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Max Rohde

David Sundaram

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# INNOVATING ON A DIME: DESIGN SCIENCE FOR SMALL TEAMS

Rohde, Max Erik, University of Auckland, 12 Grafton Rd, 1142 Auckland, New Zealand,  
m.rohde@auckland.ac.nz

Sundaram, David, University of Auckland, 12 Grafton Rd, 1142 Auckland, New Zealand  
d.sundaram@auckland.ac.nz

## Abstract

*Disruptive technological innovations often originate from surprisingly small beginnings. Giants of the Internet age such as the omnipresent Google search engine and the Facebook social networking platform have initially been designed and developed by small and independent teams. These examples are attractive to design science researchers in information systems, who desire to deliver new and innovative artifacts. We propose one possible specialization of design science research with the following central characteristics: (1) the research is focused on translating existing theory into industry standard artifacts, (2) the research is driven by small and independent teams, and (3) the researchers closely engage and directly interact with information technology in the design process. Based on the particular challenges encountered in a research project with aforementioned characteristics, we elicit a number of tentative suggestions for similar research endeavors: (1) The research should assure coherence between theoretical claims and artifact features. (2) The design process should be traceable and transparent to allow retrospective conclusions on the interactions and linkages between existing theory and artifacts. (3) The researchers should acknowledge, discuss and reflect on the influences of contextual factors on the science, craft and art of design.*

*Keywords: Design Science Research, Information Systems, Small Teams, Transparency, Traceability.*

# 1 Introduction

The advent of ubiquitous systems, smart devices, and cloud-based web platforms has radically changed the ways in which software systems are designed, developed and deployed. While release cycles for traditional organizational information systems often span years, applications intended for these emerging environments are completed in months or weeks. 10,000 applications per week are submitted to the iTunes App Store<sup>1</sup>; an indication for a pace of technological development unseen in the traditional space of enterprise systems.

Design science is a paradigm with significant potential to channel the results of information systems research into usable and useful artifacts. A robust discussion of this paradigm has resulted in sound general guidelines (Hevner, March, Jinsoo, & Ram, 2004), more specific guidance on the research process and method (Peffer, Tuunanen, Rothenberger, & Chatterjee, 2008; Sein, Henfridsson, Purao, Rossi, & Lindgren, 2011) as well as discussions of ontology and epistemology of design science research (Gehlert, Schermann, Pohl, & Krcmar, 2009; Iivari, 2007; Niehaves, 2007).

Traditionally, design-oriented endeavors in information systems have been focused on large-scale implementation projects conducted in organizational contexts. For instance, Markus, Majchrzak and Gasser (2002) portray the implementation of a novel software artifact founded with a “\$3 million grant” and implemented by “5 computer scientists”. Such research approaches provide valuable insights into organizational realities and their integration with other established paradigms such as action research holds many promises (Sein, et al., 2011). However, today’s fast moving digital spaces might require a further variation to design-oriented research, which reaches beyond the boundaries of traditional organizational contexts and design paradigms.

We argue for such a variation of design-oriented research characterized by the following elements:

- The research is focused on developing theory-driven, generalizable, industrial-strength artifacts.
- The research team is small, independent, and cohesive.
- The researchers closely engage and interact with technology in the design process.

In the following, we first reflect on a number of general requirements for design science research approaches in information systems. In the light of these requirements, we illustrate the motivation for the elements of the variation listed above. We further provide a brief interpretation of some experiences from a research project instantiating this variation. Lastly, we synthesize a number of tentative suggestions to guide this design science research approach.

## 2 Some Key Requirements for Design Science Researchers

The questions that need to be addressed in any design science research project in information systems are doubtlessly manifold. A great number of research articles building on Simon’s (1996) seminal work, the early works by Nunamaker, Chen and Purdin (1991) and Walls, Widmeyer and El-Sawy (1992) provide a rich set of valuable guidelines, methodological approaches and philosophical foundations to address these questions. As a brief reflection on the design science paradigm and its development in the discipline of information systems, we point to a number of key challenges and requirements, which have motivated initial approaches of design science and continue to be taxing issues for contemporary researchers.

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<sup>1</sup> [http://www.pcworld.com/businesscenter/article/182836/apples\\_iphone\\_app\\_store\\_approvals\\_a\\_necessary\\_evil.html](http://www.pcworld.com/businesscenter/article/182836/apples_iphone_app_store_approvals_a_necessary_evil.html)

*Requirement 1: Address discordant requirements of industry and research*

Questions of relevance have doubtlessly moved the methodological discourse in information systems in the recent past. Special issues on design science (Baskerville, 2008; March & Storey, 2008) and action research (Baskerville & Myers, 2004) explicitly advocated increasing the practice relevance of information systems research. However, any attempt to increase relevance must be carefully aligned with the intrinsic requirements for research endeavors. For instance, it has been suggested that research in information systems must uphold a certain level of independence from practical concerns (Baskerville & Myers, 2009; Steininger, Riedl, Roithmayr, & Mertens, 2009). Practitioners in the area of information technology appear to be following fashions of popular technological paradigms (Baskerville & Myers, 2009). From a researcher's perspective, these fashions are problematic as they appear and disappear frequently; while rigorous scientific inquiry requires time and should therewith be directed at long-lasting phenomena. Furthermore, while research aspires to discover intellectual 'blue oceans' (Straub, 2009), practitioners might often be concerned with incremental and/or operational improvements.

*Requirement 2: Follow a rigorous process in the inherently unpredictable search process of design research*

The question of rigor is of fundamental importance for all scientific disciplines and is rooted in the very genesis of science (Gould, 2003). Research in information systems can build upon a wide range of methodologies to achieve rigorous inquiry. Most of these approaches, including design-centered studies, recommend a more or less formal structure providing guidance how a study can be conducted. While such requirements for research projects are desirable to uphold and advance the quality of results in a discipline, a formalization of the research process is not without its own potentially curtailing consequences. Research aspires to discover the yet unknown and is therefore more difficult to plan and formalize than almost any other kind of project. This unpredictability of research complicates the establishment of formal procedures. Many significant discoveries are made in a serendipitous manner (Beveridge, 1980; Rosenman, 2002) and every step of the research process is prone to be affected by sudden instinctual insights of the researcher (Brogaard, 1999). Design, in particular, has been characterized as creative and not an exclusively rational process (Love, 2000). Furthermore, in pursuit of relevance for practice, design-oriented research is subject to the same dynamically changing technological, organizational, environmental, economical and social environments contemporary organizations and individuals encounter.

*Requirement 3: Integrate the dimensions of the technological and social world*

In the context of the philosophy of science and general systems theory, it has been theorized that scientific disciplines enquire about objects on more or less distinct levels of abstraction (Boulding, 1956; Von Bertalanffy, 1976). In contrast, design-oriented research in information systems research is inherently concerned with multiple levels of abstraction (Purao, 2002; Stamper, Liu, Hafkamp, & Ades, 2000), involving both issues arising from particularities of technological solutions as well as the social contexts in which these solutions are deployed (Orlikowski & Barley, 2001). Consequently, even if a researcher in information systems chooses to implement a software prototype, this must be done in accordance with social and organizational theories (Leonardi & Barley, 2008).

### **3 Motivation for a Small-Team Approach to Design Science**

We have provided a brief overview of a number of fundamental requirements in design-oriented research in information systems in the previous section. Although these requirements are not able to reflect on the whole richness of requirements and challenges encountered in design-oriented research, all of them have received considerable attention in discussions of design science and/or other methodologies. Each methodology offers its very own benefits in approaching these requirements. Indeed, all of these requirements have been considered in discussions of design-oriented research. In the following, we reflect on each discussed requirement and portray possible limitations of traditional

design-oriented approaches. In response to these limitations, we outline the central elements of our proposed variation of design science.

The first requirement we described centers on the necessity to meet potentially discordant requirements from practice and research. The fundamental motivation for our approach in this context is that traditional outcomes of information systems, journal and conference articles namely, are often inaccessible and/or unattractive to information technology practitioners (Straub & Ang, 2008). We propose that one possible way to mitigate this situation lies in utilizing design artifacts as possible means to disseminate the findings of the IS discipline into practical contexts. Traditional design science approaches are often limited to a specific organization or are delivered in the form of research prototypes. By focusing on one particular organization, both the unique requirements as well as practices of this organization threaten to undermine the quality and generalizability of the designed artifacts. Research prototypes are often disregarded by practitioners if they do not adhere to established expectations. These factors can possibly be mitigated, if the researcher aspires to deliver artifacts which are both theory-informed as well as following contemporary industry standards.

The second requirement we described portrays the difficulties in amalgamating the unpredictability of design-oriented research with the desirable formal structure for research endeavours. It has been observed that new and innovative products are often developed in less-formal contexts (Highsmith, 2009; Wang & Wang, 2010). In such less-formal contexts, small teams have been argued to be more effective in conducting highly conceptual work (Brooks, 2010, p. 65) as well as to deliver better quality than larger teams (Boehm & Turner, 2003). Most design science approaches do not explicitly consider the size of the research team. Thus, we understand it as one possible specialization to conduct design-oriented research centred on developing new and innovative artifacts in small, independent and cohesive teams.

The third requirement we described in the previous section highlights the need for information systems research to appreciate and integrate social and technological issues. In this context, it has been reported that “over 95% of the articles published in top management research outlets do not take into account the role of technology in organizational life” (Orlikowski & Scott, 2008). Correspondingly, many technology-oriented research outlets do not emphasize the managerial and societal implications of information technology (Glass, Ramesh, & Vessey, 2004). Our essential motivation stems from the observation that the academic discourse in information systems over-emphasizes the social dimension while ‘losing touch’ with technological details (Nunamaker, et al., 1991; Orlikowski & Iacono, 2001). Hence, we propose to focus the research on developing technological artifacts in alignment and informed by organizational and social theories.

## **4 Reflections from Practice**

We have outlined the motivation for a particular approach for design science being focused on (1) translating IS theories into industrial strength artifacts, (2) small and independent teams, and (3) direct interaction with information technology. As mentioned earlier, we do not attempt to argue for this approach as a replacement or superior approach to other research methodologies but only as a possible and sensible specialization under the paradigm of design science.

In this section, we briefly reflect on this approach in the context of one particular project. We specifically focus on a number of key issues resulting from the particularities of a small-team design science approach.

- It has proven difficult to translate IS theories into industrial strength artifacts as many theories are explanatory and not prescriptive in nature. Furthermore, achieving ‘industry standard’ results in a great number of additional requirements beyond traditional requirements in research projects (section 4.2 ‘A Long Way from Theory to Industry-Standard Artifact’).

- The fast-paced research process has turned out to be complex, versatile, and difficult to articulate in strict formal methodologies (section 4.3 ‘A Complex and Versatile Research Process’).
- The process of designing a technological artifact appeared to be as much craft and art as science (section 4.4 ‘Design: Science, Craft and Art’).

Before discussing the abovementioned issues, we will give a brief overview of the objectives and context of this research project.

#### **4.1 Research Objectives and Context**

The practical motivation for the project stems from the observation that there are few tools which allow individual knowledge workers to link pieces of distributed, unstructured information in an easy and intuitive way. Although an increasing number of products, in particular in the domain of the semantic web, provide powerful foundations to establish such semantic connections, these tools often require more advanced technological skills and/or knowledge of semantic modeling.

We reflected on this practical problem using a lens focused on the dissonance between knowledge and technology: while knowledge (from a practice-based view) is inherently emergent and fluid (Orlikowski, 2002; Thompson & Walsham, 2004), information technology is often restrictive and excels with structured rather than unstructured problems. In particular, it has been argued that the mindful application of knowledge requires a careful alignment between provided structures and situational flexibility (Levinthal & Rerup, 2006; Pentland & Feldman, 2005; Weick & Sutcliffe, 2006). The research objective for the study derived from these theoretical foundations is to: *Explore the ability of ICT mechanisms to facilitate sustainable knowledge capability by aligning routines with their structural context. Investigate if and how information technology can adapt to flexible degrees of restrictiveness and autonomy.*

The core research team is composed of four researchers with practical experience in software design, software quality management, and project management. The research interests of team members include knowledge management, model management, decision support systems and ubiquitous computing. The research is supported by a number of small university-level grants. The exchange with a number of industry partners is informal and on a casual basis. This project therefore aligns into the category of being small and independent. Furthermore, the outlined objective is primarily pursued by the design, implementation and evaluation of a novel software artifact (Nunamaker, et al., 1991). This implementation has been informed by an extensive review and synthesis of relevant literature in information systems and related disciplines. Therewith, the project meets the central requirements of the first and third element of the proposed research approach.

The research is organized into three general stages. The first stage focuses on establishing a theoretical and methodological foundation for the research as well as the implementation of an illustrative prototype. The second stage focuses on improving the prototype to meet industry-standard requirements. The third stage focuses on release and dissemination of the created artifact. Currently, the project team undergoes last quality insurance steps before releasing the prototype. Current progress and latest developments are communicated through the project website at [www.linnk.de](http://www.linnk.de).

#### **4.2 A Long Way from Theory to Industry-Standard Artifact**

The first element of the design science specialization mentioned in section 3 requires to deliver industry-standard artifacts in accordance with and inspired by IS theories. The initial scope we set for this endeavor was a focused literature review on a particular class of technology we deemed central to our objective: e-mail in the organizational context (Barreau, 2008; Ducheneaut & Bellotti, 2001). However, we quickly realized that more fundamental questions would have to be discussed to inform the design such as “What makes up knowledge in the organizational context?”, “What is the relationship between knowledge and information?” and “What factors make knowledge useful or

not?”. Although these questions are extensively discussed in the literature, there is often considerable disagreement on these matters. For instance, some understand knowledge as something, which can be transferred, stored and possessed, while others see knowledge as inherently bound to practices (Cook & Brown, 1999). Therefore, even in the well-researched area of organizational knowledge, it was necessary to discuss abstract, even philosophical, issues concerning the very nature of knowledge. Consequently, developing a system required us to bridge the gap between these abstract issues and the rather constrained reality of software implementation (Sheffield, 2005).

Furthermore, many relevant theories we encountered were directed at explaining knowledge-related phenomena in organizations rather than providing clear guidance on ‘what to do and what not do’. For instance, the enquiry of knowledge management in information systems has been classified into the dialogic, critical, interpretative and normative discourses (Schultze & Leidner, 2002). The main goals and methods of these discourses have few similarities with the epistemological, ontological and methodological understandings underlying the paradigm of design science (Gregg, Kulkarni, & Vinzé, 2001; Iivari, 2007). As a result, design-oriented research needs to translate primarily explanatory theories into prescriptive requirements as part of the process of design (Gregor, 2006; Gregor & Jones, 2007).

Table 1 illustrates the required bridging of the gap between the abstract and the applied. It exemplifies the aforementioned translation of theories into testable artifacts. This is accomplished in two dimensions: (1) Claims synthesized from explanatory theories need to be translated into prescriptive requirements (left to right) and (2) abstract requirements derived from social theories need to be specialized into executable test cases for a software solution (top to bottom). These unidirectional processes illustrate an idealized post-hoc perspective on the design process. Multiple feedback-driven iterations are likely necessary to achieve this state (Purao, 2002).

Level	Claim		Requirement
Social Theory	Individuals are one of the central drivers of organizational knowledge capability.	▶	Increase the productivity of knowledge workers to increase organizational performance.
Design Framework	Knowledge workers are more efficient when being granted autonomy.	▶	Empower knowledge workers to control and own their information and the way they interact with it.
System Architecture	Knowledge workers store and access their information by using various devices.	▶	The architecture should allow for distributed persistence of information.
Software Artifact	Knowledge workers engage with knowledge on the desktop and on the web in an intertwined manner.	▶	Test case: The prototype should allow knowledge workers to store and access information on the desktop and on the web.



Table 1. Two dimensions of translating theories into testable artifacts.

A second issue that surfaced in the process of the project was that industrial strength artifacts must meet a number of stringent requirements, which go beyond the requirements of information systems and/or design science research. However, most expectations for industry-quality artifacts are not provided as strictly defined standards. Many requirements were distributed among industry-oriented publications and the information provided by open communities such as the Apache Foundation; examples for some of these fluid ‘standards’ involved providing rigorous unit tests (using JUnit), using build and dependency management tools (Maven), pursuing strict modularity (OSGi), and building on existing application frameworks (eclipse RCP).

### 4.3 A Complex and Versatile Research Process

The second element described in section 3 proposes to conduct research in small and independent teams. We attempted to trace the process of design and the design decisions using a number of mechanisms (Table 2). As it has already been observed for organizational decision making processes

(Langley, Mintzberg, Pitcher, Posada, & Saint-Macary, 1995), we realized that a great number of interrelated, spontaneous and often unpredictable design decisions had been taken. For instance, during a project meeting a sketch of the general layout of the user interface was developed. This sketch was shown to a number of collaborators and colleagues, refined and ultimately acted as a model for a prototype user screen. However, we were unable to reconstruct the initial inspiration for this variation. Furthermore, literally hundreds of similar design activities had been undertaken during the project. Thus, following a more formal (and therewith more time intensive approach) might seriously interfere with the aspiration to deliver a timely and innovative artifact.

Element	Data Points	Communication/ Management
Formal Justifications	3 working papers, 6 conference papers and related presentations	Published in conference proceedings/ working papers and presentations available on scrib.com
Handwritten Design Notes	235 pages	Archived as scanned PDF documents
Internet Sources	394 links	Categorized and published on diigo.com
Academic References	594 citations	Categorized and published on citeulike.org on various interest-specific groups
Project Blog	91 posts + comments	Published on wordpress.com
Source Code Management	741 versions + comments	Managed with source code management system subversion

Table 2. Elements of design documentation (as of 20/10/2010).

Another factor with impact on the research process was found in environmental influences. To give an example, one central element of our research is to offer knowledge management tools wherever the knowledge worker needs them (see Table 1). This includes providing a tool on all current popular platforms, may they be Linux, Microsoft Windows or Mac OS X-based. As the programming language of choice to accomplish this task has been Java, this project has been heavily affected by Apple Inc.'s decision to deprecate Java for the next version of their OS X platform<sup>2</sup>.

#### 4.4 Design: Science, Craft and Art

The third element proposed in section 3 suggests that researchers “closely and directly interact with information technology in the research process”. In our project, this primarily involved the implementation of a software artifact. In this process, we constantly surveyed relevant technologies, which could be leveraged for the implementation, in industry-oriented publications, blogs and open source repositories like Google Code and sourceforge.org. We further published early prototypes on a blog and leveraged discussion forums like stackoverflow.com as additional sources of information. In this process, we became aware that the engagement with seemingly objective technological issues can often not be grounded entirely in empirically verified data.

The close engagement with the design of a technological artifact pointed us to three intertwined dimensions of this activity; that design can be all: science, craft and art. A scientific approach was required for some key procedures in the software concerned with network-based analysis. These routines were designed in consideration of algorithmic complexity along with rigorous performance measurements. In other instances, designing the software was performed like a craft; for instance, by leveraging proven design patterns or recommendations from the Internet sources mentioned above. Moreover, a number of aspects of the design touched upon the realm of art. For instance, the elemental questions what makes ‘good’ code can often not be answered entirely in absence of subjective measures (Case & Piñeiro, 2006).

<sup>2</sup> [http://blogs.computerworld.com/17205/apple\\_hints\\_no\\_java\\_support\\_in\\_tiger\\_os](http://blogs.computerworld.com/17205/apple_hints_no_java_support_in_tiger_os)

## 5 Suggestions for Lean Design Science Research for Small Teams

As a summary and conclusion of our discussion so far, we propose a number of suggestions for design research, which is driven by small teams and aspires to deliver industry-standard artifacts. These suggestions are made considering the listed key challenges in section 2, the motivation for the particular approach described in this article, and are colored by our own experiences as outlined in the previous section.

### ***Suggestion 1: Acknowledge and Embrace ‘Design’ to Test and Refine not Discover Theory***

A number of scholars see an intrinsic value in the ‘experiment’ of design (Lee & Nickerson, 2010; Newell & Simon, 1976; Rapp, 1981; Yoo, 2010). By shaping ideas and theories into tangible artifacts, researchers become aware of many often unanticipated constraints; the ability or non-ability to work within these constraints can lead to significant insights into the feasibility and implementability of theoretical claims. However, such ‘experiments’ are comparatively unsuited vehicles for the discovery of new explanatory theory. We suggest that a researcher engaged in design-oriented research should *acknowledge and even embrace this limitation for design-focused research*. In that, the researcher can focus on enhancing the quality, functionality and usability of the artifact and therewith aid the potential dissemination of the design artifact.

### ***Suggestion 2: Contribute Through Coherence, Conversation and Uniqueness***

We have argued that being able to meet the requirements of both research and practice has been and continues to be a taxing issue for researchers in information systems and for design-oriented research in particular. We proposed to focus design-oriented research on the translation of empirically validated theory into industry standard artifacts as one possible way to address this issue. We found that significant conceptual work was required in order to ‘bridge’ the claims of explanatory theories with the constraints of current technology and industry standards. Our second suggestion entails three elements to assure both theoretical and practical contributions:

#### *Suggestion 2a: Assure coherence between theoretical claims and characteristics of designed artifacts*

In order to assure theoretical relevance, we suggest (1) that theories should be chosen which have not been used to inform the design of an artifact or which have not yet found wide dissemination in practical contexts and (2) that the research should establish *clear and coherent conceptual linkages between theoretical claims and features of designed artifacts*. We have illustrated in Table 1 an example of coherent claims and requirements on four layers of abstraction, ranging from social theory to specific test cases for a software artifact.

#### *Suggestion 2b: Reflect and assure innovation potential with unique test cases*

With the artifact seen as an essential medium to disseminate theoretical knowledge into practical context, the characteristics of the design artifact are principal indicators of the practical relevance of the undertaken research. We suggest that an artifact is likely to be of *practical relevance if it is unique in its ability to pass a set of test cases* (provided the test cases have been derived from valid practical problems and relevant social theory). Such a claim can be established by utilizing formal software engineering practices (e.g. IEEE Std. 730-2002, IEEE Std. 829-1998, ISO 9001 clauses 7.3.5, 7.3.6). For our software prototype, a number of usage scenarios and requirements were encoded in the form of manual, semi-automatic and automatic test cases (e.g. supporting the linked data paradigm, conveniently composing information from existing information pieces, support for weak links across operating platforms, etc.).

#### *Suggestion 2c: Engage in conversation with a broader community of practitioners*

While an artifact with a unique set of features validated by formal tests suggests an innovative potential in practical contexts, it is advisable to validate the relevance of these features against

contemporary organizational and social realities. However, in contrast to other design science approaches, we suggest independence from the restrictions of a particular organization since dependence on these might affect the quality, generalizability and potential innovativeness of the artifact. Hence, we suggest that the researcher engages in a conversation with a broader community of practitioners through a number of direct and indirect channels: (1) the results of recent case studies can be utilized to synthesize relevant practical problems, (2) industry standards should be followed in design, implementation and evaluation of artifacts, and (3) the researcher should disseminate encountered design problems, proposed solutions and early as well as completed versions of created artifacts in a timely and visible manner. To this end, our project has utilized general discussion platforms such as stackoverflow.com, a project website, open source code repositories such as github.com, and social media platforms. Our experiences with a project blog have been particularly positive in attracting thousands of visitors, indicating an interest in the broader IT community for the discussed concepts.

### ***Suggestion 3: ‘Minimize the Magic’: Assure High Traceability and Transparency***

We have argued that it is difficult to define a highly formal process for design science work aligned to deliver innovative solutions within small and flexible teams. However, researchers are required to make a sound contribution to knowledge. One possible way to accomplish such a contribution is to assure the *traceability* and *transparency* of the design process. For this, the process of alignment should be meticulously documented and carefully delineated, minimizing the occurrence of ‘magical’ leaps in the design process. This enables the researcher to untangle the relationships between theory and design retrospectively. Such reflection can provide valuable insights into which aspects of the theoretical foundations hold true under the constraints imposed by information technology, and which aspects might have to be refined as a result of the design experiences. For instance, we initially focused our project on requirements derived from research on knowledge-intensive business processes. However, we realized in the process of implementation that it is difficult to design a system specific to knowledge-intensive work; non-knowledge intensive tasks are inherently intertwined with their more knowledge focused relatives, and consequently both would have to be supported in one space. Henceforth, we moved our attention to organizational routines in general rather than knowledge-intensive tasks; a shift we only became aware of in a retrospective analysis of the design process.

### ***Suggestion 4: Consider Contextual Factors in the Science, Craft and Art of Design***

The particular flavor for design science research we have discussed is characterized by a very close and constant interaction with the artifact by a small group of collaborators. While the implications of this approach for design seen as science and craft might be negligible, the possible subjectivity of design as art is not without consequences. Hence, the provision of traceable and transparent description of the design process requires the explicit documentation of *contextual factors* (Klein & Myers, 1999; Niehaves, 2007). For a small team, such a context is centered on the unique backgrounds and perspectives of the participating researchers. Further indirect factors might include the employed development environment (Storey, Fracchia, & Müller, 1999) or the general technological and societal environment (Scott & Vessey, 2002). Contextual factors can further have a considerable influence on the quality of the resulting artifacts. The project as outlined in section 4 is centered on knowledge work and knowledge workers, a domain familiar for most academic professionals. Therefore, a team of academics can be assumed to be implicitly and explicitly aware of many important issues. However, if an academic team were to design a portal, which improves young children’s experience in navigating the World Wide Web, formal data collection methods might be required to a greater extent in order to achieve a comparable level quality the design process.

## **6 Conclusions, Limitations and Future Research**

Information technology is at the forefront of forces which shape our current life and future. The discipline of information systems offers a unique academic perspective at the intersection between

social and technology-oriented research (Taylor, 2002). In this article, we argue for one possible flavor of design science research in information systems which is centered around unleashing design science's capability for technological innovation in a fast paced technological environment (Wang & Wang, 2010). This flavor is defined by (1) a focus on small and flexible teams, (2) which closely interact with information technology artifacts (3) in an attempt to disseminate IS theories in the form of generalizable industry-strength artifacts. We have discussed the motivation for such an approach as well challenges we have encountered in its application.

We synthesize a number of tentative suggestions for this particular variation of design science. First, the research should be 'lean' in that it focuses on the translating theory into high-quality artifacts. Second, both as a possible alternative source of validity and as a response to a versatile design process, the research process should be conducted in highly traceable and transparent manner. This allows the researcher to contribute to the academic discourse by reflecting on the interactions between theory and design retrospectively. Third, design has been illustrated as not entirely scientific process but as being at the intersection between science, craft and art. In order to achieve traceability and transparency in conducting design science, all these aspects of design should be considered.

Following the proposed suggestions has, like other methodological approaches, its own intrinsic limitations. First and foremost, the principal theoretical contribution lies in test, refinement, particularization and dissemination of existing theory rather than in the discovery of new theory. A second limitation lies in increased requirements for the research team. The researchers need to have command not only of the theoretical discourse and methodological requirements but also of the particular technologies and development methodologies employed for the design of the artifact. A third limitation might be seen in the suggested detachment from one particular organization (Sein, et al., 2011). However, we have argued that such a detachment might be desirable for developing particular classes of innovative and generalizable technological artifacts. Moreover, a constant conversation with practitioners is explicitly encouraged to assure the practical relevance of the artifact.

While we have focused our discussion on one project, the suggested approach has emerged from a number of similar research projects undertaken by our team. However, future research can contribute greatly to the consolidation of our proposed design science approach. For instance, although we have presented all suggestions in the context of a research project conducted by a small team, we suspect that some suggestions might also prove useful in research projects carried out by larger teams. Furthermore, we have listed a number of mechanisms to engage in conversation with a broader community of professional. Our engagement with the resulting data has been principally interpretative. We see great potential for future research to explore further forms of conversation and data analysis in the context of projects following the suggested approach.

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