a perceived problem. It seems reasonable that design science research could involve research enquiry into any aspects of the conceptual design (plan), the approach to building, or the designed artifact and its efficacy for a particular organisational context. However, there are clearly two distinct activities here: one involves the 'doing', the other, research into the 'doing'. In recognizing two sets of interrelated activities, parallels can be drawn between this aspect of design science research and action research.

In discussing potential confusions arising in action research, McKay and Marshall (2001) noted a similar confusion. Action research requires of researchers that through their enquiry they both act to ameliorate or improve a situation perceived to be problematic in some way by its owners or stakeholders, while also generating new knowledge, insights and understandings as a result of their activities. Thus action research is argued to need to be viewed as comprising two interlinked cycles or sets of interests, the problem solving interest and the research interest, which are somewhat contingent on one another and need to be each progressed satisfactorily through the action research intervention (McKay and Marshall 2001). In urging researchers to acknowledge the dual imperatives of action research, it must be remembered that this distinction between problem solving and research is drawn at a conceptual or analytical level. At the practical level, researchers and participants engage in making changes to systems of human activity in all their richness and complexity, and thus, action and research become inextricably intertwined (Bannister et al. 1994).

Likewise, in arguing that researchers should consider there to be dual interests in design science research, it must be stressed that the distinction between 'designing' and researching 'designing' can be quite subtle, and more easily and appropriately separable at a conceptual level than at a practical level. Design researchers are not merely designing an artifact to solve or ameliorate a problem: they are also charged with conducting research into some aspect or dimension of the design activity relevant to a particular problem solving space. Acknowledging the potential for conceptual distinction that may be much more blurred in real life, then raises to the fore and encourages discussion of the notion of suitable research methods for design science research.

Research Methods for Design Science Research

It is considered outside the scope of this paper to venture into discussions of what constitutes research (as opposed to other activity such as consultancy), and what constitutes knowledge. For the purposes of this discussion, we will argue that research is a process by which information is collected, analysed and interpreted to meet specific research objectives and/or to answer specific research questions (Kumar 1996). It should be characterized as deliberate, systematic, empirical, critical, credible and confirmable. The outcome of this activity we here call 'knowledge'. We deliberately differentiate knowledge from what we call 'experiential learning', that learning which results, often serendipitously, from reflective action in the real world. In this regard, we support the assertions of Davenport and Markus (1999:21) who argue that consulting (for example) should be respected *'as an alternate way to acquire and share knowledge'*, but feel the outcome from this activity needs a different label from that knowledge which may be an output of a well-designed piece of research, implemented through a rigorous application of method. Thus,

designing systems, for example, may result in experiential learning, but for it to be argued to be regarded as design research, we would argue requires some pre-meditated decisions about what the research interest and/or objective is and about data that might be gathered and analysed so as to provide some credible and plausible research outcomes and thus contribute to building a body of knowledge (McKay and Marshall 2001). So we would argue that designing may be construed as research (but is not necessarily so) only if there is a deliberate attempt to undertake design as an approach to real world problem solving which is constructed also as a well-designed programme of research. If design research is to occupy an important place in building the IS discipline's knowledge base, then rigorous and deliberate ways of enquiring into the design process and outcome need to be articulated and agreed upon by the community of research scholars.

While Vaishnavi and Kuechler (2005) attribute Hevner et al. (2004) with articulating a process for design research, we would disagree. Hevner et al. (2004) articulate some guidelines for design science research, stemming from its problem solving orientation, and then list some appropriate approaches for the evaluation of the designed artifact: they do not, in fact, propose a method or process for the conduct of design research. Vaishnavi and Keuchler (2005) do offer a method, but this appears to focus primarily on the problem solving intent of design research more than it does on rigorous enquiry. We would argue that insights from action research may again prove helpful here. As argued in the previous section, design science researchers face the dual challenge of solving a real world problem while at the same time conducting rigorous research. Thus underpinning the design science domain is the necessity of recognizing and sustaining the need to design with the intention of ameliorating a perceived problem or taking advantage of an opportunity while researching to generate new understandings and insights into the process and outcome of design activity. We argue that such design research should be informed by the existing body of knowledge in IS design science. An idealized research process, cognisant of these dual challenges is offered in Figure 1 below.

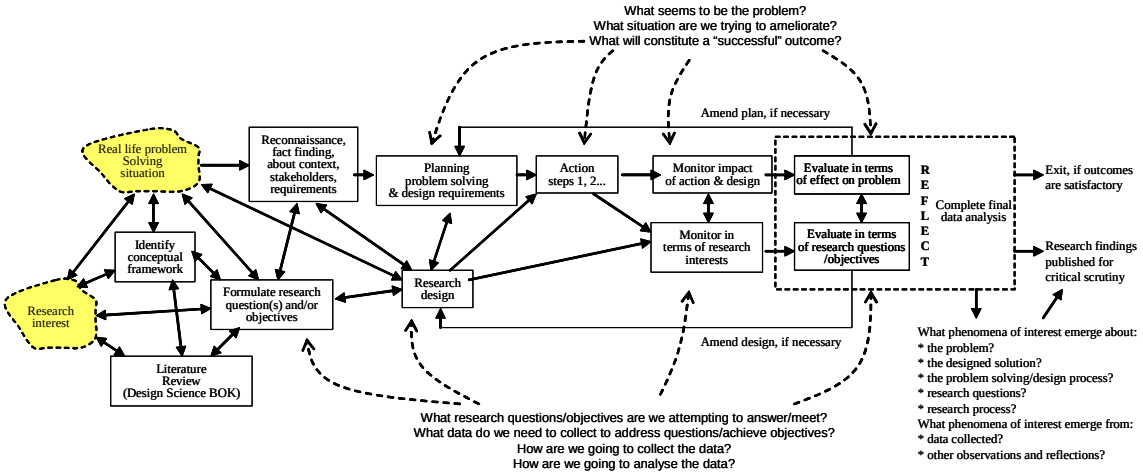

Figure 1: An ideal process for the conduct of design research

HIERARCHY OF ENQUIRY IN DESIGN

We would argue that a hierarchical classification of the full range of concepts (and artifacts) of interest to IS researchers is helpful in clarifying the nature of the discipline, hence its research interests, and the potential contribution of design science research. Behling (1978, drawing in part from the work of Simon 1962) suggests that the concept of a hierarchical system (composed of interrelated subsystems until some elemental level is reached) is helpful in identifying the domains of study of a particular discipline. Drawing on the system proposed by Behling (1978) for the discipline of organisation studies, we offer the following hierarchical system (see Table 1) to define the IS domain, and hence bound its research interests.

Level	Focus and Comments
Component	Issues associated with individual components of an Information System, including hardware, software, information, people, telecommunications, method, tools, techniques, and the like. IS researchers operating at the component level must recognise that this subsystem is subsumed within primary group, organisational, interorganisational and societal systems. Researchers operating at the component level must find a way to distinguish themselves from the work of software engineers and computer scientists, for example, whose research interests would be predominantly at this level.
Primary System Group	Issues associated with the working system implemented in a work group, including relevant business processes, within an organisation
Organisational	Issues and impacts of IS within a single organisation and its business environment
Interorganisational	Issues and impacts of IS across multiple organisations and supply chains, and their collaborative business environments
Societal	Issues and impacts of IS on larger societal groupings

Table 1: Hierarchical levels of investigation in Information Systems

IS is not necessarily unique in terms of these levels of interest, but rather distinguishes itself from many so-called reference disciplines in its interest across all these levels rather than being concentrated in one. Thus computer science, software engineering and psychology are primarily concentrated in the component level, management primarily at the group and organisational level, and sociology at the societal level, for example. Thus, how IS researchers working primarily at the component level distinguish themselves from SE and CS researchers is an important question. IS (and hence IS research) is somewhat distinguished by the fact that it is concerned across all these levels, and thus once again, it is the 'situatedness' of IS across these contexts which is vital and must be acknowledged in its paradigms, research methods and research activities. We would argue therefore, that an interest in design can be manifest in IS research at any or all of these levels. Current literature tends to focus only on design research issues and activities at the component level. Our view is rather that design research in IS needs to be broadened dramatically in its conceptualization, and can be usefully and instructively conducted at and across all levels. If design research is conceptualized as being concerned with the creation of artifacts (in the broad sense previously discussed), then such artifacts can, and indeed should be investigated at multiple levels.

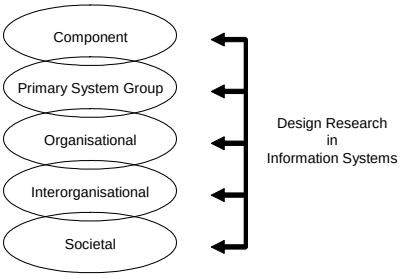

Figure 2: Expanding the scope of design science research

We would thus argue that a concentration by design science researchers at the component level is far too narrow. Rather, a design perspective in researching a range of IS artifacts at multiple levels provides a richer, and ultimately more fruitful, conceptualization from which to build knowledge of and improve practice in IS design.

CONCLUSION

The recent set of publications advocating a design science view of the IS discipline, has, we believe, a number of elements within its advocacy that potentially limit the IS discipline. We have conducted a reappraisal of the elements of the theoretical orientation suggested by these publications, a necessary reconceptualisation, we believe, if design science is to become a viable body of knowledge and design research a valued contributor to building knowledge and improving practice in IS.

The recent design science publications have too often adopted a positivistic and, we would argue, a limiting and problematic perspective for IS research. This orientation has been heavily focused on the technical software engineering perspective of the IS discipline. We have argued that these viewpoints need to be complemented by and extended by an interpretivist and social constructionist viewpoint of the IS discipline, so that the discipline retains and expands its hard-won pluralistic nature. Further, it is not just the way of looking at the world which needs to be broadened, but the focus of design science needs to be expanded from its intense concentration on the system as defined by the working software, with organizational impacts as a secondary focus, to embrace a holistic view of working software as an element of an integrated system involving people, business processes, organizational structure and strategy, and technology working synergistically to improve organisational performance. We have rejected the assertion that the design science is a paradigm, arguing instead that the paradigm being adopted by the contemporary writers on the design science is predominantly the positivist paradigm. If advocates of design science wish to put forward design science as a new paradigm for IS, then the case needs to be made for such an assertion. Finally, we have criticised the unfortunate confusion of research method (research into design) with solving the problem (designing a solution). While we may learn from the reflective practice involved in carrying out design activities as part of improving a problem situation, this does not make it research. However, research into design would need a research method and a focus that included the planning and design of research activities such as data collection and analysis. We have suggested many parallels to the dual imperatives of action research and put have forward for consideration, an idealised process model for design research.

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