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Design Science Research: A call for a pragmatic perspective

Dirk S. Hovorka
Bond University

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Dirk S. Hovorka
Bond University, Australia

Abstract
Information systems design has long been concerned with improving utility, efficiency and effectiveness â a markedly rational functionalist perspective. Applying a broader view of design paradigms reveals that information systems have a generative capacity, which enables reframing and recasting reality to enable human action based and support multiple values. Viewing Design Science Research through the lens of pragmatist philosophy reveals that broadening the ontological foundations for design theory and evaluation can increase our understanding of how people actually interact with technology to achieve ideographic goals. The secondary design of information technologies and community-based Geographic Information Systems are offered as examples for which demonstrates a pragmatic perspective enriches design directives.

Keywords: Generative Capacity, pragmatic, design science research, geographic information system, secondary design

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Pär J. Ågerfalk, Mark Aakhus and Mikael Lind

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Abstract

Information system design has long been concerned with improving utility, efficiency, and effectiveness--a markedly rational functionalist perspective. Applying a broader view of design paradigms reveals that information systems have a generative capacity, which enables reframing and recasting reality to enable human action based and support multiple values. Viewing Design Science Research through the lens of pragmatist philosophy reveals that broadening the ontological foundations for design theory and evaluation can increase our understanding of how people actually interact with information technology to achieve ideographic goals. The secondary design of information technologies and community-based Geographic Information Systems are offered as examples for which demonstrates a pragmatic perspective enriches design directives.

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Introduction

Design Science Research (DSR) has gained acceptance as a significant research approach in Information Systems. The discipline of IS has always contained a significant intellectual focus on designing systems for functional goals and the emergence of DSR lends legitimacy and credibility to IS as a field. But the current emphasis on guidelines for design science and on the structure of design theory presents the risk of a narrow functionalist view of DSR that will limit the capacity of information systems to enable human action. This research challenges the IS design community to broaden the ontological foundations of design science to include a wider array of paradigmatic foundations for both design and for evaluation of design theories. A broader ontological perspective is necessary to account for, and support the secondary design of if technological artefacts and to better identify the design principles which will enable, rather than constrain human action.

The core values of IS design science research as promulgated by Hevner et.al. (2004) revolve around IS design as a functionalist problem-solving paradigm. Although some research has recognised alternative perspectives (McKay and Marshall 2007; Niehaves 2007) there is a distinct lack of design research incorporating other design paradigms (Hirschheim and Klein 1989). The emphasis on business requirements constrains the design of information systems and privileges measures of utility and efficiency in the evaluation of design. This narrowing of consideration for what information systems should do and for what people actually do with information systems, may ultimately diminish the ability of research to contribute to develop design theory for the broad class of systems with which people engage in their information lifeworld.

This research begins to address this issue by identifying an alternative perspective, pragmatism, which shifts the focus from a rational–functionalist design and evaluation perspective to and emphasis on how information systems can be designed to support human action. Two examples, the secondary design of information systems and community based Geographic Information Systems are provided as examples how a pragmatic perspective opens the theoretical focus of design activities. Finally, the implications of inclusion of a pragmatic perspective in design science research are discussed.

Pragmatism: An Alternative Foundation for Design Science Research

An alternative to the rational functionalist paradigm which is coming to dominate design science, is to align of information systems design with pragmatic philosophies of Dewey, Pierce, and James which focus on system interventions that 'work' (Goldkhul 2004) and that provide potential for human concern and action (Winograd and Flores 1986). From this perspective the emphasis on research guidelines and theoretical structure are deemphasized and the evaluation of design – when, for what, and for whom is an information system useful becomes a primary focus. Thus design can be seen as contributing to knowledge as it can be applied in the service of action (Romme, 2003) and then is evaluated based upon value-driven goals measured over time. Design shifts from a predictive

mechanism to a generative process incorporating system dynamics, because the design process incorporates information technologies as a component embedded in complex social processes. The information system is not simply an artefact to be designed and then appropriated "as is", but rather is an assembly of things and people whose selection, configuration, implementation, and use is a generative process itself. This notion aligns with the emerging body of literature which views information systems design as a situated social action (Gasson, 1999). The processes by which such design occurs may be indeterminate and emergent, but not incomprehensible. To better understand these processes researchers need to develop theories and research methods which will help identification of opposing forces, and permits the analysis and interpretation of how complex socio-technical processes change (Robey and Boudreau 1999).

Secondary Design and Design as a Generative process

Two examples help illustrate the applicability of pragmatics to design science research. First initial research of the secondary design of information technologies in the context of use provides a basis for understanding the evolutionary trajectory for systems to fit changing problem domains, task specifications, and user interests (Germonprez et al. 2007; Hovorka and Germonprez 2009). Second, a greater interest in design as a generative process (Avital and Te'eni 2009), positions design as the production of information processes which enable humans to accomplish goals in line with their own values. These two examples provide the further basis for discussion of the role of pragmatics in design science.

Secondary Design

The IS discipline has been seeking definitive "theories" of design which help us build a clear, unambiguous artefacts. Gregor (2006) suggests the goal of design theory is to give explicit methods, techniques, and principles for artefact construction. But in observing the everyday engagement with information systems we regularly see unexpected events, behaviours, and features of systems that fall outside the scope of the original specifications (Ciborra 2002). Observations of use patterns reveal irregular, often contradictory behaviours and improvisational approximations of the designed uses. It apparent that the mindset that people will encounter and inhabit technology just as it was designed and will faithfully appropriate technology into their information lifeworld obscures the role of humans who are trying to accomplish a variety of contextual goals. The emphasis on a rational, method-driven design approach simply does not account for ongoing everyday information processes.

Initial research on tailorable technologies suggests theoretical principles of design which support tailoring and which are embedded in the system during the design and development of the system (Germonprez et al., 2007). This suggests the possibility that technologies may be adopted, used, and tailored for goals not anticipated by designers. These principles suggest how the design of tailorable information systems can support the expectation that users will modify the system in the context of

use. More recent research applies the concept of tailoring to describe the process by which end users modify information systems to fit their own tasks and use patterns. This second phase of design takes place when users discover new technologies, interact with them, and design them to fit their changing needs and circumstances (Germonprez and Zigurs, 2009). Users are acting as secondary designers by tailoring information processes in the ongoing creation and recreation of information environments. Current structural specifications and guidelines for design theory have not created theories that account for the phenomena of secondary design despite the recognition that the task domain is modeled differently by users and designers. (Dourish 2001) and that information systems are often be used in unanticipated ways (Winograd and Flores 1986). Thus, prior design research has recognized that secondary design is likely to occur but has not explained how or why it occurs.

GIS and Generative Design

Geographic Information Systems (GIS) are used for communicating scenarios or stories which illustrate patterns in spatial or location-based data, thereby imparting knowledge which may not have previously been evident. One strength of GIS is its capacity to integrate information from disparate sources into a summarized form that is more comprehensible than its separate parts. Whereas the majority who encounter GIS often see only the end-product of a GIS analysis in the form of a map, GIS provides mechanisms to input, aggregate, derive, and synthesize the totality of information depicted in that map. GIS is comprised of a powerful set of tools for collecting, storing, transforming, retrieving, and displaying spatial locations and attributes (Burrough 1986). Furthermore, a human GIS analyst provides the vital link of active intelligence, enabling the discrete components of the GIS to accomplish or produce a coherent analysis based on needs of end users. GIS analyses provide a particularly powerful means of portraying ideas, in part because it is often more simple and effective to interpret information through pictures, such as two-dimensional (2-D) maps, charts and 3-D visualizations, than through words. Three-dimensional renderings may be even more captivating and engaging for interpretation of scenarios than 2-D maps, as they enable swift comprehension. GIS can thereby assist assimilation of information by allowing participants to envisage current, alternate, or future frames of reference.

As human communities seek to address issues of climate change, sustainability, resilience, and greater involvement in relevant affairs, the ability of community members to participate in generative decision making is expanding. IS Design Science increasingly is recognizing the growing need for using information systems to create “new ways of being that did not previously exist and a framework for action that would not previously made sense” (Winograd and Flores 1986, p. 177). The Generative Capacity perspective on design (Avital and Te'eni 2009) represents a shift from the functionalist emphasis on problem solving, utility, and efficiency, to a pragmatic emphasis on the potential for human action, and a neohumanist highlighting of emancipation from existing social order and the potentiality of change (Hirschheim and Klein 1989). Community-based GIS provide generative

capacity in a community's ability to produce new configurations and reframe mental models for sustainability, as well as to challenge the status quo of what is frequently a top-down process of development (Avital and Te'eni 2009). Specifically, the convergence of a number of factors has changed the information landscape regarding communities' options to pursue sustainable values, rather than politically dictated patterns of growth, development, and functionalist goals. These factors include public access to a wide variety of environmental, geophysical and biodiversity data, Web-based provision of geographic information system services, and low cost analytic programs. Furthermore, there is a widening recognition that sustainability requires decision-making on dynamic systems, not merely events or states, and perhaps most importantly, an increasing desire to reduce a long-standing information asymmetry between local communities and government or corporate decision makers. Traditionally, development, resource utilization, and conservation decisions have resided with regulatory authorities. But in some parts of the world, particularly Australia, there is momentum toward supporting participatory resource planning that has been reflected in legislation and funding in resource management and rural development (Walker et al. 2002).

We suggest that creating a community-based GIS is not limited to the design of an artefact. Instead, it encompasses a broad design process that itself is a socio-technical system which can serve as a generative force for emancipatory social activism supporting local definitions of sustainable values (Rattray 2006). We put forward the view that GIS development and use at a community level is a potentially constructive social process, and not simply a tool designed to solve the problem of translating spatially referenced information into cartographic representation of patterns and relationships (Obermeyer 1998).

Design as Value Definition

The design of all information systems is ultimately teleological – systems are designed for a purpose. But if the goal of a community GIS is to develop an information centre which will guide decisions toward values of sustainability and resilience, researchers and communities must reach a consensus regarding what is meant by "sustainability." Meadows (2008) asserts that that economic growth is recognised as a major component to virtually all problems. But many leaders misunderstand the nature of systems and feedbacks and make decisions which push communities in the wrong direction. Growth *per se* is not sustainable and resilience of human communities cannot occur independently of environmental concerns. As pointed out by Fiksel (2006), the more efficient a company becomes in terms of its use of resources, the larger the rebound effect, resulting in a larger ecological footprint. The same situation occurs in communities, except that the growth drivers are both economic and population based. In addition, the behaviour of built and natural systems over time is quite often non-linear and therefore difficult to predict and control (Folke et al. 2002). Therefore, sustainability and resilience must include long-term measures of community health, environmental health, and economic health, not merely growth in all areas.

In many cases, the word sustainability is used by government agencies, property developers, and resource extraction industries to describe sustained (rather than sustainable) markets, sustained housing developments, or sustained mining, as if unlimited growth is possible. Communities, on the other hand, may be far more interested in intangible goals such as sustaining, maintaining, or preserving quality of life, desired neighbourhood characteristics, community economics, view sheds, environment, noise levels, or development/agriculture/conservation ratios. Furthermore, disillusionment with the *status quo* may embolden other communities to better understand proposed changes to, or implementation and application of, government regulations and their implications for land use. Other communities may be looking to move from passive acceptance to leading from within—to better develop their awareness of local resources and their inherent value, or to better understand emergency preparedness, or to develop independence from government or corporate control of utilities, food, or other life necessities. Climate Change awareness has generated the desire to reduce local contributions to a carbon footprint (Australian_Government 2007), and to incorporate building practices designed within regional climactic context (Department of Public Works 2002). Some communities are looking for a 'voice' as a better means of communicating local knowledge of place, to be represented in decisions being made about their community. In addressing some of these concerns, or at least with more awareness of them, communities may feel better equipped to respond to change, while sustaining or maintaining their unique character and the way of life they value.

Recent conceptualizations of sustainability increase the emphasis on social and environmental values, requiring a shift in the underlying paradigm of design and evaluation of information systems. Our current design science attitude trivializes the generative capacity of systems by focusing on a functionalist paradigm of design and evaluation. An example comes from the current discussion of sustainability as being based on the "triple bottom line" of economic, social, and environmental dimensions (Figure 1). The usual emphasis (Figure 1 Left side) is placed on economic measures at the expense of the other dimensions. A pragmatically informed approach to value creation may lead communities to balance social and environmental concerns with economics.

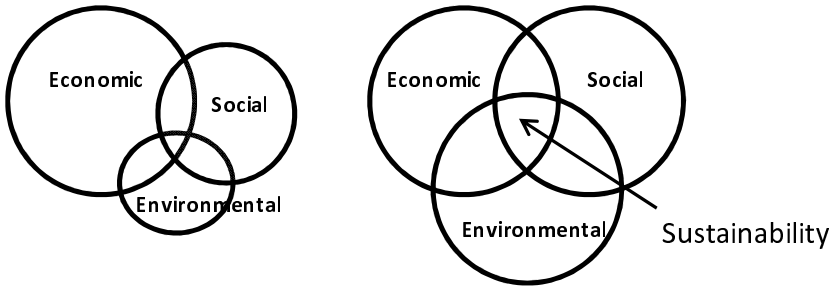

Figure 1. Non-utilitarian Value Creation

This conceptualization obscures alternative design paradigms such as the pragmatic basis of enabling human action or the neo-humanist goals of emancipation from organizational or social power

structures (Hirschheim and Klein 1989). The figure suggests that environmental and social well-being are amenable to the same type of simple utility measures as economic health. The perspective of generative capacity provide a design attitude that permits the design and evaluation of the information system to support the reconfiguration of sustainability dimensions without excluding alternative non-utilitarian ethics values. The design consideration of community GIS provide system attributes which support boundary spanning, creativity, multiple perspectives, serendipitous findings, and non-exclusivity.

Community-based GIS has the potential of reducing power-based information asymmetries and enabling community stakeholders to understand the alternative and provide inputs to the process that will put forward their own intangible values over the traditional profit/efficiency values which many IS systems support. As GIS tools become web-enabled and easier to access, information asymmetry is reduced and the decision-making process becomes less centralized (Figure 2). But a major impetus for the shift has been the desire by communities to have a greater input in the decision-making process, and by an increasing interest in community sustainability and intangible values. This allows for the co-generation of values such as sustainability and resilience among members of a community and also between the community and external entities.

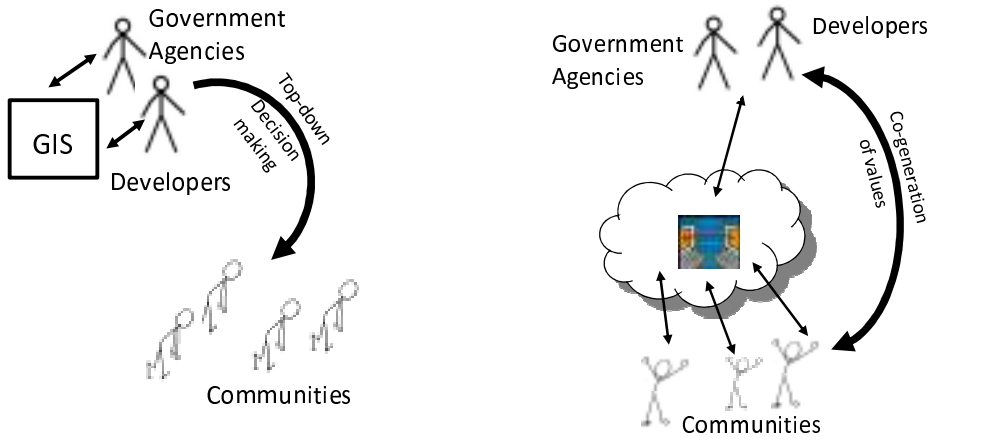

Figure 2 – Realization of GIS in Support of Generative Capacity

One of the most generative mechanisms of community GIS is exhibited in its use for planning support. Lieske et. al. (2008) discusses several cases from Australia in which GIS components were utilized in planning support systems which provide information, and outputs that were used to enlighten the planning tasks. Specifically, the capabilities to develop 3-D visualizations of proposed changes and the capability to build scenarios allows stakeholders to visualize and assess alternatives.

In several instances, the community was able to influence the direction of development plans through their input (Lieske et al 2008).

Development of sustainable values in a Design Science framework requires an expansion of the fundamental philosophy, shifting from a singular focus on rational functionalist design/evaluation to pragmatic fulfilment of multi-dimensional human actions which are informed by human values (Goldkhul 2004). The design and use of community-based decision processes can be informed by the concept of generative capacity (Avital and Te'eni 2009). Here the emphasis is on contextually new possibilities and configurations. This will involve divergent thinking to create multiple models of options that may not have a single optimal solution (Avital and Te'eni 2009). Importantly, the design of information systems that enable generative capacity is characterised by their ability to evoke new thinking, and to be adaptable to multiple use patterns and tasks.

The evocative features of visualization, simulation, and communication are natively supported. Prior studies of community-based GIS also reveal two additional characteristics of which support generation of alternatives. The ability to incorporate local knowledge and user-generated data into multiple layers which can be added or hidden means the IS is non-exclusive. The ability to incorporate diverse views with presentation of contradictions and disputes democratizes the decision-making process and may potentially lead to increased buy-in of the decisions. In addition, the GIS can be empowering by providing a locus of data, representation, and discussion around which values and goals can be identified. The rationale underlying alternatives, values, and decisions can be represented and communicated in the system, thus preserving the history of processes for future reference. This can be a valuable asset as community contexts change and new choices require attention.

Discussion

This research emphasizes that incorporating a pragmatist perspective in design science research will broaden our ability to theorise about systems which fulfil a range of goals beyond the constraints of our current functionalist emphasis. Secondary design and community-based GIS can be considered processes which can have a generative capacity for change and action, rather than stable, unchanging material artefacts. This shift in design attitude de-emphasises the identification of the problem domain, and the kernel theories which will 'solve' the specific problem, relying instead on identification of assets, opportunities and values. In addition, the evaluation of systems is not based on utilitarian business performance measures, but rather on a more pragmatic philosophy in which actions and values are social constructions situated in context. Systems can be used to surface competing interests and values and a variety of knowledge interests (Goldkhul 2004). Dring secondary design, people inhabit information systems and made redesign the technology at linguistic, presentation, and functional levels. Although such secondary design is constrained by the underlying technology and by social norms, the design-in-use occurs through users' interactions with the reflective and active environments embedded in the technology (Germonprez et.al 2007). In the case

of community GIS, "when community-based projects have empowerment as part of their mission...they help people, accomplish existing tasks and also build capacity..." which enables the acquisition of transferable knowledge and skills (Rattray 2008 p 30).

Further research will be needed into the contexts in which *the information process* enabled by the system influences outcomes in a positive direction. Much research in IS naively assumes that the information systems will have deterministic and positive impact. This type of technical determinism may indeed occur for well defined problems that are more amenable to 'solutions' through automation of ongoing processes. But in realizing long-term values incorporating intangible aspects such as sustainability, communities are constantly changing. The actual stakeholders may change and the values of the stakeholders may also change as economic conditions, environmental factors, population, and numerous other factors are played out against the backdrop of evolving community values. Although the design process may overcome technical and economic barriers to community GIS, Design Research would benefit from bounding the conditions under which GIS helps stakeholders with divergent values arrive at consensus – a generative social process.

This research contributes to the discussion in three ways: First we put forward the view that a pragmatic perspective in Design Science Research for information systems shifts the emphasis to enabling human action and supporting a wide range of values beyond functionalist values of utility and efficiency. Secondary design is a process which directly influences people's ability to act by modifying the mediation of information processes in the attainment of goals. Community-based GIS have the potential to encourage and support long-term sustainability and resilience as communities strive to meet the twin challenges of climate change and rising energy costs. A key issue lies in reframing the goal of design science to look beyond the technological artefacts to include the processes which enable human action. Design must therefore include how/when/why humans will use technologies in situated contexts. In addition, the incorporation of a pragmatist philosophy emphasizing human actions and value-creation over traditional utility and efficiency measures changes the criteria by which socio-technical systems are designed and evaluated.

Second, the generative role in reframing and recasting alternatives is evident in both examples discussed. The secondary design engaged by users represents a process by which people try scenarios and alternatives and continue to negotiate meaning. GIS allows even more apparent visualizations and what-if scenario testing and the continued monitoring of economic, environmental, quality of life, and resource allocation measures. The design evaluation process shifts from a one-off event to ongoing evaluation of complex socio-economic-technical systems.

Finally, we propose that the design and use of information systems can provide mechanisms by which users can identify, discuss, and reconfigure values and alternatives. Just as traditional requirements elicitation can help identify key assets, issues, and values, the design and use of the collaborative information systems provides a language and a focus for empowerment, involvement and reframing action and values.

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Office:
Sprouts
University of Amsterdam
Roetersstraat 11, Room E 2.74
1018 WB Amsterdam, Netherlands
Email: admin@sprouts.aisnet.org

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