MIS Quarterly

RESEARCH ESSAY

ACTION DESIGN RESEARCH[1]

Maung K. Sein
University of Agder, Post Box 422, 4604 Kristiansand S, Norway {Maung.K.Sein@uia.no}

Ola Henfridsson
Viktoria Institute, Hörselgången 4, 417 45 Göteborg, Sweden;
University of Oslo, Boks 1072 Blindern, 0316 Oslo, Norway {ola.henfridsson@viktoria.se}

Sandeep Purao
Penn State University, University Park, PA 16802, U.S.A. {spurao@ist.psu.edu}

Matti Rossi
Aalto University School of Economics, P.O. Box 21220, 00076 Aalto, Finland {matti.rossi@aalto.fi}

Rikard Lindgren
IT University of Gothenburg, 412 96 Göteborg, Sweden;
University of Borås, 501 90 Borås, Sweden {rikard.lindgren@ituniv.se}

Design research (DR) positions information technology artifacts at the core of the Information Systems discipline. However, dominant DR thinking takes a technological view of the IT artifact, paying scant attention to its shaping by the organizational context. Consequently, existing DR methods focus on building the artifact and relegate evaluation to a subsequent and separate phase. They value technological rigor at the cost of organizational relevance, and fail to recognize that the artifact emerges from interaction with the organizational context even when its initial design is guided by the researchers' intent.

We propose action design research (ADR) as a new DR method to address this problem. ADR reflects the premise that IT artifacts are ensembles shaped by the organizational context during development and use. The method conceptualizes the research process as containing the inseparable and inherently interwoven activities of building the IT artifact, intervening in the organization, and evaluating it concurrently. The essay describes the stages of ADR and associated principles that encapsulate its underlying beliefs and values. We illustrate ADR through a case of competence management at Volvo IT.

Keywords: Action design research, action research, design research, emergence, ensemble artifact, organizational intervention, research method

[1]Carol Saunders was the accepting senior editor for this paper. Juhani Iivari served as the associate editor.

Introduction

There is a broad consensus that Information Systems research must respond to a dual mission: make theoretical contributions and assist in solving the current and anticipated problems of practitioners (Benbasat and Zmud 1999; Iivari 2003; Rosemann and Vessey 2008). This perspective is reflected in reviewing practices and editorial pointers from premier journals in the field. Yet, the discipline continues to lament the disconnect between research and practice (Benbasat and Zmud 1999; Dennis 2001; Kock et al. 2002; Sein et al. 2003). The difficulty is often traced to (1) the conflicting interpretations of the core of the discipline (Benbasat and Zmud 2003; Iivari 2003, 2007b), (2) the difference in the research approaches and values of design-oriented and organization-oriented researchers (Hevner et al. 2004; Lee 1999; March and Smith 1995), and (3) the conflict between responding to practitioner concerns and the methodological rigors required for academic contributions (Gallupe 2007).

A proposed strategy for rediscovering the dual mission of IS research is to reemphasize the core of the discipline as the development and use of IT artifacts in organizations (Benbasat and Zmud 2003; Iivari 2003, 2007b; Orlikowski and Iacono 2001). To this end, Hevner et al. (2004) have articulated a design science approach that emphasizes a construction-oriented view of IS research centered around designing and building innovative IT artifacts. Their approach provides IS researchers an opportunity to go beyond explanation, toward research that generates design knowledge relevant for practitioners (Hevner et al. 2004). However, traditional design science does not fully recognize the role of organizational context in shaping the design as well as shaping the deployed artifact.

We argue that the relevance challenge for IS requires a research method that explicitly recognizes IT artifacts as "shaped by the interests, values, and assumptions of a wide variety of communities of developers, investors, users" (Orlikowski and Iacono 2001, p. 131) without letting go of the essence of design research[2] (DR): (1) innovation and (2) dealing with a class of problems and systems. Although others echo the view of artifacts as emergent from an organizational context (Iivari 2003, 2007b; Orlikowski 1996), existing DR methods do not reflect this perspective. For example, the method articulated by Peffers et al. (2008) does not recognize that artifacts emerge in interaction with organizational elements. This view is manifested in the separating and sequencing of key steps such as "design and development" and "evaluation," where a suitable demonstration context is selected after building the artifact.

In this essay, we argue that a solution to this problem requires a DR method that simultaneously aims at building innovative IT artifacts in an organizational context and learning from the intervention while addressing a problematic situation (Baskerville and Wood-Harper 1998; Hevner et al. 2004). We propose a solution in the form of a new research method for DR that draws on action research (AR) and call it action design research (ADR) after a term first coined by Iivari (2007a). ADR stresses the influence of the relevance cycle (Hevner 2007) by providing explicit guidance for combining building, intervention, and evaluation in a concerted research effort.

The essay proceeds as follows. In the next section, we justify the need for a new DR method. We then describe ADR by presenting its stages and principles. Next, we demonstrate the usefulness of ADR through an empirical example. The essay concludes with a discussion of implications for IS research.

The Need for a New Design Research Method

A key assertion in this essay is that the core of the IS discipline is the IT artifact. While the exact form and definition of an IT artifact is a much-debated issue, we simply affirm that our focus is on artifacts as ensembles. By ensemble artifact, we specifically mean the material and organizational features that are socially recognized as bundles of hardware and/or software (Orlikowski and Iacono 2001). This definition reflects a "technology as structure" view of the ensemble artifact, where structures of the organizational domain are inscribed into the artifact during its development and use (Orlikowski and Iacono 2001). It accommodates designers' building and organizational stakeholders' shaping in a single definition, thereby softening the sharp distinction between development and use assumed in dominant DR thinking.

Designing ensemble artifacts involves dimensions beyond the technological, because they result from the interaction of design efforts and contextual factors throughout the design process (see Gregor and Jones 2007). The interaction between these dimensions becomes manifested in the form, structure, goals, and conceptualization of the artifact (Iivari 2003; Orlikowski and Iacono 2001). We argue that there is a need for a research method that explicitly recognizes artifacts as ensembles emerging from design, use, and ongoing refine-

[2]We use the term *design research* to denote the idea of design as research, similar to that proposed by Hevner et al (2004), instead of the notion of researching design activities.

ment in context. Although design researchers have begun to acknowledge this need (see Hevner 2007), no concerted method exists to provide the required guidance and rigor (Iivari 2007b). We elaborate on our argument by first critically examining DR.

The Problem of Sequencing and Separation in Design Research

DR seeks to develop prescriptive design knowledge through building and evaluating innovative IT artifacts intended to solve an identified class of problems (Hevner et al. 2004, March and Smith 1995). The results of DR include not only innovative artifacts but also knowledge about creating other instances of artifacts that belong to the same class (Purao 2002; Vaishnavi and Kuechler 2006). This knowledge is sometimes referred to as design principles (Markus et al. 2002; Pries-Heje and Baskerville 2008; Walls et al. 1992).

In most DR efforts, awareness of the problem precedes the development of the artifact, which is then followed by evaluation (Vaishnavi and Kuechler 2006). This prevailing approach to DR is captured in the "build and *then* evaluate" cycle (italics ours) proposed by March and Smith (1995) and advocated by Nunamaker et al. (1991) and Hevner et al. (2004). DR thus places axiological emphasis on utility (Venable 2006) traced to the problem identified at the beginning of the research project. In spite of calls to bridge the last mile (Nunamaker 2007) and test in real life settings (Hevner 2007), few DR efforts have attempted to balance the conflicting demands of (1) addressing a class of problems, and (2) intervening in authentic settings (exceptions include Berndt et al. (2003) and Markus et al. (2002)). Indeed, existing DR methods (e.g., Nunamaker et al. 1991; Peffers et al. 2008, Walls et al. 1992) continue to suggest stage-gate models (see Cooper et al. 2002) that require moving from, say, problems to goals to conceptualizations to design to evaluation. Following artifact building, evaluation assesses whether the intended outcomes were realized.

This sequencing, which separates building from evaluating, does not meet the needs of a research method that has built-in relevance and rigor cycles for designing innovative ensemble artifacts. In addition, although current DR methods are strong in their support of abstraction and invention, they consider organizational intervention to be secondary (Cole et al. 2005). To explicitly account for such interventions, and thus expand and enhance the DR approach, we turn to a research approach that has organizational intervention at its very heart, namely AR.

Incorporating Action

AR combines theory generation with researcher intervention to solve immediate organizational problems (Baburoglu and Ravn 1992; Baskerville and Wood-Harper 1998). Thus, AR aims to link theory with practice, and thinking with doing (Susman 1983). It is typically an iterative process based on working hypotheses refined over repeated cycles of inquiry (Davison et al. 2004; Susman and Evered 1978).

Given these characteristics, it is not surprising that the idea of cross-fertilization between AR and DR has received much attention recently (de Figueiredo and de Cunha 2007; Järvinen 2007; Lee 2007; Loebbecke and Powell 2009). Some researchers stress that the two approaches are similar (de Figueiredo and de Cunha 2007; Järvinen 2007; Lee 2007), while others point out their differences (Iivari and Venable 2009). Still others suggest a middle ground where methodological support is provided by either incorporating principles of AR in DR (Pries-Heje et al. 2007) or combining the two (Sein et al. 2007).

These attempts keep AR and DR conceptually apart even when the two are used as part of the same research process. For instance, Iivari (2007b) proposes a two-step process: first designing an IT artifact through DR and then evaluating the artifact by implementing it in an organization through an AR project. In a similar vein, Lee (2007) places March and Smith's (1995) framework of DR into AR cycles where the specific form of AR is dialogical action research (Mårtensson and Lee 2004), and essentially promotes using the two methods in conjunction. Finally, Cole et al. (2005) suggest (1) adding a "reflection" phase to DR to augment learning, (2) adding a "build" phase to AR to concretize learning and framing the output of AR as a DR artifact, such as prototypes, frameworks, or models, and (3) an integrated research approach combining the two. These contributions are steps toward developing a DR method that accommodates the interaction of design efforts and contextual factors throughout the design process.

A feature of these cross-fertilization attempts is that they combine AR and DR by either sequencing or interleaving self-contained steps. They add organizational intervention but reproduce the sequencing and separation problem of DR. Cole et al. (2005), for example, separate building from intervention, and separate the two from evaluation. By ignoring the interplay between planned design and the context, they do not capture the emergent nature of the ensemble artifact, and, in effect, disregard arguments by Iivari (2003) that design outcomes are not final. While the researcher may guide the initial design, the ensemble artifact emerges through the interaction between design and use. This means that the artifact must eventually reflect intended as well as unintended organizational consequences. Such reshaping is not just reacting to the environment but also intentional changes to the design (Nandhakumar et al. 2005). Various forms of the organizational context are thus inscribed into the artifact during its development and use. As the process unfolds, mutated forms of the artifact emerge and can be distinguished at different points in time (see Gregor and Jones 2007).

A new research method is needed to conduct DR that recognizes that the artifact emerges from interaction with the organizational context even when its initial design is guided by the researchers' intent. We propose ADR as such a method.

The ADR Method

ADR is a research method for generating prescriptive design knowledge through building and evaluating ensemble IT artifacts in an organizational setting. It deals with two seemingly disparate challenges: (1) addressing a problem situation encountered in a specific organizational setting by intervening and evaluating; and (2) constructing and evaluating an IT artifact that addresses the class of problems typified by the encountered situation. The responses demanded by these two challenges result in a method that focuses on the building, intervention, and evaluation of an artifact that reflects not only the theoretical precursors and intent of the researchers but also the influence of users and ongoing use in context.

Since it focuses on ensemble artifacts, ADR deals with certain critical issues. First, evaluation efforts cannot follow building in a sequence as suggested in prior, stage-gate models of DR. Second, controlled evaluation efforts are difficult to design and conduct. Finally, innovation must be defined for the class of systems typified by the ensemble artifact. The ADR method contains stages and principles that address these issues. In the following, we describe the stages, each anchored by principles that capture the underlying assumptions, beliefs, and values (see Figure 1).

Stage 1: Problem Formulation

The trigger for the first stage is a problem perceived in practice or anticipated by researchers. It provides the impetus for formulating the research effort. The input for this formulation can come from practitioners, end-users, the researchers, existing technologies, and/or review of prior research. Often coupled with an initial empirical investigation of the problem, this stage includes determining the initial scope, deciding the roles and scope for practitioner participation, and formulating the initial research questions.

The problem formulation stage identifies and conceptualizes a research opportunity based on existing theories and technologies (see Hevner et al. 2004). A critical element is securing long-term commitment from the participating organization(s) beyond this stage. Another critical element is defining the problem as an instance of a class of problems. Although this definition may be tentative, it lays the groundwork to address the tension between solving the problem as encountered and deals with a broader class of problems.

Once identified, articulated, and scoped, the problem serves as inspiration for research efforts and presents the opportunity for scholarly knowledge creation. A researcher–client agreement similar to AR efforts (Davison et al. 2004) can become the basis for mutual understanding of the scope, focus, and mode of inquiry. It also sets up the roles and responsibilities of the research team that includes researchers and practitioners. Figure 2 depicts the tasks in the problem formulation stage.

This stage draws on two principles: practice-inspired research and theory-ingrained artifact.

Principle 1: Practice-Inspired Research. This principle emphasizes viewing field problems (as opposed to theoretical puzzles) as knowledge-creation opportunities. ADR seeks these opportunities at the intersection of technological and organizational domains, although the degree of novelty can vary across the two. The intent of the ADR team should not be to solve the problem *per se* as a software engineer or a consultant might. Neither should it be only to intervene within the organizational context of the problem. Instead, the action design researcher should generate knowledge that can be applied to the class of problems that the specific problem exemplifies. As a result, the research activity is problem-inspired (Markus et al. 2002; Vaishnavi and Kuechler 2006).

Principle 2: Theory-Ingrained Artifact. This principle emphasizes that the ensemble artifacts created and evaluated via ADR are informed by theories. To define what constitutes a theory, we use Gregor's (2006) criterion of "the power to generalize." Gregor considers systems of statements that allow generalization and abstraction to be theories. The level of predictive power can vary, and theories can range from universal laws of natural science to ones with more restricted scope, such as the technology acceptance model (TAM). Following Venable (2006), we believe that Gregor's theories

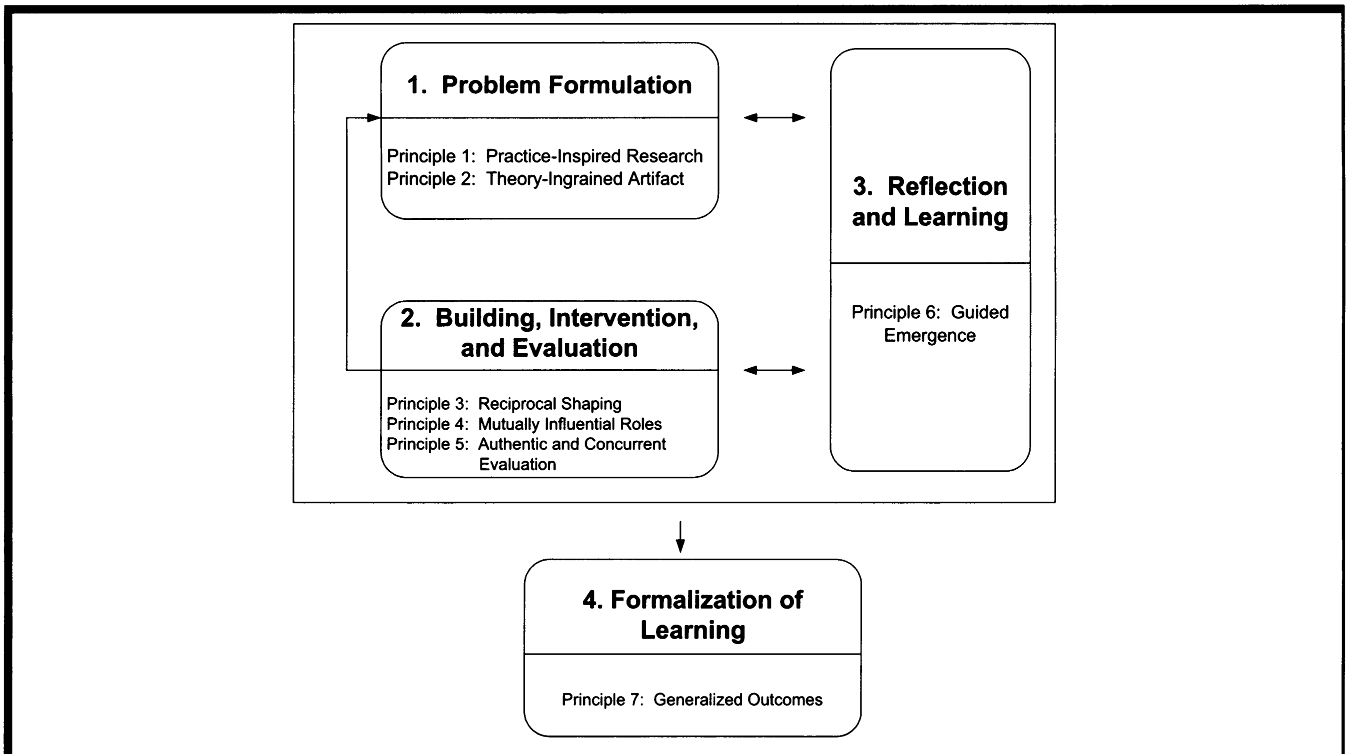


Figure 1. ADR Method: Stages and Principles

(1) Identify and conceptualize the research opportunity
(2) Formulate initial research questions
(3) Cast the problem as an instance of a class of problems
(4) Identify contributing theoretical bases and prior technology advances
(5) Secure long-term organizational commitment
(6) Set up roles and responsibilities

Figure 2. Tasks in the Problem Formulation Stage

of Type IV (explanation and prediction theories) or Type V (design theories) are likely candidates for ADR.

This principle acknowledges three overlapping uses of prior theories: to structure the problem (Type IV), to identify solution possibilities (Type IV), and to guide design (Type V). This principle suggests that, like technology designers who inscribe in the artifact theoretical traces that reflect the sociopolitical context of the design situation (Hanseth and Monteiro 1997), the action design researcher actively inscribes theoretical elements in the ensemble artifact, thus manifesting the theory "in a socially recognizable form" (Orlikowski and Iacono 2001, p. 121). This act of inscribing, however, results in only the initial design of the theory-ingrained artifact. It is then subjected to organizational practice, providing the basis for cycles of intervention, evaluation, and further reshaping.

Stage 2: Building, Intervention, and Evaluation

The second stage of ADR uses the problem framing and theoretical premises adopted in stage one. These premises provide a platform for generating the initial design of the IT artifact, which is further shaped by organizational use and subsequent design cycles. Carried out as an iterative process in a target

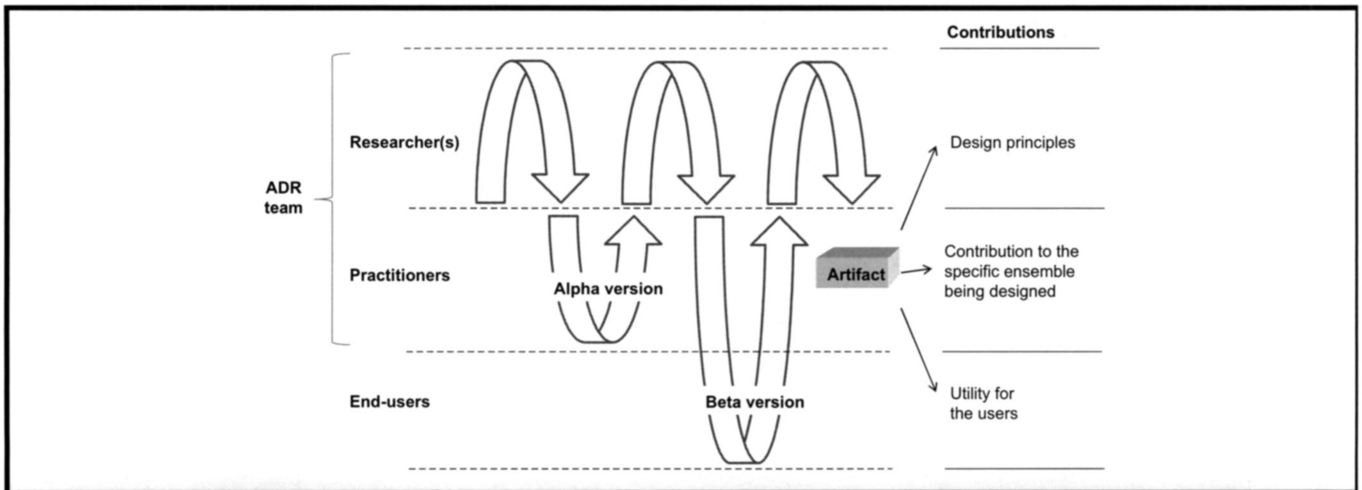


Figure 3. The Generic Schema for IT-Dominant BIE

environment, this phase interweaves the *building* of the IT artifact, *intervention* in the organization, and *evaluation* (BIE). The outcome of the BIE stage is the realized design of the artifact. During BIE, the problem and the artifact are continually evaluated, and the design principles are articulated for the chosen class of systems. This stage also clarifies the locus of innovation, which may come from the artifact design or the organizational intervention. This difference represents the key choice influencing the research design followed by the ADR team. We identify two end points for the research design continuum: IT-dominant BIE and organization-dominant BIE.

IT-Dominant BIE: At one end of the continuum, the BIE may be IT-dominant. This approach suits ADR efforts that emphasize creating an innovative technological design at the outset. An example of an artifact that may spawn an IT-dominant BIE cycle is new process grammars to generate and manage business process alternatives (e.g., Lee et al. 2008). Practitioners with first-hand experience of the projected use setting have opportunities to influence the design throughout this stage. Early designs and alpha versions serve as light-weight interventions in a limited organizational context. The emerging artifact, as well as the theories ingrained in it, are continuously instantiated and repeatedly tested through organizational intervention and subjected to participating members' assumptions, expectations, and knowledge. This highly participatory process builds organizational commitment and guides the eventual design of the ensemble artifact.

Building on these initial interactions, the ADR team takes a more mature artifact (beta version) into a wider organizational setting. This step allows for a comprehensive intervention that involves evaluating the artifact in the use setting. The goal of this large-scale evaluation is the ongoing refinement of the artifact as it is shaped and reshaped by the use context. This stage of intervention may result in the exit of the researchers or spawn a new BIE cycle. Figure 3 illustrates the generic schema for IT-dominant BIE.

Organization-Dominant BIE: At the other end of the continuum is organization-dominant BIE, suited for ADR efforts to generate design knowledge where the primary source of innovation is organizational intervention. An example of an artifact that can spawn organization-dominant BIE is the set of tools created by Pries-Heje and Baskerville (2008) for structuring decision-making situations in organizations.

During the iterations in this form of BIE, the ADR team challenges organizational participants' existing ideas and assumptions about the artifact's specific use context in order to create and improve the design. Each iteration ends with an assessment of the artifact and design principles that it represents. This form of BIE deploys the artifact in the organization early in the design iterations. The iterations stop either when the organization decides to adopt or reject the ensemble artifact, and/or when the contributions of additional cycles are marginal. Figure 4 illustrates the generic schema for organization-dominant BIE.

The two BIE forms define a continuum. Several points are possible along this continuum, including a high degree of innovation in both the technological and organizational ends. Figure 5 depicts the tasks in the BIE stage.

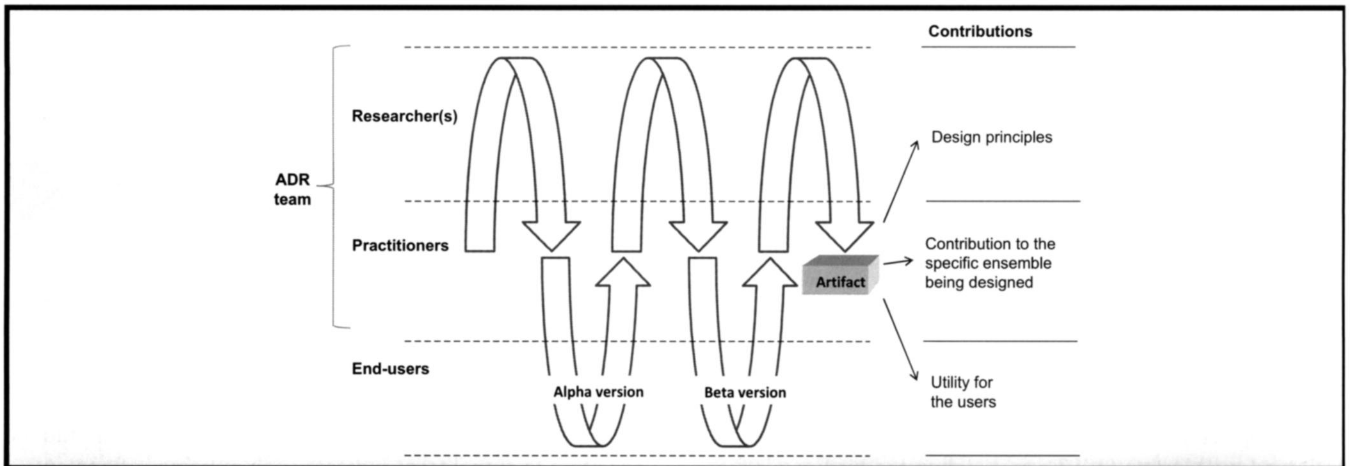


Figure 4. The Generic Schema for Organization-Dominant BIE

(1) Discover initial knowledge-creation target
(2) Select or customize BIE form
(3) Execute BIE cycle(s)
(4) Assess need for additional cycles, repeat

Figure 5. Tasks in the Building, Intervention, and Evaluation Stage

This stage draws on three principles: reciprocal shaping, mutually influential roles, and authentic and concurrent evaluation. Together, these principles emphasize the inseparability of the domains that influence the ADR project.

Principle 3: Reciprocal Shaping. This principle emphasizes the inseparable influences mutually exerted by the two domains: the IT artifact and the organizational context. The ADR team may engage in recursive cycles of decisions at finer levels of detail in each domain. This iterative process is similar to what DeGrace and Stahl (1990) describe as solving "wicked problems." For example, the ADR team may use its chosen design constructs to shape its interpretation of the organizational environment, use this increasing understanding of the organizational environment to influence the selection of design constructs, and/or interleave the two. Depending on the BIE form, the starting domain for these iterations can change, reflecting the research setting and the researcher's stance.

Principle 4: Mutually Influential Roles. This principle points to the importance of mutual learning among the different project participants. Action design researchers bring their knowledge of theory and technological advances, while the practitioners bring practical hypotheses and knowledge of organizational work practices. These perspectives and contributions may compete with one another or be complementary (Mathiassen 2002). Moreover, while individuals may play different and even multiple roles, these roles may not be mutually exclusive. Nevertheless, a clear assignment of these responsibilities is important to enable reflecting on the experience by each participant.

Principle 5: Authentic and Concurrent Evaluation. This principle emphasizes a key characteristic of ADR: evaluation is *not* a separate stage of the research process that follows building. In this, ADR differs from the stage-gate models proposed in prior work (see March and Smith 1995; Peffers et al. 2008). Instead, decisions about designing, shaping, and reshaping the ensemble artifact and intervening in organizational work practices should be interwoven with ongoing evaluation, although their specific format may vary based on the BIE form.

Evaluation cycles for the alpha version are formative, contributing to the refinement of the artifact (Remenyi and Sherwood-Smith 1999; Scriven 1996) and surfacing anticipated as well as unanticipated consequences. Later evaluation

(1) Reflect on the design and redesign during the project
(2) Evaluate adherence to principles
(3) Analyze intervention results according to stated goals

Figure 6. Tasks in the Reflection and Learning Stage

of the beta versions is summative, assessing value and utility outcomes. However, controlled evaluation can be difficult to achieve in an ADR project due to the emergent nature of the artifact. Therefore, evaluation opportunities should be sought following natural controls where possible, similar to tactics followed by Markus (1983), and elaborated by Lee (1989). Consequently, authenticity is a more important ingredient for ADR than controlled settings.

Stage 3: Reflection and Learning

The reflection and learning stage moves conceptually from building a solution for a particular instance to applying that learning to a broader class of problems. This is a continuous stage and parallels the first two stages (see Figure 1). The stage recognizes that the research process involves more than simply solving a problem. Conscious reflection on the problem framing, the theories chosen, and the emerging ensemble is critical to ensure that contributions to knowledge are identified. It is also important to adjust the research process based on early evaluation results to reflect the increasing understanding of the ensemble artifact. Figure 6 depicts the tasks of this stage.

This stage draws on one principle: guided emergence.

Principle 6: Guided Emergence. The terms *design* and *emergence* seem antithetical because the former implies external, intentional intervention, whereas the latter conveys a sense of organic evolution. This principle, therefore, uses the term *guided emergence* to capture a vital trait of ADR: the interplay between the two seemingly conflicting perspectives. It emphasizes that the ensemble artifact will reflect not only the preliminary design (see Principle 2) created by the researchers but also its ongoing shaping by organizational use, perspectives, and participants (see Garud et al. 2008; Iivari 2003) (see Principles 3 and 4 respectively), and by outcomes of authentic, concurrent evaluation (see Principle 5). These refinements include not only trivial fixes but also substantial changes to the design, meta-design, and meta-requirements (Walls et al. 1992) that culminate in changes to the artifact, similar to the idea of mutations described by Gregor and Iivari (2007). Anticipated as well as unanticipated consequences prompt these refinements during the BIE iterations, which provide an opportunity for the ADR team to generate and evolve design principles throughout the process. This principle emphasizes that the ADR team should be sensitive to signals that indicate such ongoing refinement.

Stage 4: Formalization of Learning

The objective of the fourth stage of ADR is to formalize the learning. Following Van Aken (2004), the situated learning from an ADR project should be further developed into general solution concepts for a class of field problems (see Principle 1). Casting the problem-instance into a class of problems (see Stage 1) facilitates this conceptual move. Researchers outline the accomplishments realized in the IT artifact and describe the organizational outcomes to formalize the learning. These outcomes can be characterized as design principles and with further reflection, as refinements to theories that contributed to the initial design (see Principle 2). Figure 7 depicts tasks in this stage.

This stage draws on one principle: generalized outcomes.

Principle 7: Generalized Outcomes. Generalization is challenging because of the highly situated nature of ADR outcomes that include organizational change along with the implementation of an IT artifact. The resulting ensemble is, by definition, a bundle of properties in different domains. This ensemble represents a *solution* that addresses a *problem*. Both can be generalized. This move from the specific-and-unique to generic-and-abstract is a critical component of ADR. We suggest three levels[3] for this conceptual move: (1) generalization of the problem instance, (2) generalization of the solution instance, and (3) derivation of design principles from the design research outcomes.

[3]We thank the associate editor for suggesting the idea of levels of generalization.

(1) Abstract the learning into concepts for a class of field problems
(2) Share outcomes and assessment with practitioners
(3) Articulate outcomes as design principles
(4) Articulate learning in light of theories selected
(5) Formalize results for dissemination

Figure 7. Tasks in the Formalization of Learning Stage

The first level consists of casting the original *problem* as an instance of a class (following the foundation laid in Principle 1). The second level entails reconceptualizing the specific *solution* instance into a class of solutions, because an ADR effort will result in a highly organization-specific solution. The third level requires reconceptualizing the learning from the specific solution instance into design principles for a class of solutions. These design principles, which are identified and refined through the reflection and learning stage, are fully formulated and articulated during this stage of formalizing learning. The design principles capture the knowledge gained about the process of building solutions for a given domain, and encompass knowledge about creating other instances that belong to this class (Dasgupta 1996; Purao 2002). The design principles are shaped via the BIE cycles of the ADR project. Their derivation follows an inductive step similar to that suggested by Lee and Baskerville (2003); it connects the generalized outcomes, in the form of design principles, to a class of solutions and a class of problems.

ADR at Volvo

In this section, we illustrate how ADR can be applied by describing a research project conducted at Volvo IT. The case was previously presented in published work as AR with a design orientation (Lindgren et al. 2004). However, it provides excellent material that can be reinterpreted to illustrate the major features of ADR. Already at the time of publication, we[4] reasoned that the methodology used, canonical action research (Davison et al. 2004; Susman and Evered 1978), provided little support for interweaving the building of the IT artifact, intervening in the organization, and evaluating. We noted that "such guidance would have enabled us to focus more on learning and reflection about the interplay between the knowledge generation and emergent changes in the client-system infrastructure" (Lindgren et al. 2004, p. 466). The articulation of ADR principles and stages should be seen as an attempt to formulate a method that addresses this problem.

Before using the ADR lens to reflect on how the Volvo project was carried out, the next subsection describes the class of problems in focus: competence management in organizations.

Competence Management as a Class of Problems

Competence management denotes the specification of an organization's competence needs, the identification of competence gaps, competence sourcing, competence development through training and coaching, and the staffing of projects (Baladi 1999). Properly executed, competence management ensures that employees have access to the competences necessary for helping the organization to reach its objectives. Organizations have long recognized the strategic importance of IT for providing a common platform for competence management activities. In the past, organizations relied on database applications, spreadsheets, and Word documents for managing competencies. Over time, more advanced IT systems have been proposed to respond effectively to the user requirements for competence management practice.

As a particular class of information systems, full-blown competence management systems (CMS) are specifically designed to help organizations manage competence at the individual and organizational levels (Alavi and Leidner 2001; Andreu and Ciborra 1996; Davenport and Prusak 1998; Hustad and Munkvold 2005). The main characteristic that such systems share is storing measurements of organizational members' competencies in hierarchical tree structures (see Figure 8). The systems use a grading scale to indicate the level of skill for a certain competence. With stored competence data as a basis, CMS facilitate searching for specific competencies and analyzing gaps between existing and wanted competencies. They are thus designed to support organizations in managing their competence in a structured and efficient way.

[4]We report the case in first person to reflect the personal decisions and reflections of the authors from the original paper while the research was carried out, and their re-interpretation in writing this paper.

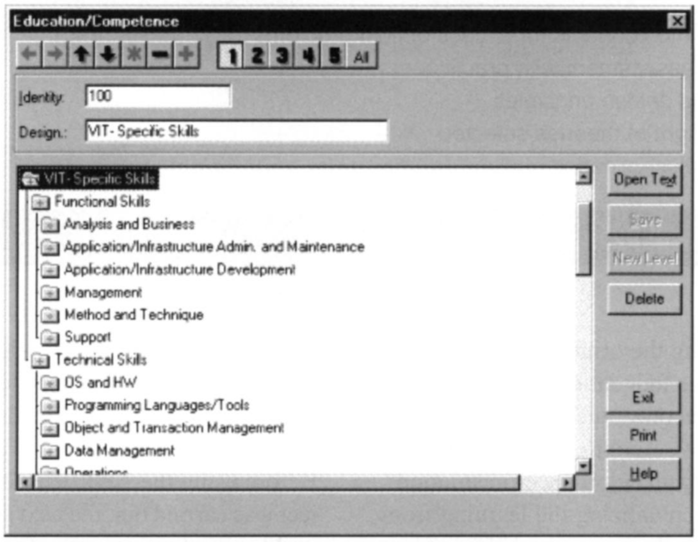


Figure 8. Competence Tree of Existing System

Recognizing that knowledge work processes differ qualitatively from personnel administration processes managed by human resource departments, we suspected that existing CMS and their associated, implicit, design theories would not adequately serve the unique requirements of this class of design situations. This suspicion served as a stimulus to form a research program to investigate this problematic situation. Several organizations such as EHPT (formerly Ericsson/Hewlett-Packard Telecom), Frontec, Guide, Volvo Car Corporation, Volvo IT, and Volvo Truck Corporation participated in the program.

CMS at Volvo IT

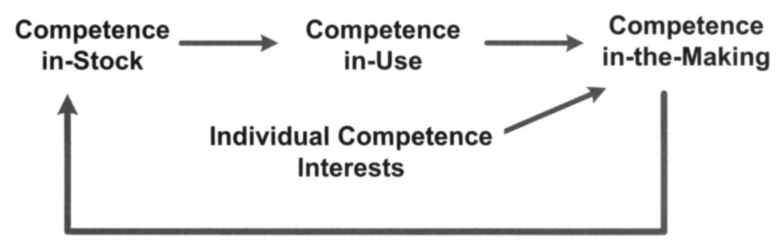
The project began in July 1999, and continued for two and a half years at Volvo IT. The objective was to develop and test design principles for CMS. Such design principles were expected to be an important theoretical contribution, because they would both provide guidance to developers and set a new agenda for design research.

In the **problem formulation** stage, we diagnosed inaccurate and incomplete competence data as a central problem with the existing CMS, TietoPersona/HR. We identified three stakeholders: the Web Program Center, the HR department, and knowledge workers. Together with the researchers, representatives from these three groups formed the ADR team. Based on focus group discussions, participant observation, technology review, workshop sessions, semi-structured interviews, and attempts to adapt existing technology, our initial study traced the competence data problem to system functionality and features (see Table 1). Specifically, the existing CMS isolated users through hierarchically structured competence descriptions, emphasized only historical competence, and was perceived by the users as following a rigid reporting style. We observed how users misrepresented themselves in the system, provided incomplete information, and recorded competence information inconsistently across different organizational units. This reduced the use of the current CMS, and users perceived it to be ineffective. After failing to reconfigure the system to overcome these problems, we anticipated that poor data quality would remain a continuing problem within the confines of existing systems.

We concluded from our examination of HR literature (Lawler 1994; Lawler and Ledford 1992; Sandberg 2000) that Tieto Persona/HR lacked the dynamism necessary for an effective competence management practice at Volvo IT. Instead, it manifested the so-called job-based assumptions that reflected fossilized practices such as hierarchical capture of past competencies. This mismatch made the existing system counterproductive to competence management and development.

Based on the results of the problem formulation stage, the ADR team decided to explore a new direction. The **BIE stage** was initiated by envisioning CMS that employed a skill-based (as opposed to job-based) model of competence (Lawler 1994). Rather than emphasizing job descriptions and ways to find and shape individuals to fit them, this model

Table 1. Problems with Existing CMS	
Problem	**CMS in Use**
User isolation caused by hierarchically structured competence descriptions	• Restricted access to competence information to avoid internal recruiting • Individual users could only view their own competence descriptions • Knowledge sharing hampered
Emphasis on past competence by ignoring emerging and future competences	• Users hid competences to avoid unattractive assignments • Users overvalued competences to get attractive assignments • Users' competence development interests were unsupported
Rigid reporting style by allowing only analysis of predefined parameters	• Little support for strategic human resources planning • Inflexible reports



Competence-in-Stock: Competence that an individual has developed in the past.
Competence-in-Use: Competence that an individual applies in a competent fashion.
Competence-in-the-Making: Competence that an individual purposively develops, motivated either by their own competence interests or organizational competence needs.

Figure 9. The Competence Typology (Adapted from Figure 1 in Lindgren et al. 2004, p. 440)

focuses on the individual and her ability to contribute to the organization's competence and competitive advantage. On reviewing the literature and existing technology, we discovered that no prior research existed on designing such CMS for knowledge-intensive organizations. Therefore, we framed the research as addressing not just the concerns specific to Volvo IT, but rather, the class of field problems: competence management for knowledge-intensive organizations.

We further operationalized this theoretical framework of a skill-based approach into a life-cycle perspective of competence (see Muffatto 1998; Orlikowski 2002). We summarized this perspective as a typology consisting of three forms: competence-in-stock, competence-in-use, and competence-in-the-making (see Figure 9). Given the problems of user isolation and the emphasis on past competence, the typology was important to focus on individual competencies as an ongoing accomplishment.

Through ongoing reflection during the BIE stage, the ADR team identified three design principles that would realize this life-cycle perspective of competence: transparency, real-time capture, and interest-integration. Each design principle corresponded to a specific competence type. The transparency principle would make competence-in-stock visible and accessible to the entire organization, and was intended to address the user isolation problem discovered in the problem formulation stage. The real-time capture principle would allow for real time tracking of competence-in-use, addressing the problem of inaccurate data by generating competence data as it emerged through knowledge work in action. Finally, the principle of interest-integration would facilitate the capture of competence-in-the-making, accommodating individuals' interests as a proxy for the skills they are motivated to develop.

The working hypothesis of the ADR team was that CMS embodying these principles would be more effective than existing systems. To evaluate this working hypothesis, we translated these principles into desired features such as "find competence" and "community." Operationalizing these principles into features allowed us to move toward implementation together with Volvo IT practitioners. To complement

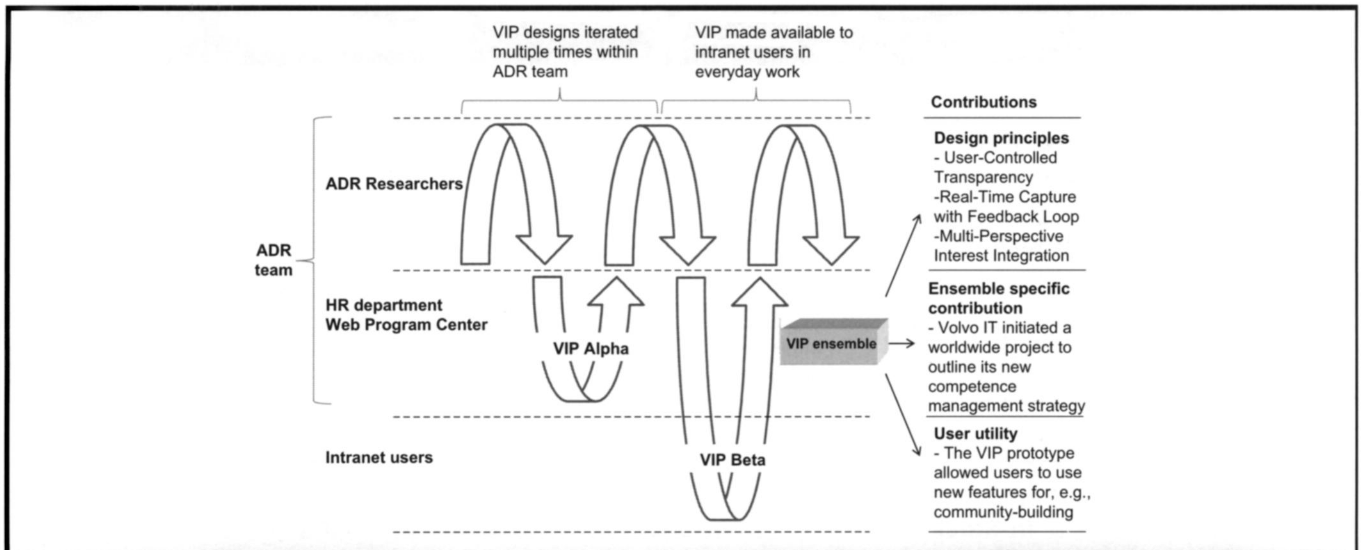


Figure 10. IT-Dominant BIE in the CMS Project at Volvo IT

the existing system, TietoPersona/HR, the ADR team decided to create intelligent agents for monitoring intranet documents and finding patterns in them according to a given set of parameters. We planned a prototype following these ideas that allowed user-defined agents to proactively seek matches based on a user's interests.

The projected system design departed substantially from the existing CMS. The BIE form selected was therefore IT-dominant BIE (see Figure 10). The three stakeholders groups identified in the problem formulation phase, the Web Program Center, the HR department, and knowledge workers, had specific roles. In the alpha-cycle, we iterated and evaluated early designs within the ADR team, who contributed different perspectives on design and use of CMS. Given their mission, the Web Program Center represented the building strand of BIE. For instance, the main developer of the ADR team was a senior information architect at this Center (he was also a Ph.D. student serving a central role in the research team). As the main problem owners, HR managers primarily directed their attention to intervention. In the ADR team, they took responsibility for aligning emerging design principles with their immediate and projected competence management problems. The iterations within the ADR team resulted in an intermediate design, implemented as a prototype called VIP (Volvo Information Portal). Figure 11 depicts the "find competence" feature of VIP.

In the beta cycle, knowledge workers, or end-users, became more involved in the process. The VIP prototype was introduced into the wider organizational setting through a comprehensive intervention. It was implemented on Volvo IT's intranet, made available to all intranet users at their Göteborg office, and evaluated in everyday work for a 10-week period. Thirty end-users were introduced to the beta prototype through workshops with departmental managers, HR managers, project managers, system developers, and technicians. In the workshops, users were trained and the vision of a new competence management practice was articulated by the ADR team. Twenty users, roughly mirroring the original composition of the group, remained active participants at the end of the evaluation period.

Throughout the execution of the BIE phase, the three stakeholders at Volvo IT represented the different focal points of the phase: building, intervention, and evaluation (see Figure 12). This organization of the project enabled the concurrency needed in the BIE phase.

Our intervention of introducing the beta prototype and the resulting formative evaluation revealed both anticipated and unanticipated consequences (see Table 2). Focus group discussions, participant observation, and semi-structured interviews showed that end users at Volvo IT appreciated VIP's implementation of transparency, which allowed users to identify colleagues based on mutual interests and to initiate knowledge sharing networks. The implementation also revealed an unanticipated consequence: potential disincentives for networking. In cases where a specific competence could not be located in the system, some individuals perceived a sense of vulnerability when nobody was found having the competence or sharing the interest of the user.

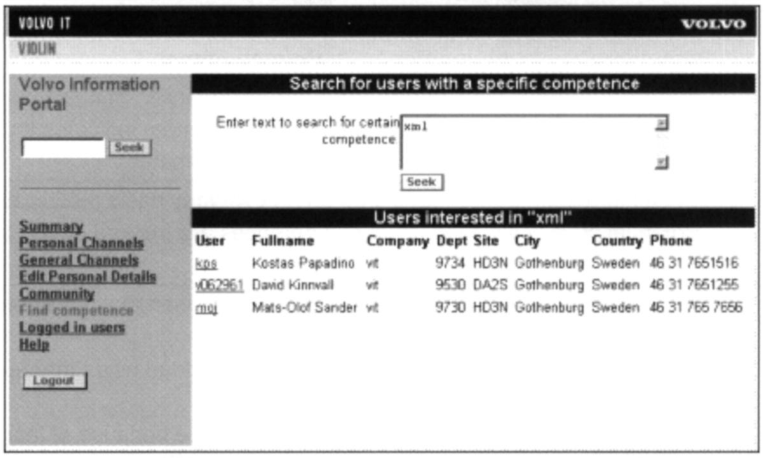


Figure 11. The "Find Competence" Feature of VIP

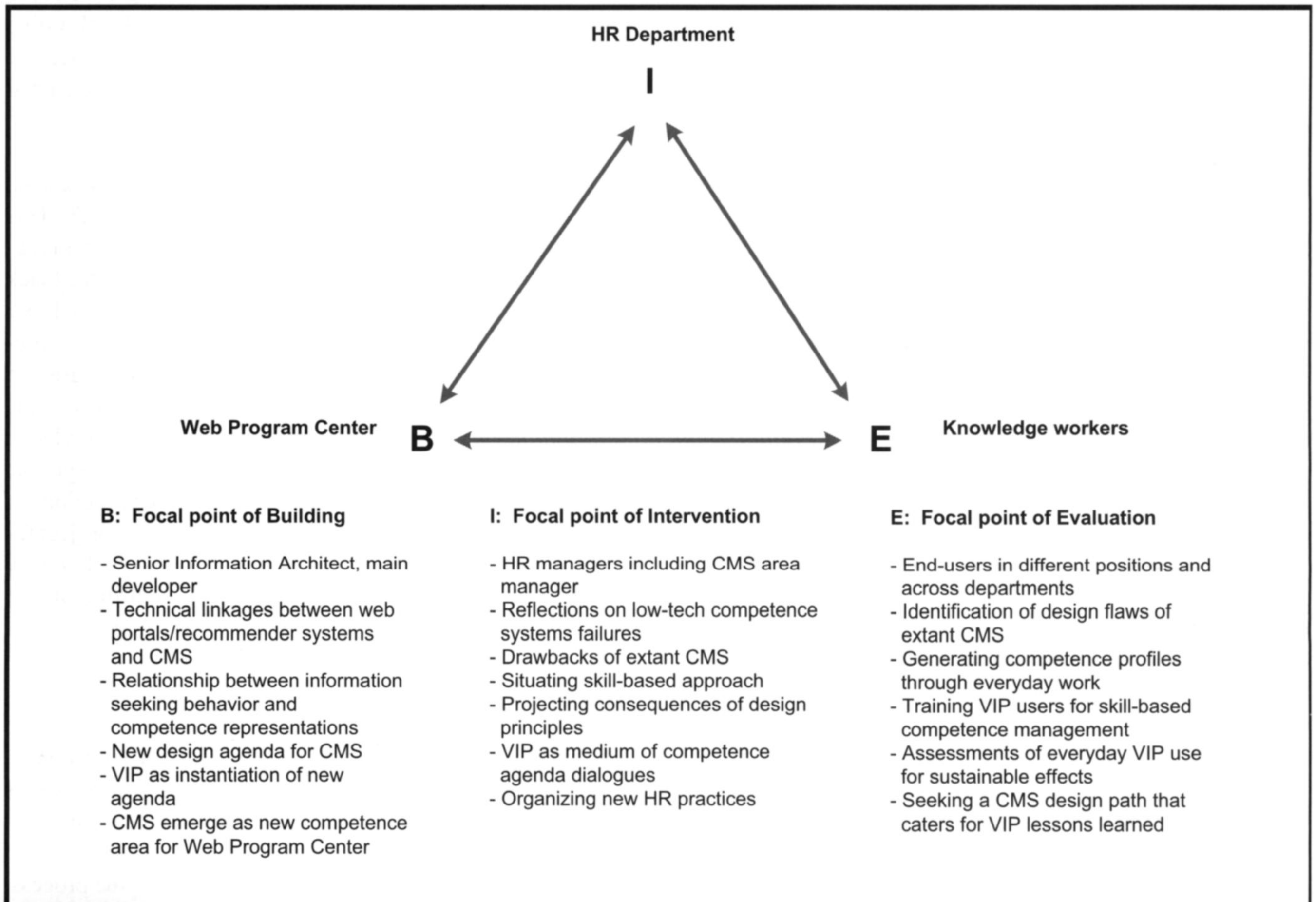


Figure 12. Detailed View of BIE at Volvo IT

Table 2. Consequences of Building, Intervention, and Evaluation of VIP

Design Principle	Consequences
Transparency	• Facilitated identification of colleagues at Volvo IT with mutual interests (anticipated) • Potential to hamper knowledge sharing when system indicates that no one else in the organization shares a particular interest (unanticipated)
Real-Time Capture	• Useful for tracking what people do on an everyday basis (anticipated) • Potential privacy violation when competences are tracked on the basis of system use (unanticipated)
Interest-Integration	• VIP was appreciated for implying a future orientation that would stimulate competence development (anticipated) • Risk that competent individuals get heavier workload when interests become visible to entire organization (unanticipated) • Little managerial incentives for promoting VIP use because of lack of performance criteria related to the tracking of competence-in-use and competence-in-the-making (unanticipated)

Users also valued VIP's ability to capture competence and competence interests in real-time, especially for accurately tracking competence-in-use, which was problematic with the previous CMS. However, the potential violation of privacy perceived by some end users when making personal information transparent and traceable in real-time was an unanticipated consequence of the real-time capture principle. Finally, users appreciated the principle of interest-integration for its support of competence development and future-orientation. Yet, heavier workload was feared by competent employees when their interests were made public, particularly in areas where many other workers wished to develop a competence. This was an unanticipated consequence of VIP use, as was managers' relative lack of interest, which we could trace to the absence of performance criteria for competence-in-use and competence-in-the-making. With hindsight, we can now say that these episodes revealed the ensemble nature of the emerging VIP prototype, with elements beyond those the ADR team had initially designed.

In **reflecting and learning**, we noted that the evidence collected on VIP and its embedded design principles revealed both anticipated and unanticipated consequences. This helped us understand the VIP prototype as an ensemble. Based on what we had learned about VIP in the end-user context, we revised the design principles (see Table 3; changes are in italics). For instance, we revised the transparency principle by adding user control over their competence profiles to reduce perceived anxiety.

We operationalized the revised set of design principles in another iteration of the ensemble artifact that included managerial policies concerning competence development, control, sharing, and tracking for its application in competence management. Throughout the BIE stage, we could observe how VIP emerged. On an organizational level, Volvo IT initiated a worldwide project in which its new competence management strategy was influenced by the learning gained in the project.

The final stage, **formalization of learning**, explicitly defined the VIP prototype as representative of the class of CMS. This resulted in the formalization of a set of design principles (e.g., user-controlled transparency, real-time capture with feedback loop, and multi-perspective interest-integration; see Table 3). This articulation of the class of problems, the class of solutions, and the design principles for this class directly satisfied ADR's generalization principle. The design principles define the DR contribution and represent design knowledge emerging from the application of ADR. Ensemble specific knowledge and user utility are also important contributions of an ADR project. In the CMS case, Volvo IT's new project for a new competence management strategy and VIP's new features for community-building were such contributions.

Summary of the Case

The right-hand side of Figure 10 summarizes different contributions of the CMS project, while Table 4 summarizes its ADR process. The first two columns of the table map the project tasks against the ADR principles. The third column traces the ensemble artifact at different stages of the process.

In reinterpreting the CMS project at Volvo IT, our retrospective analysis revealed a few critical changes to the manner in which the research was reported earlier by Lindgren et al. (2004). These changes reflect the important contributions of

Table 3. Revised Set of Design Principles

Design Principle	Description
User-Controlled Transparency	Competence-in-stock should be visible and accessible to the entire organization. *However, the control over which competence data is publicly displayed should rest with the user.*
Real-Time Capture *with Feedback Loop*	The system should track competence-in-use in real-time to generate competence data as it emerges through knowledge work in action. *However, users should be able to amend the system's representation of their competence.*
Multi-Perspective Interest Integration	Competence-in-the-making should be captured by accommodating individuals' interests as a proxy for the skills that they are motivated to develop. *However, the organization's perspective should also be incorporated into the system to address the potential tension between individuals' interests and the organization's needs.*

Table 4. Summary of the ADR Process in the CMS Project

Stages and Principles		Artifact
Stage 1: Problem Formulation		
Principle 1: Practice-Inspired Research	Research was driven by the need for better IT support of competence management in knowledge-intensive organizations.	***Recognition***: Shortcomings of the existing CMS recognized as lacking the dynamism necessary for effective competence management.
Principle 2: Theory-Ingrained Artifact	The theory used was the skill-based model of competence and a competence typology.	
Stage 2: BIE		
Principle 3: Reciprocal Shaping	Poor data quality was expected to be an ongoing problem. Problems encountered were iteratively addressed and formulated as early design principles in collaboration with practitioners.	***Alpha Version***: The artifact conceived as a design idea; it should be reflective of the skill-based (not job-based) model of competence. ***Beta Version***: VIP prototype designed to implement skill-based competence and evaluate early design principles.
Principle 4: Mutually Influential Roles	The ADR team included researchers and practitioners in order to include theoretical, technical, and practical perspectives. The lead designer was an employee from Volvo IT who was also a Ph.D. student.	
Principle 5: Authentic and Concurrent Evaluation	VIP was first evaluated within the ADR team and then in the wider setting of end-users at Volvo IT.	
Stage 3: Reflection and Learning		
Principle 6: Guided Emergence	The ensemble nature of the VIP artifact was recognized. Furthermore, design elements for the IT component and changes to assumptions related to work practices emerged.	***Emerging Version and Realization***: New requirements for the VIP artifact based on results emerging in the BIE stage. A revised version of the initial design principles.
Stage 4: Formalization of Learning		
Principle 7: Generalized Outcomes	A set of design principles for CMS was articulated, positioning VIP as an instance.	***Ensemble Version***: An ensemble embodying the design principles and managerial policies for CMS use.

the ADR method. First, the analysis revealed the role of concurrent evaluation in the way the artifact emerged from the interplay between design ideas contributed by the researchers and social/organizational forces in the environment. Second, the analysis clarified the ensemble nature of the artifact as a result of not only the development by the ADR team but also its shaping by individual and organizational practices. Third, the analysis highlighted the artifact as an instance of a class of artifacts, namely CMS, and identified design principles for this class, thus generalizing the findings.

Discussion

Our essay is built upon the premise that ensemble artifacts are dynamic and emerge from the contexts of both their initial design and continual redesign via organizational use (Gregor and Jones 2007; Iivari 2003; Orlikowski and Iacono 2001). This integrated view requires bridging concerns traditionally separated by disciplinary boundaries. To this end, we developed ADR as a DR method that explicitly recognizes the emergence of artifacts at the intersection of IT and organization (see Lee 2001; Orlikowski and Barley 2001).

ADR supports knowledge creation through the design and appreciation of ensemble artifacts. We outline ADR as a research method with the potential to encourage researchers to pursue more holistic perspectives on artifact design and use compared to dominant DR thinking. By intervening through concurrent building and evaluation, action design researchers are well positioned to analyze the continuing adaptation of the artifact and the local practices of its use, and to make such analysis the basis for generalizing. This mode of reasoning is important because technological artifacts typically exhibit emergent properties that are unanticipated during design (Iivari 2003). Thus, ADR is well suited to answer the call for theorizing ensemble artifacts (Orlikowski and Iacono 2001) by investigating their evolution over time and in use (Gregor and Jones 2007; Iivari 2003).

Knowledge Outcomes from ADR

We have illustrated the use of ADR through a case that exhibits its essential properties. However, because the VIP project was not conducted explicitly as ADR, it cannot be viewed as an exemplar of its application. It nevertheless generated new knowledge through the in-context design of an artifact, which was inscribed with theoretical elements.

In conceptualizing IT artifacts as ensembles, we recognize that they are shaped by the context of their use. For example, since VIP was meant to help an organization manage the competence of its employees, it follows that its managerial policies shape how the system is used. These policies should be incorporated when formulating principles for the class of information system to which VIP belongs. In return, the lessons learned from the development and use of VIP informed Volvo IT in formulating a competence management strategy.

It should be clear that the CMS case exemplifies designing artifacts in context with the objective of generating scholarly knowledge. To determine the contribution of ADR, however, it is worth exploring whether a project that followed an existing DR method would have yielded similar results. This is a hypothetical question, which nevertheless is important to address when evaluating the value of ADR. Such evaluation is by necessity bounded by assumptions about causal agency and the logical formulation of the theoretical argument (Markus and Robey 1988). The logical formulation of theoretical arguments in ADR follows that of process studies, which means that "causation consists of necessary conditions in sequence" and that the absence of such necessary conditions will hinder the outcome from occurring (Markus and Robey 1988, p. 590).

Current DR methods are based on stage-gate models in that they separate and sequence building and evaluation. Thus, they do not support the conditions necessary for generating knowledge about the ensemble artifact through design. Such conditions include a process where building, intervention, and evaluation are integrated (i.e., BIE). In the CMS case, the use of a DR method (such as the one articulated by Peffers et al. 2008) could presumably have led to the initial VIP prototype. However, the shaping of the design principles over multiple artifact versions through intervention and evaluation in competence management practice would not have been supported by this method.

We therefore argue that applying an existing stage-gate DR method would not have yielded the same results as did our case. However, there is no guarantee that ADR will always lead to new design knowledge even when the necessary conditions are established in a sequence. In keeping with the assumptions of process research, chance and randomness will play a role (Markus and Robey 1988). In such a case where no viable design principles emerge from the project, we cannot say that the action design researcher has achieved the research goal.

It should be emphasized that ADR is not intended to replace extant DR methods. Many design problems are better suited to a stage-gate model of DR. Examples may include systems developed for fly-by-wire systems or nuclear plants. By the same token, ADR is useful for open-ended IS research problems that require repeated intervention in organizations to establish the in-depth understanding of the artifact–context relationship needed to develop a socio-technical design agenda for a specific class of problems.

Related Approaches

Our essay contributes to the growing body of literature that explores the intersection of AR and DR (Cole et al. 2005; de Figueiredo and de Cunha 2007; Iivari and Venable 2009; Järvinen, 2007; Lee 2007; Pries-Heje et al. 2007). First, ADR represents a comprehensive research method that outlines stages and principles. This has not been the case so far in this literature. For example, Lee (2007) describes possible steps of an integrated approach but does not outline grounding principles. Pries-Heje et al. (2007) stress the importance of evaluation and learning in organizational settings, but they do not propose a process or method. De Figueiredo and de Cunha (2007) examine the pragmatics of combination but only provide a sketch of a combined process. Second, we argue that this literature tends to reproduce the sequencing problem of DR. While organizational intervention is added to the traditional DR process, the approaches still combine DR and AR by either sequencing or interleaving self-contained steps.

We believe that ADR complements and extends this discourse. As is appropriate for an applied discipline, IS researchers must in one way or another fulfill the dual mission of advancing theory while producing knowledge to support IS practitioners in solving current and anticipated problems. ADR emphasizes the inseparability of building, intervention, and evaluation, reflecting the nature of ensemble artifacts. It is therefore neither a simple aggregation nor the simple interleaving of steps. Nor does it represent just a middle ground between AR and DR in terms of methodological guidance. Specifically, ADR bridges the use-oriented perspective of the IT artifact (e.g., Orlikowski 2000) and the technological perspective (e.g., March and Smith 1995). The primacy of iteration in principles such as reciprocal shaping and mutually influential roles recognizes and emphasizes the interdependence of building, intervention, and evaluation.

However, it is not straightforward to synthesize AR and DR. For instance, Iivari (2007b) argues that AR and DR differ historically, practically, ontologically, and epistemologically, as well as methodologically. ADR reconciles these diverse views by articulating a method that guides simultaneous building, intervention, and evaluation. While AR and DR can and should continue to coexist in the IS domain, methods such as ADR suggest that it is possible to develop a DR method that inherits elements of both approaches and where they have significant overlap (Iivari and Venable 2009). ADR seeks to occupy the space where research contributes to further our understanding of IS through developing artifacts in context and reflecting on the process. The ADR principles and process trace a path through this methodological space. In balancing the knowledge interests of different research streams, variations are inevitable. Variants that emphasize a greater role for design abstractions or a greater role for organizational change processes must necessarily be part of the family of methods that this methodological space will encompass. While ADR is a DR method, it may be tempting to interpret it as a variant of AR as well, especially in view of our reinterpretation of Lindgren et al. (2004). However, ADR has a number of stringent requirements that AR does not. First, ADR requires a DR contribution in the form of design principles. Second, these principles should address a class of problems. Third, the outcomes should be innovative. Epitomized in its title "Design Principles for Competence Management Systems," the Lindgren et al. paper complies with these requirements and can therefore be used to illustrate our method for incorporating action in DR.

Concluding Remarks

This essay provides methodological guidance for IS researchers who study the design of ensemble artifacts. While the case presented in this essay illustrates such research, we are aware of other researchers who are serendipitously doing what we have articulated as ADR. For instance, in personal communication, Vogel (2009) identified a project at IBM in alliance with the University of Arizona as an early example (see Grohowski et al. 1990; Vogel et al. 1990). By articulating stages and principles, our essay puts forward ADR as a method for conducting research that seeks simultaneously to satisfy calls for theorizing the IT artifact (Orlikowski and Iacono 2001) and engaging in relevant research (Dennis 2001). ADR reaches into the very core of IS: *designing* IT artifacts while allowing for their *emergence* in an organizational context, and seeking utility in the *ensemble* they represent.

Acknowledgments

We thank Omar El-Sawy, Pertti Järvinen, Peter Axel Nielsen, Lorne Olfman, Jeremy Rose, Suprateek Sarker, Ulrike Schultze, the four anonymous reviewers, and the associate and senior editors for constructive and insightful comments on earlier versions of this manuscript. We are also thankful for the feedback received when presenting our research in workshops at various universities and at IRIS and DESRIST conferences. Finally we thank Elizabeth Gross for editing.

References

Alavi, M., and Leidner, D. E. 2001. "Knowledge Management and Knowledge Management Systems: Conceptual Foundations and Research Issues," *MIS Quarterly* (25:1), pp. 107-136.

Andreu, R., and Ciborra, C. 1996. "Organizational Learning and Core Capabilities Development: the Role of IT," *Journal of Strategic Information Systems* (5:1), pp. 111-127.

Baburoglu, O. N., and Ravn, I. 1992. "Normative Action Research," *Organization Studies* (13:1), pp. 19-34.

Baladi, P. 1999. "Knowledge and Competence Management: Ericsson Business Consulting," *Business Strategy Review* (10:4), pp. 20-28.

Baskerville, R. L., and Wood-Harper, A. T. 1998. "Diversity in Information Systems Action Research Methods," *European Journal of Information Systems* (7:2), pp. 90-107.

Benbasat, I., and Zmud, R. W. 1999. "Empirical Research in Information Systems: The Practice of Relevance," *MIS Quarterly* (23:1), pp. 3-16.

Benbasat, I., and Zmud, R. W. 2003. "The Identity Crisis Within the IS Discipline: Defining and Communicating the Discipline's Core Properties," *MIS Quarterly* (27:2), pp. 183-194.

Berndt, D., Hevner, A., and Studnicki, J. 2003. "The CATCH Data Warehouse: Support for Community Health Care Decision Making," *Decision Support Systems*, (35:3), pp. 367-384.

Cole, R., Purao, S., Rossi, M., and Sein, M. K. 2005. "Being Proactive: Where Action Research Meets Design Research," in *Proceedings of 24th International Conference on Information Systems*, D. Avison, D. Galletta, and J. I. DeGross (eds.), Las Vegas, NV, December 11-14, pp. 325-336.

Cooper, R. G., Edgett, S. J., and Kleinschmidt, E. J. 2002. "Optimizing the Stage-Gate Process: What Best Practice Companies are Doing–Part Two," *Research Technology Management* (45:5), pp. 21-27.

Dasgupta, S. 1996. *Technology and Creativity*, New York: Oxford University Press.

Davenport, T. H., and Prusak, L. 1998. *Working Knowledge: How Organizations Manage What They Know*, Boston: Harvard Business School Press.

Davison, R. M., Martinsons, M. G., and Kock, N. 2004. "Principles of Canonical Action Research," *Information Systems Journal* (14:1), pp. 65-86.

de Figueiredo, A., and de Cunha, P. 2007. "Action Research and Design in Information Systems: Two Faces of a Single Coin," in *Information Systems Action Research: An Applied View of Emerging Concepts and Methods*, N. Kock (ed.), New York: Springer, pp. 61-96.

DeGrace, P., and Stahl, L. H. 1990. *Wicked Problems, Righteous Solutions*, Upper Saddle River, NJ: Prentice Hall.

Dennis, A. R. 2001. "Relevance in Information Systems Research," *Communications of the Association for Information Systems* (6), pp. 40-42.

Gallupe, R. B. 2007. "The Tyranny of Methodologies in Information Systems Research," *SIGMIS Database* (38:3), pp. 20-28.

Garud, R., Jain, S., and Tuertscher, P. 2008. "Incomplete by Design and Designing for Incompleteness," *Organization Studies* (29:3), pp. 351-371.

Gregor, S. 2006. "The Nature of Theory in Information Systems," *MIS Quarterly* (30:3), pp. 611-642.

Gregor, S., and Iivari, J. 2007. "Designing for Mutability in Information Systems Artifacts" in *Information Systems Foundations: Theory, Representation and Reality*, D. Hart and S. Gregor (eds.), Canberra: ANU Press, pp. 13-24.

Gregor, S., and Jones, D. 2007. "The Anatomy of a Design Theory," *Journal of Association for Information Systems* (8:5), pp. 312-335.

Grohowski, R., McGoff, C., Vogel, D., Martz, B., and Nunamaker, J. 1990. "Implementing Electronic Meeting Systems at IBM: Lessons Learned and Success Factors," *MIS Quarterly*, (14:4), pp. 368-383.

Hanseth, O., and Monteiro, E. 1997. "Inscribing Behavior in Information Infrastructure Standards," *Accounting, Management & Information Technologies* (7:4), pp. 183-211.

Hevner, A. 2007. "A Three Cycle View of Design Science Research," *Scandinavian Journal of Information Systems* (19:2), pp. 87-92.

Hevner, A. R., March, S. T., Park, J., and Ram, S. 2004. "Design Science in Information Systems Research," *MIS Quarterly* (28:1), pp. 75-105.

Hustad, E., and Munkvold, B. E. 2005. "IT-Supported Competence Management: A Case Study at Ericsson," *Information Systems Management* (22:2), pp. 78-88.

Iivari, J. 2003. "The IS Core – VII: Towards Information Systems as a Science of Meta-Artifacts," *Communications of the Association for Information Systems* (12), pp. 568-581.

Iivari, J. 2007a. "Nothing is as Clear as Unclear: Iivari's Response," *Scandinavian Journal of Information Systems* (19:2), pp. 111-117.

Iivari, J. 2007b. "A Paradigmatic Analysis of Information Systems as a Design Science," *Scandinavian Journal of Information Systems* (19:2), pp. 39-63.

Iivari, J., and Venable, J. 2009. "Action Research and Design Science Research: Seemingly Similar But Decidedly Dissimilar," in *Proceedings of 17th European Conference on Information Systems*, Verona, Italy, June 8-10.

Järvinen, P. 2007. "Action Research is Similar to Design Science," *Quality & Quantity* (41), pp. 37-54.

Kock, N., Gray, P., Hoving, R., Klein, H., Myers, M., and Rockart, J. 2002. "IS Relevance Revisited: Subtle Accomplishment, Unfulfilled Promise, or Serial Hypocrisy," *Communications of the Association for Information Systems* (8), pp. 330-346.

Lawler, E. E. 1994. "From Job-Based to Competency-Based Organizations," *Journal of Organizational Behavior* (15:1), pp. 3-15.

Lawler, E. E, and Ledford, G. 1992. "A Skill-Based Approach to Human Resource Management," *European Management Journal* (10:4), pp. 383-391.

Lee, A. 1989. "A Scientific Methodology for MIS Case Studies," *MIS Quarterly* (13:1), pp. 33-50.

Lee, A. 1999. "Rigor and Relevance in MIS research: Beyond the Approach of Positivism Alone," *MIS Quarterly* (23:1), pp. 29-34.

Lee, A. 2001. "Editorial," *MIS Quarterly* (25:1), pp. iii-vii.

Lee, A. 2007. "Action is an Artifact: What Action Research and Design Science Offer to Each Other," in *Information Systems*

Action Research: An Applied View of Emerging Concepts and Methods, N. Kock (ed.), New York: Springer, 2007, pp. 43-60.

Lee, A., and Baskerville, R. L. 2003. "Generalizing Generalizability in Information Systems Research," *Information Systems Research*, (14:3), pp. 221-243.

Lee, J., Wyner, G., and Pentland, B. 2008. "Process Grammar as a Tool for Business Process Design," *MIS Quarterly*, (32:4), pp. 757-778.

Lindgren, R., Henfridsson, O., and Schultze, U. 2004. "Design Principles for Competence Management Systems: A Synthesis of an Action Research Study," *MIS Quarterly*, (28:3), pp. 435-472.

Loebbecke, C., and Powell, P. 2009. "Furthering Distributed Participative Design: Unlocking the Walled Gardens" *Scandinavian Journal of Information Systems*, (21:1), pp. 77-106.

March, S. T., and Smith, G. 1995. "Design and Natural Science Research on Information Technologies," *Decision Support Systems* (15:4), pp. 251-266.

Markus, M. L. 1983. "Power, Politics, and MIS Implementation," *Communications of the ACM* (26:6), pp. 430-444.

Markus, M. L., Majchrzak, A., and Gasser, L. 2002. "A Design Theory for Systems That Support Emergent Knowledge Processes," *MIS Quarterly* (26:3), pp. 179-212.

Markus, M. L., and Robey, D. 1988. "Information Technology and Organizational Change: Causal Structure in Theory and Research," *Management Science* (34:5), pp. 583-598.

Mathiassen, L. 2002. "Collaborative Practice Research," *Information Technology & People* (15:4), pp. 321-345.

Muffatto, M. 1998. "Corporate and Individual Competencies: How do They Match the Innovation Process?," *International Journal of Technology Management* (15:8), pp. 836-853.

Mårtensson, P., and Lee, A. S. 2004. "Dialogical Action Research at Omega Corporation," *MIS Quarterly* (28:3), pp. 507-536.

Nandhakumar, J., Rossi, M., and Talvinen, J. 2005. "The Dynamics of Contextual Forces of ERP Implementation," *Journal of Strategic Information Systems* (14:2), pp. 221-242.

Nunamaker, J. F. 2007. "Traveling the Last Research Mile," Distinguished Lecture at the Symposium on Progress in Interdisciplinary Research in Information Technology, Stillwater, OK.

Nunamaker, J. F., Chen, M., and Purdin, T. D. M. 1991. "Systems Development in Information Systems Research," *Journal of Management Information Systems* (7:3), pp. 89-106.

Orlikowski, W. J. 1996. "Improvising Organizational Transformation Over Time: A Situated Change Perspective," *Information Systems Research* (7:1), pp. 63-92.

Orlikowski, W. J. 2000. "Using Technology and Constituting Structures: A Practice Lens for Studying Technology in Organizations," *Organization Science* (11:4), pp. 404-428.

Orlikowski, W. J. 2002. "Knowing in Practice: Enacting a Collective Capability in Distributed Organizing," *Organization Science* (13:3), pp. 249-273.

Orlikowski, W. J., and Barley, S. R. 2001. "Technology and Institutions: What Can Research on Information Technology and Research on Organizations Learn from Each Other?," *MIS Quarterly* (25:2), pp. 145-165.

Orlikowski, W. J., and Iacono, C. S. 2001. "Research Commentary: Desperately Seeking the 'IT' in IT Research—A Call to Theorizing the IT Artifact," *Information Systems Research* (12:2), pp. 121-134.

Peffers, K., Tuunanen, T., Rothenberger, M. A., and Chatterjee, S. 2008. "A Design Science Research Methodology for Information Systems Research," *Journal of Management Information Systems* (24:3), pp. 45-77.

Pries-Heje, J., and Baskerville, R. 2008. "The Design Theory Nexus," *MIS Quarterly* (32:4), pp. 731-755.

Pries-Heje, J., Baskerville, R., and Venable, J. 2007. "Soft Design Science Research: Extending the Boundaries of Evaluation in Design Science Research," in *Proceedings of the Second International Conference on Design Science Research in IT (DESRIST)*, Pasadena, CA, May 13-15, pp. 18-38.

Purao, S. 2002. "Truth or Dare: Design Research in the Technology of Information Systems," unpublished manuscript, Georgia State University.

Remenyi, D., and Sherwood-Smith, M. 1999. "Maximize Information Systems Value by Continuous Participative Evaluation," *Logistics Information Management*, (12:1), pp. 14-31.

Rosemann, M., and Vessey, I. 2008. "Toward Improving the Relevance of Information Systems Research to Practice: The Role of Applicability Checks," *MIS Quarterly* (32:1), pp. 1-22.

Sandberg, J. 2000. "Understanding Human Competence at Work: An Interpretative Approach," *Academy of Management Journal* (43:1), pp. 9-25.

Scriven, M. 1996. "Types of Evaluation and Types of Evaluator," *Evaluation Practice* (17:2), pp. 151-162.

Sein, M. K., Bostrom, R. P., and Olfman, L. 2003. "Mutual Learning and Informing between Academia and Practice in ISD: A Learning Theory Perspective," Chapter 47 in *New Perspective on Information Development: Theory and Practice*, G. Harindranath and J. Sillince (eds.), New York: Kluwer/Plenum.

Sein, M. K., Rossi, M., and Purao, S. R. 2007. "Exploring the Limits to the Possible: A response to Iivari," *Scandinavian Journal of Information Systems* (19:2), pp. 105-110.

Susman, G. 1983. "Action Research: A Sociotechnical Perspective," in *Beyond Method: Strategies for Social Research*, G. Morgan (ed.), Newbury Park, CA: Sage Publications, pp. 95-113.

Susman, G., and Evered, R. 1978. "An Assessment of the Scientific Merits of Action Research," *Administrative Science Quarterly* (23), pp. 582-603.

Vaishnavi, V., and Kuechler, B. 2007. "Design Research in Information Systems," ISWorld (available at http://home.aisnet.org/displaycommon.cfm?an=1&subarticlenbr=279; accessed April 17, 2007).

Van Aken, J. E. 2004. "Management Research Based on the Paradigm of the Design Sciences: The Quest for Field-Tested and Grounded Technological Rules," *Journal of Management Studies* (41:2), pp. 219-246.

Venable, J. 2006. "The Role of Theory and Theorising in Design Science Research," in *Proceedings of the First International Conference on Design Science Research in IT (DESRIST)*, Claremont, CA, February 24-25.

Vogel, D. 2009. Personal communication.

Vogel, D., Nunamaker, J., Martz, B., Grohowski, R., and McGoff, C. 1990. "Electronic Meeting System Experience at IBM," *Journal of MIS*, (6:3), pp. 25- 43.

Walls, J. H., Widmeyer, G. R., and El Sawy, O. A. 1992. "Building an Information Systems Design Theory for Vigilant EIS," *Information Systems Research* (3:1), pp. 36-59.

About the Authors

Maung K. Sein is a professor of Information Systems at the University of Agder, Norway. With a Ph.D. from Indiana University, he has led a nomadic life geographically (from Asia to North America to Europe), academically (from engineering to finance to IS), and scholarly (from end-user training to systems development to his current focus areas—ICT and development, e-Government, and proactive research approaches). He has previously served at Indiana University, Florida International University, and Georgia State University in the United States, and as an adjunct professor at the University of Bergen in Norway. He has published in, among others, *MIS Quarterly, Information Systems Research, Information Systems Journal, Communications of the ACM, The Information Society*, and *Human Computer Interaction*, and has widely presented his research. His editorial board experience includes *MIS Quarterly, MIS Quarterly Executive, Communications of the AIS, e-Service Journal, Electronic Journal of e-Government, IT for Development Journal*, and guest-editing special issues of *Communications of the ACM* and *Scandinavian Journal of Information Systems*. He has chaired and served on the program committees of several conferences. To relive his past life in practice as an engineer and systems developer, he finds time to break bread with practitioners when not having coffee with doctoral students or beer with colleagues. His work and sheer wanderlust has taken him to all the continents except Antarctica and so many countries that he is within striking reach of joining The Century Club.

Ola Henfridsson is the research director of the Viktoria Institute, Sweden, and adjunct professor at the Department of Informatics, University of Oslo, Norway. His research interests include digital innovation, technology management, and organizational adaptation of IT, as well as process and design-oriented research. The outcome of this research has been published in *Information and Organization, Information Systems Journal, Information Technology and People, Journal of Strategic Information Systems, MIS Quarterly*, and other journals in the information systems discipline. He is a senior editor of the *MIS Quarterly* and serves on the editorial boards of *Information Technology and People* and *Journal of the Association for Information Systems*.

Sandeep Purao is an associate professor at the College of Information Sciences and Technology at Penn State University, University Park. He was previously on the faculty of the CIS Department at Georgia State University, and has been a visiting faculty member a t the University of Washington in Seattle and the University of Agder in Kristiansand, Norway. His research focuses on the design, evolution, and management of techno-organizational systems, blending research methods from social science and software engineering. Research outcomes from these efforts include design knowledge and innovative IT artifacts, and a greater understanding of how these artifacts can benefit organizational work and structure. His work has appeared in journals such as *Information Systems Research, ACM Computing Surveys*, various *IEEE Transactions, Journal of MIS, Information & Organization, Information Systems Journal, Communications of the ACM, Decision Support Systems, European Journal of Information Systems, Computer Supported Cooperative Work*, and *Journal of the Medical Informatics Association*, as well as conference proceedings such as ICIS, WITS, ER, and DESRIST. Several organizations and consortia including the National Science Foundation have supported his research. He serves in an editorial capacity for *MIS Quarterly* and *Journal of the AIS*, among others, and has chaired and served on program committees of several conferences.

Matti Rossi is a professor of Information Systems at Aalto University School of Economics. He received his Ph.D. in Business Administration from the University of Jyväskylä in 1998. He has been the principal investigator in several major research projects funded by the Technological Development Center of Finland and the Academy of Finland. His research papers have appeared in journals such as *Communications of the ACM, Journal of AIS, Information and Management*, and *Information Systems*, and more than 30 have been presented at conferences such as ICIS, ECIS, HICSS, and CAiSE. He has served on the editorial board of *Scandinavian Journal of Information Systems* and is currently a member of the editorial board of *Journal of the Association for Information Systems* and *Journal of Database Management*.

Rikard Lindgren is a professor of Informatics at the IT University of Gothenburg, Sweden, and the University of Borås, Sweden. His research interests include design-oriented action research, IT innovation, knowledge management, standardization, and ubiquitous computing. His research has been published in *European Journal of Information Systems, Information and Organization, Information Systems Journal, Journal of Strategic Information Systems, MIS Quarterly*, and other outlets. In 2003, he was awarded the OR Society's Stafford Beer Medal for the best paper published in *European Journal of Information Systems* and *Knowledge Management Research and Practice*. Rikard currently serves on the editorial boards of *Information Systems Research* and *Scandinavian Journal of Information Systems*.