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ABSTRACT

Over the last few decades, the field of information systems has shown a steadily increasing interest in design-oriented research. This is manifested through the emergence of different ontological and epistemological positions among IS researchers. Some challenges arise from this development, such as (a) a need to understand design-oriented IS research in relation to design-oriented approaches in other disciplines, and (b) a need for design theory representation that targets and is useful to stakeholders in both research and practice. This paper proposes a conceptual framework for understanding design-oriented research, and its implications for research with a focus on meeting the two challenges mentioned above.

Keywords

Design theory, Design Science Research, Design Patterns, Theory representation

INTRODUCTION

Information systems (IS) researchers have shown an increased interest in design-oriented research over the last two decades. Scholars express that design science research is becoming recognized as equally important as behavioral research in the IS field (Hevner 2007; Iivari 2007). Design is even described as "fundamental to the IS discipline" in a recent *MIS Quarterly* special issue on design science research (March and Storey 2008). Ontological issues in design-oriented IS research are currently being debated in special issues in leading journals, conference tracks, and dedicated conference for design science research in IS. Purao et al. (2008) provide a good overview of this development. It has been suggested that we may understand the situation as an emergence of two 'schools' of design-oriented IS research (Carlsson 2007). First, a school of thought exploring the epistemology and methodology of IS design science research (Hevner et al. 2004; March and Smith 1995; Walls et al. 1992; Walls et al. 2004). Second, a school of thought primarily dealing with the issue of how to formulate design theory in IS (Gregor and Jones 2007; Walls et al. 1992; Walls et al. 2004).

Design-oriented research is also an important topic in various related disciplines. One well-known example of this is the concept of design patterns, originally suggested as a representation of design guidance within architecture (Alexander et al. 1977) and popularized in computer science by the 'gang of four' (Gamma et al. 1995). Computer science design patterns typically show generic object-oriented design solutions to common software design problems. A pattern is a generic solution to a class of problems. By applying a design pattern to a problem, a situated solution adapted to the problem may be rapidly developed. A pattern is thus a way of packaging re-usable design knowledge. Design-oriented human-computer interaction (HCI) researchers have adapted the design pattern concept into that of interaction design patterns (IDPs)—patterns addressing user interface design issues. Several scholars have put forward ideas on how to structure IDPs (Borchers 2001; Folmer et al. 2005; Tidwell 2005; van Welie 2003). Obviously, interaction design patterns and IS design theories represent an interest in design guidance that spans across disciplines. This shared interest between research communities is inadequately addressed. Purao et al. (2008) discusses this type of problem and calls for "bridging the inherent multi-disciplinarity with a common language" (Purao et al. 2008, p. 18).

An additional challenge suggested by Purao et al. (2008) concerns the dissemination of results to multiple audiences. This concerns both the practical utility of research results. Hevner et al, for instance, propose that we need to communicate our research both to technology-oriented and management-oriented audiences. These target groups take different action, and possess different skills, which means that they are interested in different types of design guidance. Additionally, the research community is an obvious target group, given the ideal of research as a cumulative process, building on and contributing to an existing body of knowledge (Gregor and Jones 2007; Hevner et al. 2004). Sutcliffe (2006) suggests that we need to 'unfold' theory so that different actors are only exposed to what they need to know, saving them from irrelevant and unnecessary complex issues.

Winter (2008) proposes an analytic framework that interrelates a number of important issues found in the first 'school' mentioned above. The purpose of this paper is to contribute with a conceptual framework that may serve as an instrument for analysis and structured reasoning about design-oriented IS research generally, without taking the starting point in a specific set of ontological and epistemological assumptions. Implications for research are discussed, with a focus on the challenges to design-oriented research discussed above. The term *design-oriented* research is used in order to be inclusive, with respects to different strands of research. As a response to the challenge of multi-disciplinarity, we argue there is a need to understand various design-oriented research strands and their relation to one another.

The paper is structured as follows: The next section discussed core ideas in three strands of IS research. This is followed by a presentation of the framework for design-oriented IS research concepts. The three strands are interpreted using the framework, followed by a discussion on how to represent design-oriented research results. Conclusively, the contribution is summarized, along with a discussion on implications for research.

THREE STRANDS OF DESIGN-ORIENTED RESEARCH

A review of the literature on design-oriented research in IS reveals three different strands, which are sometimes depicted as being quite distinct or even incommensurable: (a) Information Systems Design Theory (ISDT), (b) Interaction Design Patterns (IDP) and (c) IS Design Science Research (DSR). While (a) and (c) corresponds to the two 'schools' mentioned above, (b) has not received the same attention within IS as in the field of human-computer interaction. We would argue that, although different, these three strands share similarities but highlight different ideals, and that they when viewed together represent a large number of design-oriented IS research concepts.

Information Systems Design Theory

In their award winning article on the anatomy of a design theory, Gregor & Jones (2007) deal with how to represent theory in design-oriented research. Although the use of the word theory is debated in design-oriented research—March & Smith (1995), for example, propose that we should rather speak of *constructs*, *methods*, *models*, and *instantiations* as products of design-oriented research—we adopt Gregor & Jones' (2007) notion of design theory in this paper for practical reasons. Gregor & Jones (2007) propose that a design theory should be described using the following eight aspects.

First, a design theory must address its *purpose and scope*. Said Gregor and Jones, "[…] The set of meta-requirements or goals that specifies the type of artifact to which the theory applies and in conjunction also defines the scope, or boundaries, of the theory." (2007, p. 322) A design theory should inform the reader of the type of problem to which it provides a solution. This part of the theory description is a contextualization: a definition and demarcation of the applicability of the theory.

Second, *constructs* of the core concepts of a design theory should be defined. A design theory should clearly state the meaning of its "entities of interest" (Gregor and Jones 2007).

Third, a design theory consists of *principles of form and function*, addressing the conceptual solution to the problem: "The abstract 'blueprint' or architecture that describes an IS artifact, either product or method/intervention" (Gregor and Jones 2007). How to formulate principles of form and function in IS design theory has been challenged though. Principles may focus a combination of (a) the characteristics of the IT artifact, (b) the design process—a 'source' social setting where the IT artifact is brought to existence, and (c) the 'target' social setting where the IT artifact will be implemented. This distinction makes clear that different types of measures may be described in a design theory: (a) artifact design principles, (b) principles for adaption of the design process, and (c) principles for induction of change in the organization where the IT artifact will be put into action. Gregor and Jones propose a specific category (*principles of implementation*, see below), to describe the implications of the theory on the design process.

Fourth, since the IT artifact is viewed within its emergent social setting (Gregor and Jones 2007; Orlikowski and Iacono 2001), *artifact mutability* should be addressed in a design theory. Gregor and Jones (2007, p. 322) suggest that an IS design theory should address "[…] what degree of artifact change is encompassed by the theory".

Fifth, a design theory should specify *testable propositions*. Walls et al. (1992) propose that an IS design theory for a product should consist of meta-requirements (a class of goals for the theory), and a meta-design (the conceptual solution to the problem class). A product hypothesis is used to test if the meta-design satisfies the meta-requirements. Further, a design theory for a design process would comprise a design method. Such a design method should result in an IT artifact that is consistent with the meta-design. A design process hypothesis is used to test this. Gregor and Jones' (2007) distinguish between quantifiable and measurable *algorithmic* propositions and more qualitative *heuristic* propositions. The latter were discussed by van Aken (2004, p. 227) in terms of, "If you want to achieve Y in situation Z, something like action X will help." The idea of clearly and distinctly stating design goals at a meta-level provides a basis for evaluating what is achieved

when applying the design theory. Such evaluation may be conducted in different ways; for example, through building an artifact, implementing it in some social context, and then evaluating the results in light of what the theory predicted.

Sixth, some scholars argue that *justificatory knowledge* is needed to explain *why* the theory prescribes specific principles of form and function and principles of implementation, which is important in order to build a cumulative research tradition (Gregor and Jones 2007). However, the necessity of theoretical justification in a design theory has been questioned (Hevner et al. 2004; Venable 2006) and some scholars propose that too much focus on the existing body of knowledge may counteract innovation (e.g. Iivari 2007). Gregor and Jones, however, argue quite rightly that there is always *some* type of justificatory knowledge in design situations.

Seventh, design theory may optionally include *principles of implementation*. To increase its usefulness and credibility, design theory should include advice on how to apply the theory in a practical design situation (Gregor and Jones 2007). That is, there is a need to explain how the design theory impacts the design process. Gregor and Jones uses a well-known example, linked to the relational model of databases where a principle of implementation is the normalization of relations; that is, a number of steps in which specific rules are applied to increase the quality of the model.

Finally, an ideal put forward in IS design theory (Gregor and Jones 2007; March and Smith 1995; Walls et al. 1992) is to provide *expository instantiation(s)* of the theory. An instantiation is a step towards providing evidence to the theory—an instance is required to perform an evaluation. Gregor and Jones put forward the idea that an instantiation of an artifact is optional in a design theory, although it may strengthen the credibility of the theory. The design product as such is also a carrier of design knowledge (Iivari 2007). Thus, the artifact is an important means to communicate knowledge among stakeholders, for example, among researchers and designers.

Interaction Design Patterns

An interaction design pattern defines its *purpose and scope* through descriptive categories such as "use when," "context," "problems," and "forces." Borchers (2001) draws on computer science design patterns (Gamma et al. 1995) and suggests that an interaction design pattern description should include a discussion of forces and counter-forces. This is to inform readers about necessary conditions for successful application of the pattern and obstacles that may militate against its application in particular situations. These forces may be conceived of as an additional "service" to the reader, allowing them to make sense of the circumstances under which the pattern is applicable.

The literature on interaction design patterns suggests several ways of representing the solution to the problem in terms of *principles of form and function*. Solutions are commonly presented as narratives (Tidwell 2005). Borchers (2001) proposes the solution to be shown in several ways: as diagrams (depicting the main idea), as opening illustrations (quickly to allow the reader to get an idea of the pattern), and as detailed solution descriptions.

Interaction design patterns are typically focused on user interface design. However, some researchers increase the scope of principles of form and function to address also *architectural consequences* of the proposed design. It has been argued that the gap between user interface issues and technological solutions need to be bridged (Folmer et al. 2005) and that this can be done by providing a detailed account of (principles for) a technical solution. This will allow for interaction designers to understand better the consequences for implementation of their design suggestions—for example, the implications for IT artifact mutability.

Interaction design patterns typically include some form of *justificatory knowledge*, albeit typically not linked to theory. The human-computer interaction literature is permeated with various types of design guidance. The concept of claims (Sutcliffe 2006; Sutcliffe and Carroll 1999) addresses the need for a sound theoretical grounding in addition to empirical design examples. Dearden and Finlay (2006) explain the difference by stating that "patterns emphasize their grounding in multiple examples of successful designs, whereas claims emphasize grounding in theory." However, although practical utility is mentioned as a means for grounding design patterns, Dearden and Finlay (2006, p. 86) also propose "one of the most obvious weaknesses in HCI research on patterns to date is the lack of substantive evidence of their benefits for actual design practice."

An interaction design pattern typically includes *design examples* that reveal a complete a solution to the problem class (Borchers 2001; Tidwell 2005).

Design Science Research

The work of Hevner et al. (2004) has had a major influence in the design science research strand. Although others have proposed alternative ontological and epistemological positions (Iivari 2007) and suggested that design science research in IS needs to be open to epistemological pluralism given the youth of the paradigm (Niehaves 2007; Purao et al. 2008), we would argue that Hevner et al. (2004) represent this strand well due to the high impact of their 2004 *MIS Quarterly* publication.

Thus, we select their view as a representative of this strand. It should be noted that this it is not our intention to advocate their view of IS design science research; it is used here simply for being well known and for presenting the topic extensively. They advocate seven guidelines for IS design science research as follows.

The first guideline concerns *design as an artifact*. Hevner et al. (2004) explain their view by stating that "[...] we include not only instantiations in our definition of the IT artifact but also the constructs, models, and methods applied in the development and use of information systems." This view of the artifact is clearly in line with March and Smith (1995) who propose that the result of design science research should be expressed as constructs, methods, models and instantiations. Hevner et al. (2004) point out that the IT artifact as such does not include people or organizations, but that IT needs to be designed and evaluated in some social context. Design science research may deal with a mix of technology-based artifacts (e.g. user interface properties), organization-based artifacts (e.g. incentives) and people-based artifacts (e.g. consensus building) to provide solutions to some class of problems.

The second guideline, *problem relevance*, promotes the ideal that design science research should focus on problems that are relevant to practice and also innovative. Researchers should "acquire knowledge and understanding that enable the development and implementation of technology-based solutions to heretofore unsolved and important business problems." (Hevner et al. 2004)

The third guideline advocates *design evaluation*; that is, a design artifact should be evaluated in a rigorous way in order to show its qualities. Various evaluation methods from the knowledge base may be used to assess qualities of the artifact. However, a point is made that some form of relevant and well-executed evaluation is necessary as part of the design process to determine when the design process has found a solution to the problem.

The fourth guideline, *research contributions*, states that the product of design science research may be a design artifact (as discussed above), additions to the knowledge base (constructs, models and methods), and methodologies for evaluation.

The fifth guideline advocates *research rigor*. This is imperative in order to differentiate between IS research and the practice of IS development. Said Hevner (2007), "Research rigor in design science is predicated on the researcher's skilled selection and application of the appropriate theories and methods for constructing and evaluating the artifact." It must be noted that design science research cannot rely solely on the knowledge base, since such an ideal would be counterproductive to innovation. A multitude of sources may complement the knowledge base; for example, existing artifacts and creative insights (Hevner 2007).

Further, a sixth guideline characterizes *design as a search process* with inherent iterative characteristics. The solution to a problem is to be found in a design cycle where design proposals are produced and evaluated until a satisfacing solution to the problem at hand is found (or rather agreed upon by the stakeholders involved).

Finally, the seventh guideline deals with *communication of research*. Design science research should be communicated both to technology-oriented and management-oriented audiences. A number of guidelines for how to 'package' research results in a practically useful way are proposed.

A FRAMEWORK FOR DESIGN-ORIENTED RESEARCH CONCEPTS

Apparently, the categories used in understanding design-oriented research within the three strands laid out above deal with different phenomena and exist at different levels of abstraction. As shown below, these can be further elaborated using three orthogonal polarities as follows.

Hevner et al. (2004) point out that design research is inherently concerned with both research activities and design activities. From the perspective of inquiry as a theory of knowledge (Dewey 1938) these are necessarily intertwined but are still possible to distinguish for analytic purposes. While design activities are primarily concerned with the design of artifacts and their properties and social contexts, research activities are primarily concerned with understanding those artifacts and contexts and the design process. Thus, we make a conceptual distinction between *research* and *design* in design-oriented IS research.

When speaking of design, it is possible to distinguish between the process of design and the product of that design process (Walls et al. 1992). In ordinary speak, both are commonly referred to as design, but distinguishing the two types of phenomena are important in any scholarly discourse on the subject. Thus, we make a conceptual distinction between *process* and *outcome* in design-oriented IS research.

Finally, as pointed out by Argyris and Schön (1974) it is possible to distinguish two different aspects of theory: espoused theory and theory-in-use. The former relates to how we express a theory of action and the latter to how such expressions are used to inform our actions in practical situations. Hence, espoused design theory corresponds to generalized theoretical

notions about design and design research that are put into practice during design research and design activities, producing certain outcomes. Accordingly, we make a conceptual distinction between *abstract* (espoused) and *concrete* properties of design theory in IS research, where the latter includes both theory-in-use and the concrete results (instantiations).

The remainder of this section uses the three polarities as an instrument to construct a framework of design-oriented research categories. Rudimentary combinatorics suggests that given three polarities, eight (two to the power of three) combinations are possible. The design-oriented concepts from the three strands can be mapped onto these as shown in Table 1.

Phenomena	**Abstract**	**Concrete**
Process of design *(Practical utility)*	*Principles of implementation* (ISDT, IDP) *Design as a search process* (DSR)	Actual design process that resulted in an *expository instantiaton* / *design as an artifact*.
Product of design *(Practical utility)*	*Purpose and* scope (IDP) Principles *of form and function* (ISDT, IDP) *Artifact mutability* (ISDT) *Architectural consequences* (IDP)	*Expository instantiation* (ISDT) *Design example* (IDP) *Design as an artifact* (DSR)
Process of research *(Relevance, rigor, innovation)*	*Research rigor* (DSR) *Problem Relevance* (DSR) *Design evaluation* (DSR)	Actual research process governed by and expressed in fidelity to the abstract process of research.
Product of research *(Cumulative research tradition)*	*Purpose and scope* (ISDT) *Communication of research* (DSR) *Research contributions* (DSR) *Constructs* (ISDT) *Testable propositions* (ISDT) *Justificatory knowledge* (ISDT)	Actual research results, expressed in fidelity to the abstract product of research (e.g. a design theory).

Table 1. An Ideal Typical Framework for Design Science Research Concepts

The positioning of design-oriented concepts from different strands within the framework allows us to understand better their meaning in relation to one another. However, it should be noted that the categories in the framework are not part of the framework as such – they are merely represented there in this context, to illustrate how they may be conceived from this point-of-view.

The framework in Table 1 allows for a synergistic understanding of design theory in IS. While recognizing the anatomy of a design theory as proposed by Gregor & Jones (2007), we argue that that such theory (the concrete product of research) should ideally meet the following criteria:

- It is represented in accordance with the abstract research product. The ideal of a cumulative research tradition is promoted this way; scholars and practitioners will recognize the structure and content of design theories. When actually enacted in-use it will of course diverge from the abstract espoused theory.

- It contains a representation of the process of design. The ideal of practical utility is addressed by providing prescriptions on how to work in the design process. The process of design may be expressed both in abstract (i.e. prescriptive instructions how do work; method advice) and concrete (i.e. a well-documented example of an actual design process, based on the abstract espoused theory).

- It contains a representation of the product of design. Here, at the abstract level, the ideal of practical utility is met through prescriptions for how to design the IT artifact and how to induce change in the social setting(s) where the IT

artifact will be embedded. At the concrete level, design knowledge resides in the instantiation, which consequently is a pedagogical means in communicating the design theory to others.

- The process of research is represented in a transparent way to address how the ideals of relevance, rigor, and innovation have been addressed. The abstract process of research is concerned with epistemological and methodological issues, while the concrete research process shows the actual research process. These aspects of the theory, how it came into being, is also important in order for other scholars to assess its contribution to research; that is, to its position in the cumulative research tradition within some paradigm of design-oriented research.

We may also discuss the concept of interaction design patterns in terms of the framework: They are clearly oriented towards the product of design, providing designers with both abstract knowledge (principles of form and function of the IT artifact, with an emphasis on the human-computer interface) and concrete knowledge (design examples). The ideal of *practical utility* appears dominant in relation to interaction design patterns.

IS design science research, highlighting rigor, relevance and well-executed evaluation of artifacts, is clearly focused on the process of research. In addition, there are guidelines for both the process of design (*design as a search process*), and on the product of design (*design as an artifact*). The product of research is also addressed through the guidelines *communication of research* and *research contributions*. Design science research is clearly the one most concerned with the ideals of rigor and relevance in design-oriented research.

CONCLUSION

In this paper, we have proposed a conceptual framework for discussing different strands of design-oriented research and their interrelationships. Three polarities (design v. research, product v. process, and abstract v. concrete) constitute the foundation for structuring the framework. As examples, three commonly cited strands of research within IS and human-computer interaction have been synergistically mapped onto the framework.

The framework provides a structure of concepts at a level that is not limited to a specific set of ontological and epistemological presumptions. Thus, the framework at hand allows us to understand design-oriented concepts based on different value-orientations or ideals, which resonates with recent calls for epistemological pluralism in design-oriented research (Niehaves 2007; Purao et al. 2008). The framework calls for reflection about espoused theory (linguistically expressed abstractions) in four categories, however it does not prescribe what that theory should be. Further, it allows for structured reasoning about the relationship between espoused theory v. the results of the use of such theory; and its use as such. In essence, it is a response to the challenge to "bridging the inherent multi-disciplinarity with a common language" (Purao et al. 2008, p. 18). Another implication for research is that the framework may be used for 'unfolding' theories to make them more accessible for stakeholders due to reduced complexity, as suggested by Sutcliffe (2006). The idea is that a research result, a representation of knowledge, is multi-facetted: We may reveal or conceal different aspects of it depending on the intended target group or the fulfillment of selected ideals for theorizing. The framework provides a structure for communicating research results to different audiences in a structured and well-reflected manner. As such, it may be food for thought for scholars striving to meet the challenge of disseminating results to multiple audiences (Purao et al. 2008).

The three strands, governed by partially divergent ontological and epistemological assumptions, highlight different scholarly ideals. In line with Niehaves (2007) and Purao et al. (2008), we argue that such pluralism is both unavoidable and desirable in the emergence of a tradition of design-oriented IS research. However, to paraphrase Iivari (2007), this is not an attempt to advocating a Gyro Gearloose style of research. On the contrary, this framework aids in reflecting about ideals, and it also points out some directions toward an ontological and epistemological positioning. Such a positioning is a starting point for design-oriented research, and the basis for making important decisions about how to address issues in each category in the proposed framework.

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