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Adjusting the Paradigmatic Shift: IS Design as Intervention in Social Practice

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Abstract. Hevner et al. (2004) have triggered an important debate on design science and its relationship with behavioral research. We make a contribution to this debate by extending the scope of Hevner et al.'s seminal research framework. When designing IT artifacts which are socially embedded, dealing with wicked situations becomes an essential challenge. Like Hevner et al., we argue that American Pragmatism provides a sound philosophical underpinning for design science. However, when coping with the dialectics and dynamics of wicked situations, we argue that design science research should not reduce the phenomena of technology appropriation to the testing of pre-defined theories. By contrary, appropriation should be systematically integrated into an empirically grounded theory building which takes into account the dialectics of the co-evolution of practices and IT artifacts. We will discuss conceptual and methodological implications of this perspective and will present a modified research framework for Information Systems as a design science.

Keywords: Design Science, Organizational Practices, Epistemological Foundations, Research Methodology, IT-Appropriation

1 Introduction

The IS research discipline relies mainly upon two sets of theories: theories of human behavior and theories of design. The problem of building effective and efficient information systems (IS) has recently been approached from a design science perspective (Hevner et al. 2004). Here, the authors present a research framework which aims at bridging the gap between a behavioral science understanding of IS and a theoretically informed approach to the design of IT artifacts. Presenting the most prominent attempt to (re-) orientate IS research as a design science, Hevner et al. (2004) have initiated an ongoing discourse on the theoretical foundation and the methodological consequences of such a stance.

This paper adds to this discourse from a practice-theoretical stance developed by theorists such as Giddens and Bourdieu (Reckwitz 2002). This school of thinking understands social practices as routinized patterns of human action which are encompassed by mental as well as physical forms of activity and are greatly imprinted by objects, especially by tools, media, and their usage. A practice is grounded in background knowledge that is both not entirely explicit and which contains emotional as well as motivational elements. Practices, therefore, represent collective patterns of interaction that are reproduced in their specific contexts.

A practice-theoretical position has been adopted by technology researchers before (e.g. Orlikowski & Iacono 2001; McCarthy & Wright 2004; Wulf 2007), who criticize the reification of "technological artifacts as objects of study apart of their making and use" (McCarthy & Wright 2004, p. 26). In opposite to this assumption, the practice-theoretical position underlines that technology is inherently social and practical, situated in ordinary everyday activities. Methodologically, technology should therefore be studied from within and related to the context of its use which includes activities of developing technology, intervening in the organization, and evaluating technology use (cf. Sein et al. w.Y.).

In this paper, we adopt a practice-theoretical concept of technology by focusing on the social embeddedness of IT artifacts and by stressing the methodological consequence that IS research should embrace the social practices for which IT artifacts are designed and in which they are appropriated and routinely used.

With regard to IT artifacts, we are dealing with a dual nature: On the one hand, IT artifacts are formally specified and their computational behavior is determined by the coding activities translated into machine language and carried out on a

microprocessor. When used by human actors, the computational behavior becomes, on the other hand, part of human agency and the artifact's meaning gets subject to interpretation and social construction.

This dual nature is a consequence of our understanding of human agency, defined counterfactually as the power to 'act otherwise' (Giddens 1984, p. 14): The computational behavior is determined by coding activities, yet this does not determine the way the computational behavior is interpreted and appropriated "to use it constructively, to incorporate it into one's life for better or worse" (Poole & De Sanctis 1989, p. 150). Appropriating the IT artifact at hand, users are forced to make sense of it, which requires creativity, a sufficient understanding of the artifact's functionality, and experience with the activities at hand. (cf. Pipek 2005; Stevens 2009).

Our understanding of socially embedded artifacts follows the notion of an "ensemble view on technology (…) focusing on the dynamic interactions between people and technology - whether during construction, implementation, or use in organizations, or during the deployment of technology in society at large" (Orlikowski & Iacono 2001, p. 125f). Our approach stresses the interrelation of technical artifacts and social phenomena not primarily on the meso- (organizations, communities, culture) or macro-level (society) but on the micro-level of situated practices (cf. OTD, Stiemerling et al. 1998, Rohde 2007). The notion of "socially embedded artifacts" is related to their "dual nature" addressing the formal, computational behavior as well as the human agency in using and appropriating these artifacts.

We argue that a comprehensive research perspective for IS needs to take the dual nature of IT artifacts into consideration and must incorporate their interactions with the user's social practices. Our theoretical and methodological considerations aim at strengthening the relevance of the design science paradigm in IS by grounding the design in practices and by investigating into the artifacts' appropriation. The contribution of this note is to add to the current discourse by means of critically discussing ontological and epistemological assumptions of Design Science Research and by suggesting an extended research framework for IS.

The paper is structured as follows:

- First, we will investigate the philosophical underpinnings of the diverse design concepts in the literature and broaden Hevner et al.'s (2004) understanding by presenting an alternative reading of American Pragmatism.
- Second, we will elaborate on the theoretical foundation of designing for social practices with specific focus on the structuring of social practices through

IT artifacts. We comprehend the design and use of IT artifacts as being shaped by a specific social and historical context.

- Third, we will discuss methodological implications for design science research. We will demonstrate shortcomings of a positivistic perspective on socially embedded IT artifacts and will argue that an alternative perspective is needed which would take into account the social practice in organizations.

We will illustrate our argumentation by empirical evidence from a design project which focuses on the development of indoor navigation support of firefighters. The project was motivated by the observation that fatal accidents occur when firefighters are not able to find a safe way out of a burning building before the air of their respiration equipment is used up (Denef et al. 2008). To deal with this problem, a socio-constructivist perspective was applied to gain a profound understanding of navigation practices of firefighters and to explore opportunities for navigation support by enhancing given or bring about novel practices. The project was set up according to a participatory design approach (Ramirez & Dryks 2010) supplemented by ethnographic studies working sequentially with troops first from the Paris and then from the Cologne firefighter departments (Denef et al. 2008). The design process involved a variety of different stake holders from academia and industries, in particular about 30 firefighters from the two organizations and firefighting officers of different hierarchical levels. We will refer to experiences and findings from this project to exemplify some central arguments.

2 LIMITATIONS OF THE DESIGN SCIENCE PERSPECTIVE

Hevner et al.'s (2004) highly quoted paper claims design science to be a suitable approach for information systems research. The authors introduce two distinct research paradigms in IS: behavioral science research and design science research. The former is understood as a "problem understanding paradigm", the latter as a "problem solving paradigm" (cf. Niehaves & Stahl 2006).

By developing the consequences of these perspectives on IS research, Hevner et al. (2004) have initiated a vivid international discussion, widening our understanding of appropriate research methods. The authors provide a holistic framework for IS research by linking the IS design perspective which attempts to ultimately determine the necessary functions of IT artifacts according to given requirements, with the behavioral science perspective that explains and predicts the ways the artifacts are used. Within this framework, they place the characteristics of the technical artifacts in the centre of IS research and focus on

the design processes which lead to their emergence. They generally regard this as a wicked problem (p. 81). Beyond delivering useful and useable IT artifacts, design research additionally leads to results that augment the scientific knowledge base for design.

Limitations in the concept of design

Hevner et al.'s (2004) design concept stays in the tradition of Simon's (1969) work. Epistemologically, this perspective presumes that problem understanding knowledge is positively given while knowledge relevant for problem solving is rather lacking. Based on this presumption, design research is conceived mainly as an optimization process of an artifact based on a utility function and the definition of constraints for its application.

For designing socially embedded IT artifacts, however, we argue that we need to develop an appropriate understanding of reflexive design processes in which well-defined problems, stable requirement specifications and clear casual connections are often missing. Accordingly, several authors have criticized this design concept and developed an alternative understanding that conceives design as an intervention into social practices, as a reflective practice confronted with wicked design problems. Sein et al. (w. Y.) propose an Action Design Research approach which focuses both on the design of IT artifacts and the action that embeds these artifacts in the use practice. Tripp (1991) uses the term "design as optimization" to characterize Simon's design paradigm while coining the term "design as dialogue" to characterize an alternative approach. Our paper follows the later line of thinking by rising theoretical and methodological concerns.

As a prominent proponent of an alternative design concept, Schön (1983) pointed out that design is not a linear process in practice. Adopting John Dewey's (1938) pragmatist theory of inquiry, Schön conceptualizes design to be an inquiry process characterized by uncertainty, uniqueness, and conflict. Problems do not present themselves to the practitioner as a given, but are constructed during the course of work. Design is understood to be a reflexive "conversation" with a given situation (cf. Schön 1983). A similar concept is outlined by Rittel & Webber (1973). Following them, wicked problems imply that every solution is a "one-shot operation" which consequentially leaves "traces" that cannot be undone. Every wicked problem is essentially unique. So there is not any general theory which determines the right practice. As a consequence, designers are confronted with the dilemma that "there is no right to be wrong"; even if in such situations there is neither an ethically well-defined situation nor a sound theoretical base to differentiate right from wrong.

At the first glance the firefighter project is dealing with a clear and well-defined problem: Namely, making the work of the firefighters safer, e.g. by using the new opportunities of mobile and wearable ICT. However, this is more a vague technological promise than a well-defined specification of the real problem and of the requirements a design solution has to satisfy. This should not be misinterpreted as if this vagueness is an expression of poor design science research. In opposite, we argue that vagueness and wickedness often are essential parts when trying to solve real-world problems. In Ramirez & Dyrks (2010) this issue is discussed in detail, thus we just give an outline here.

Current attempts on navigation support typically follow a rationalistic design concept where the problem is framed from an engineering perspective. Within that perspective one tries to solve the well-specified technical challenge, e.g. by creating a sensor net so that the actual indoor position of people can be measured more accurately. However, looking at the technical aspect alone neglects that navigation practices are a "collective craft or art, where technology is only one of the relevant pieces, but not the only one" (Denef et al. 2008, p. 184).

In order to overcome the shortcomings of a pure engineering perspective, one has to empirically study the current navigation practices in detail. Yet, this practice analysis alone would also be insufficient to frame the design space in an appropriate manner. As stated by practice theories (Reckwitz 2002), practices are bound in general to be existing, but contingent socio-technical conditions. In our research, we have shown that this also holds for the case of navigation. With the help of the "Wizard of Oz" paradigm (Kelley 1984) we simulated a technical system that provides an accurate indoor position as well as a scenario for the breakdown of the system. In response to this design intervention, we observed that firefighters changed their way to navigate radically (cf. Denef et al. 2008 for more detail). This change coincidentally changed the problem definition and the (design) requirements for an appropriate solution.

The epistemic dimension of design (to know what navigation support is needed and how it can be realized technically) could therefore not be separated from the ontic dimension of design (to change the socio-technical context of navigation by design interventions). Because of these dialectics any design for navigation support must start with a vague and temporary understanding of the real-world problem and its context only. The methodical consequences are discussed below in more detail.

Limitations in the philosophical underpinning

The IS design science perspective as articulated by Hevner et al. (2004) basically relies on behavioral science and design science as complementary but

inseparable disciplines to analyze, design, and evaluate information systems. While they regard behavioral science as research efforts for the development and justification of theories that explain and predict human or organizational behavior, they understand design science as research efforts for extending the boundaries of human or organizational capabilities by building and evaluating new artifacts that meet specified business needs: “The goal of behavioral research is truth. The goal of design science is utility. As argued above, our position is that truth and utility are inseparable. Truth informs design and utility informs theory. An artifact may have utility because of some as yet undiscovered truth. A theory may yet to be developed to the point where its truth can be incorporated into design” (Hevner et al. 2004, p. 80).

Making use of a utilitarian school of thought, Hevner et al. (2004) provide an elegant attempt to combine both paradigms. Reflecting on their own epistemological considerations, they place American Pragmatism into the tradition of pragmatist philosophy thereby interpreting it mainly as a utilitarian, positivistic philosophy. In contrast, we follow a constructivist interpretation of Pragmatism in which IS design is rather understood as a complex task to create a socially embedded IT artifact. The utility of the artifact does not present itself to the practitioners as given, but analogue to the necessity of problem framing, it must be constructed in the given situation and must be proven by its use in practice. The human actors are engaged in appropriation work: the artifact’s functions are explored, routines of enacting the functions for effective use are internalized, and by doing the users’ action competence is expanded and, at the same time, his/her social practice is challenged.

Thus, an appropriation for skilful and effective use typically constitutes a new practice and new ways of doing things. Adopting the IT artifact thus intervenes with the social practice as being originally reflected in the design (Brödner 2006; cf. fig. 1). The self-referentiality of this double transformation process – explicating aspects of practice as objectified knowledge into artifact functions and appropriating these functions for enhanced practice – makes IS design a “wicked problem” (Rittel & Webber 1973).

This pragmatist perspective closely relates to Oevermann’s (2005) evolutionary concept of social practices in which he adopts Peirce’s pragmatist epistemology as well as Mead’s philosophy of the present when analyzing what constitutes everyday life practice (Lebenspraxis). His evolutionary philosophy leads to the seminal insight that to deal with a wicked problem is a process of transition from old to new in which the objective world is changed, while, at the same time, the acting subjects and their social practice evolve. Applying this

perspective to wicked design problems, indicates where Hevner et al.´s (2004) utilitarian and positivistic approach towards IS design becomes inadequate.

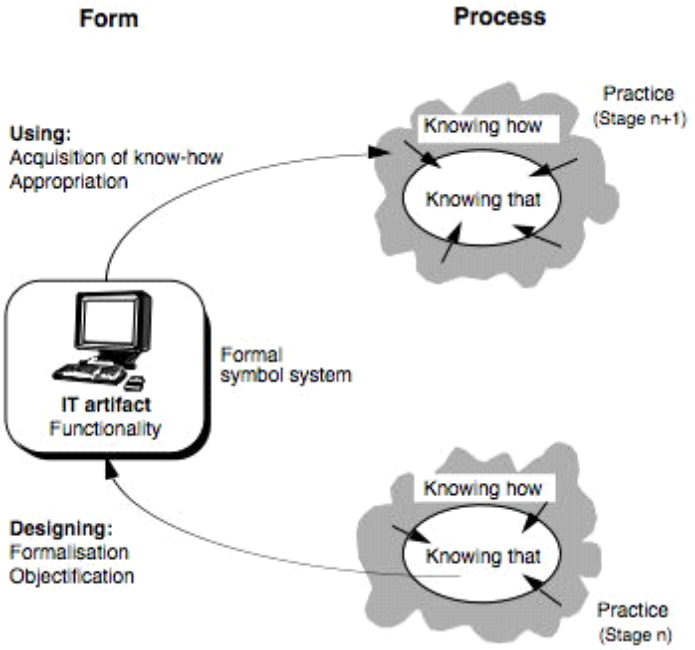

Fig.1: T tting functions to effective use

Explicit conceptual knowledge about a social practice ("knowing that") is needed for deriving functional requirements. This knowledge gained by (external or self-) observation is fragmentary and perspective-dependent, and therefore, limited in principle. Moreover, this knowledge describes a practice being changed by the observation and even more by the artifact's use whose functions are designed on the basis of this knowledge. Finally, a growing body of studies shows evidence for user-initiated creativity beyond design processes, which aims at altering tool configurations, combinations, and usages in organizational practice (cf. Pipek 2005). So, appropriation and design are both creative activities and as such they are subject to contingency and interpretation. Due to these reasons, the effects the artifact has on a social practice and, in particular, its utility, cannot be evaluated beforehand, as we will discuss below.

A theoretical foundation of design science must not only clarify knowledge about appropriate design solutions, but also about problems' constituents. Hevner et al.'s (2004) assumption that design problems are given facts in social reality is, at least, imprecise and under-complex as it does not distinguish between subjects as part of a social world and subjects as interpreters of their social world.

Another difficulty concerns the rigor criteria: Hevner et al. (2004, p. 87) claim that design science builds on the application of rigorous methods in designing and

evaluating an IT artifact. However, regarding IS design as a wicked problem, rigorous methods for creating sufficient knowledge for design and for evaluating the utility of IT artifacts seems, according to Rittel & Webber's (1973) and Schön's (1983) critical view on rational planning and design, to be neither available nor applicable. This model of design science does not take into account that the self-referentiality of design and appropriation activities lead to a double step sequence of transformation.

Due to these considerations and regarding the underlying design problem, Hevner et al.´s (2004) design science concept runs the risk of losing much of its potential to constitute a new research paradigm. While the concept of "bounded rationality", prominent among proponents of rational choice theory, helps to reconcile theoretical results with empirical findings, it fails to capture the dialectical relationship between the practice competence in 'divergent' situations (Schön 1983, p. 49) and the historical development of social practices.

In order to augment Hevner et al.'s (2004) approach concerning socially embedded IT, we suggest to ground design science research on an evolutionary design philosophy, which understands design not just as an optimization task under constraints, but rather as an intervention with a social practice that leaves it with "epistemic traces" that cannot be undone after completion.

Taking the example of the firefighters' indoor-navigation problem, a rational, positivistic approach would define the design problem as an improvement of technical tools, e.g. the automatic generation of indoor maps. Contrary to this, in our design case study the analysis of firefighters' practice let to a more differentiated and evolving problem definition. Understanding indoor navigation in its complex and situated nature characterized by embodied action as well as collaborative routines helped us to come up with an alternative problem description: to support the given practices which led to the design vision of developing artifacts which allow for annotating space. Exploring different prototypes of manually deployable markers let to design concepts which support firefighters in (collaboratively) constructing a spatial understanding of the burning building. The designed solution, therefore, did not focus on a pure technical improvement but tried took the given practice of co-constructing and annotating space seriously and looked for manners to augment it.

Relevance of social practice

We understand design activities as reflexive "conversation" with and within uncertain, unique and contentious situations (Schön 1983); truth and utility are not seen as given facts in social reality, but are fundamentally embedded in social practice and, therefore, are subject to negotiation and social construction. This fact can be illustrated by the example of Lotus Notes being deployed in a large

consultancy firm as presented by Orlikowski (2000). Different user groups with similar tasks within the same organization make highly different use of functions of the same application and thereby develop different practices in doing their job. There obviously is not any common utility assigned to the application.

Furthermore, design in and for social practice is facing timely constraints under terms and conditions of history and dynamics. In other words, design decisions can neither rely on a given and independent social reality nor can it draw on existing and stable utility evaluation criteria. Contrary to the basic assumptions of a positivist perspective, design decisions for socially embedded IT artifacts have to cope with socially constructed and interpreted reality and decision criteria.

Moreover, social practice cannot be thought of being independent of its observation, since any observation, i.e. any distinction and denomination of social phenomena, inevitably takes place in the same social world that is being observed and changed by the observation. Social scientists, like system designers, have to interpret features of a social system as an object of observation in which they themselves take part as observers. Hence, the process of observation itself changes the social practice as object of observation; it is reflexive in the sense that the explicit knowledge gained about the practice – as well as the technical artifacts derived from that knowledge – become part of the practice's resources and rules being changed by this ("double hermeneutics", see e.g. Giddens 1984).

According to their knowledge based design of IT artifacts, Hevner et al. (2004) develop an ahistorical view that regards "utility" to be fairly independent of the social practice's history. In contrast, we rather suggest an enhanced understanding of IS as the academic field dealing with socially embedded IT artifacts that emerge from and intervene with organizational practices. We understand an organization's social practice as being structured by the use of technical artifacts, while, in turn, their design, appropriation, and use emerge from dynamic social practices in organizations.

Comparing the navigation practices between Parisian and Cologne firefighters, it turned out that they have developed differently. Among others these differences are due to different operational tactics and tool usages. While the Cologne firefighters move into burning building always equipped with a water hose, their Parisian colleagues explore buildings in troops just connected to each other with a life line. The usage of chalk played a major role in the firefighters' collective construction of space, they used it for annotating doors inside the building as well as for lining out maps of the burning building.

The different ways to solve the same problem – namely indoor navigation – in different ways demonstrate that practices are socio-historically contingent.

Moreover, they are affected by the design intervention. In the case of the design project, for example, firefighters start to change the way they reflect of its own practices picking up the concept of smart markers – a concept introduced by the action-design researchers. Reciprocally the way they appropriate the concept provide important hints for the design of the next generation prototypes.

3 STRUCTURING SOCIAL PRACTICES THROUGH IT ARTIFACTS

Our perspective on social practices, inherently embracing the interaction with IT artifacts, is based on the constructionist view that our experienced reality is being socially constructed (Berger & Luckmann 1984) rather than "discovered" in an independently existing world. Cognition evolves through neither deduction nor induction, but rather through the creative operations of abduction in concept formation and artifact appropriation (Peirce 1935).

We prefer this perspective to positivistic approaches for a number of reasons. First, it reflects the fact that cognition and knowledge are always mediated by language while inseparably being embedded in social practices. Objective cognition or 'truth', therefore, is not available. Second, the observation – and even more so the shaping – of social practices is subject to 'double hermeneutics': The process of gaining knowledge through concept formation is self-referential in the sense that it changes the social practice it refers to in the very moment it is performed; observing a social practice inevitably means to intervene. Third, it transcends the infertile dispute over subjective acting versus objective structures in comprehending human action, and it simultaneously explains both the inertia as well as the dynamics of change in social practices. Fourth, it comprehends the functional properties of IT artifacts as a product of conceptualizing social practices, while the collective appropriation of the functions for effective practical use makes them a part of these practices. It thus informs design activities as interventions of organizational development rather than as the functional shaping of useful artifacts.

According to this perspective, we assume that organizations emerge and reproduce themselves as social systems through continued sense-making as well as mutually related and coordinated acting of their members. These processes of continuous action and interaction are based on grown routines and assumed expectations. In the course of their continuous action flow, actors may generate explicit knowledge through reflection and concept formation. This conceptual knowledge can be expressed and objectified in the form of linguistic signs, of

organizational schemes, or in the form of technical artifacts that represent, although incompletely, a social practice.

In particular, technical systems like IT artifacts can be constructed as a product of reflecting and conceptualizing practical human activities through modeling and objectifying explicit knowledge about these activities in terms of formal operations and procedures ("auto-operational form", Floyd 2002). In this way, IT artifacts in their functions and properties incorporate formal aspects or features of human practice. Built to support work in organizations, they set specific action requirements for effective use for which they must, however, be appropriated again. Appropriation for skilful and effective use thus constitutes a new practice which results in new ways of doing things. Since they are derived from abstract, de-contextualized knowledge, technical artifacts (in particular IT systems) always contain empty 'slots' that have to be filled in use through 're-contextualization', i.e. by interpreting and applying their functions appropriately to given situations. Consequently they are, due to the scope of interpretation within the limits of their action requirements, open for diverse use practices (Pipek & Wulf 1999; Pipek & Wulf 2009; Brödner 2006). The resulting recurrent social practice produces and reproduces a particular social structure of technology use (Orlikowski 2000). Consequently, the design and use of IT artifacts has to be regarded as an integral part of an organization's social practices and dynamics and, hence, as a part of organizational development (cf. Wulf & Rohde 1995)

4 METHODOLOGICAL IMPLICATIONS

Design projects for socially embedded IT must cope with the open structuration of appropriation processes in and for the social practices of an organization which cannot be sufficiently anticipated. In our perspective, designing and appropriating IT artifacts should be conceived as interventions in social practices that initiate collective learning processes. These contextual conditions are inescapable facts of what social practice design research has to cope with. Therefore, we suggest that IS as a design science should provide methods to organize design and implementation processes in a reflexive and evolutionary way that allows for iteratively revised and improved versions of the system or its modules. An evolutionary procedure for IS design has to cope with the "symmetry of ignorance" (Fischer 2000) where communication breakdowns between users and designers are often experienced since these stakeholders belonging to different cultures and often lack common ground. Design science research is specifically confronted with these issues based on the high level of innovativeness and the interdisciplinary character of such projects (in opposite to routine design work). In these wicked design problems, it is difficult to articulate

beforehand what precisely the real benefits of a design solution for a certain practice are.

In their critical reflection on the behavioral science paradigm, Hevner et al. (2004) state that "the behavioral-science research paradigm is reactive with respect to technology in the sense that it takes technology as 'given'" (2004, p. 98). We argue that the authors are somehow reactive to organizational practices as they take organizational requirements and constraints as "given". We consider both reactive perceptions as problematic for the design of socially embedded IT artifacts. According to the above mentioned assumptions, we prefer an integrated perspective of IS research that focuses on the interplay between iteratively designed and re-designed technical artifacts and dynamic requirements of an evolutionary organizational practice. Therefore, practice oriented IS research projects have to follow an evolutionary process model themselves. Such an evolutionary project organization allows for combining the IT design (respectively configuration) efforts with the collective appropriation and learning efforts in order to put the application to effective use (cf. Rohde & Wulf 2013).

Designing navigation support for firefighters, we applied such a socio-constructivist perspective by following a participatory approach. As mentioned above, practitioners from different organizations of different hierarchical levels were involved. According to the dialectic interpretation of a pragmatic perspective and an evolutionary approach, alternative approaches to annotate space in burning buildings were explored in an evolutionary manner, uncovering and challenging existing practices in a series of prototyping activities. Dealing with the wicked problem of indoor navigation under extreme conditions, the design objective was not merely limited to the technical artifact as such, but its embeddedness was treated by simulating future practices under real-world-like conditions. The evaluation of the different alternative prototypes looked at achieving technical performance, while, at the same time, focusing on opportunities for its organizational appropriation.

In order to apply this approach, we were faced with the dilemma that feedback about using the technology in practice was needed, while it was ethically unjustifiable that in serious situations firefighters had to rely on a beta version of new technology (as a "try and error" kind of evaluation in practice would require). This forced us to find an appropriate and safe way to enable the co-evolutionary growth of design artifacts, use practices and theoretical knowledge at the same time. To solve this methodological challenge, we made use of the existing body of knowledge and the sophisticated facilities in firefighting to simulate work practices under real-world like conditions in a safety manner. Usually, these facilities are used for trainings purposes. However, these training facilities offered

the opportunity to evaluate prototypes of different levels of functional perfection, to uncover existing navigation practices in reconnaissance missions and to explore their potentials for technology-induced innovation.

As a result of these explorations and interactions between designers, action researchers and firefighters, a design concept was elaborated to support spatial sense-making abilities of the firefighters with the help of physical markings used to annotate burning buildings in their very specific manner. This RFID-based marking technology offers an additional layer of spatial information to support and enrich given navigation practices (cf. Ramirez & Dryks 2010).

Table 1 shows the main differences of our perspective and the approach of Hevner et al. (2004) with regard to basic theoretical assumptions, to the understanding of an appropriate design science paradigm for IS, and to (methodological) evaluation implications:

	Hevner et al.	Author et al.	Example
Ontological and Epistemological Grounding	Ontological and epistemological realism, Positivism	Social constructivism (consensus theory of cognition through abduction)	Design is not dealing with a reality existing independently of its observer. Therefore, an interactive analysis and deep understanding of social practice are needed (here: firefighter's indoor navigation abilities and strategies).
Interpretation of American Pragmatism	Emphasizing the utilitarian facet	Emphasizing the evolutionary, dialectic facet	Design is not identifying the best solution for a given problem. It is understood as an evolutionary rapprochement and adaptation of prototypic design solutions to find suitable fit with practice (here:

			participatory design of prototypes together with firefighters).
Objective for Design	Optimization of technical artifact (static problem)	Technical artifact in its interaction with social practices (dynamic and wicked problem)	Designing does not lead to the most effective tool but creates prototypic alternatives evaluates them by analyzing changes in practice (here: ethnographic study (participant observation) of firefighters' adoption of prototypes in their indoor navigation practice).
Evaluation of Design	Technical quality with respect to given requirements	(1)Technical quality as a precondition for (2) Organizational appropriation	Design does not refer to the Status Quo, but to a dynamically changing situated context and unexpected effects (here: analyzing and supporting the firefighters' appropriation of design solutions in trainings and practice).

Table 1: Differences with regard to the design science perspectives of Hevner et al. (2004)

We also have to reconsider the mode of knowledge building within the IS community. Hevner et al. (2004) claim that design can build on de-contextualized conceptual knowledge in the form of theories and methodologies (cf. the knowledge base in their research framework). However, context matters when appropriating innovative artifacts in organizational practice is concerned. Therefore, we suggest that design case studies should be an additional category of the knowledge base (cf. Wulf 2007). A design case study documents work in the design history over the different phases of an extended design science research approach (cf. the Harvard Business School's approach on case-based knowledge).

Therefore, design case studies ideally consist of three phases: (1) They offer micro-level descriptions of the social practices before any intervention takes place. (2) They should describe the innovative ICT artifact from a product as well as from a process perspective. They include a description of the specific design process, the involved stakeholders, the applied design methods, and the emerging design concepts. A focus should lie on the documentation of how changes in social practices have been anticipated and how these considerations have influenced the design of the ICT artifacts. (3) Design case studies document the introduction, appropriation, and potential re-design of the ICT artifact in its respective domain of practice (cf. Rohde et al. 2009, Wulf et al. 2011). Although these design case studies do no not focus on a meso- or macro-perspective, they often include a micro-analytical perspective on cultural, societal or political context (e.g., Saeed et al. 2008, 2010, 2011, Wulf et al. 2013a, 2013b).

These considerations have methodological consequences for design science research in two respects: An adequate project organization (and a process framework) for design science research would be required, developing the reflexivity needed in the co-evolution of social practices and IT artifacts. Secondly, methodological implications should be addressed based on the fact that artifacts are always embedded in continued sense-making processes.

Interpretations of social practices are historically contingent. They evolve together with the appropriation of the IT artifact. In this process unanticipated opportunities for the design of the artifact may emerge. However, emergence in the appropriation process cannot be observed before the intervention has occurred. Following the argument of Nett & Stevens (2008), it would be an act of blindfolding, if design science research did not care about such kinds of emergence and reflect upon it systematically.

Dealing with design as an intervention into social practice, it seems necessary to accept the “logic of discovery” by recognizing and deliberately building on the creative operations of abduction in concept and knowledge formation as well as in artifact appropriation, instead of only following the “logic of justification” that restricts itself to rigorously testing predefined hypotheses (cf. Reichenbach 1938). Comparable to opportunistic changes in organizations (cf. Orlikowski & Hofman 1997), the resolution process of the initial wicked problem will normally produce various unexpected and unplanned changes that can be used for the establishment of a new efficient social practice. With its emphasis on methodological rigor, design research risks to ignore such unplanned, emergent innovations.

From a methodological point of view, some actual trends in HCI, which are grounded on a situated, pragmatist approach (McCarthy & Wright 2004), can be

read as elaborations of a ‘research through design’ approach. This approach shares our understanding of social practices as being historically contingent. In this perspective artifacts play an important role in initiating change processes as they enable new ways of acting in and reflecting on the world.

5 CONCLUSION

Based on a critical reflection of Hevner et al.’s (2004) seminal paper with regard to the design of socially embedded IT artifacts, we have suggested an expansion of their design science framework. From a theoretical perspective, we elaborated on the interrelations between social practices and designing IT artifacts. Due to the “double hermeneutics” (Giddens 1984) of designing these artifacts, IS design faces a wicked problem. Appropriating IT artifacts for practical use happens to be inherently creative, the effects of which cannot be fully anticipated (Orlikowski & Hofman 1996, Pipek & Wulf 2009). Therefore, design intentions for IT artifacts and their practical use are inseparably interwoven. From a pragmatist perspective, both design and use of IT artifacts always own an element of creative action (Joas 1992) which can be theoretically understood as an abductive process. This view has conceptual implications: IS research deals with socially embedded IT, and therefore, has to investigate into appropriation processes and their relationship with historically grown social practices.

Shifting the perspective of IS research from the design of IT artifacts to the shaping of socially embedded systems, i.e. developing the relationship between IT artifacts and social practice, helps to overcome the antagonism between artifact design and social behavior. Concentrating on meaningful and intentional human activities in their socio-cultural and historical context instead, conceives the design as a social practice itself, which is directed towards developing other social practices by designing artifacts and stimulating their appropriation in organizational settings. This approach requires a simultaneous analysis of social activities, the artifacts’ functionalities, the design processes, and the organizational change. The unavoidable interrelatedness of technical and social systems has also been stated before in the approaches of socio-technical systems (Emery & Trist 1969, Mumford 2003), although these concepts did not go as far as integrating an historical perspective and a comprehensive understanding of social practice.

Certain methods developed in the Scandinavian tradition of Participatory Design might add to this collection (Greenbaum & Kyng 1991), although these approaches do only offer a limited perspective with regard to appropriation

processes. Recently, the approach of Action Design Research (ADR) has been proposed, which might help to overcome some of these limitations (Sein et al., w. Y.).

Since the design and implementation of IT systems is a reflexive endeavor in the sense that the systems' appropriation and use change the social practices they are designed for; frequent changes of functional requirements during the system design and implementation are inevitable. A toolkit of design research methods has to recognize this fact. IS research will increase its social relevance, if its findings contribute to theoretical insights into social practices. Its theoretical concepts and methodological approaches need to cope with the complexity and dynamics of social reality.

Beyond the ontological and epistemological foundations considered above, a goal-oriented development of social practices, embracing the implementation and use of IT artifacts, also requires an ethical foundation. Since interventions do not only affect the effectiveness and efficiency of social practices but do also greatly impact on the well-being of the actors involved, the legitimating issue is at stake. The question arises of who has the right to intervene, of what could be the normative base, and according to which set of values should the change process be guided. From our point of view, such a legitimation can only be derived from the social practice itself. Taking users and their needs seriously requires their involvement in the design process. Discussions on values, a definition of goals, an analysis of requirements, the development of design solutions, participative (re-)design cycles, the appropriation of artifacts in the social practice of organizations, and the collaborative evaluation of design projects seem to be methodological prerequisites for the legitimation of design interventions into social practices.

It is the main merit of Hevner et al. (2004) to have started the scientific discourse on a (re-) conceptualization of IS design. However, in our view their epistemological and ontological perspective constrains the analytical focus and the scope of their research framework. Especially the utilitarian conception of their approach bears the risk of limiting the social relevance of IS design research. By suggesting an epistemological opening, we try to sharpen the understanding of IS design as a scientific effort to deal with the design and use of IT artifacts embedded in and shaped through the social practices of organizations.

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