Technology-Mediated Learning Systems For Project Work

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A Design Theory

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Abstract. Project-based ways of organizing are characterized by temporary structures, idiosyncratic work arrangements and non-routine, creative tasks. As such, projects hold great promise for learning and knowledge creation at the level of the individual participant, but their transient nature offers little support for the sedimentation of such learning within the organizational fabric. Project-based organizations therefore face a number of learning challenges. To address these challenges through the use of technology, this paper develops a design theory for technology-mediated learning systems that support learning processes in project-based organizations. Two organizations participated in our 30-month action research effort, which involved the generation of three design principles, the development of two design concepts, and the implementations of three prototypes and their empirical assessments. The design principles were derived from a kernel theory informed by theories of learning and distributed cognition.

1 Introduction

Whereas traditional organizations aspire to permanence, economies of scale and routinization of tasks, project-based ways of organizing are characterized by temporary structures, idiosyncratic work arrangements and non-routine, creative tasks (DeFillippi and Arthur 1998). While these features make projects effective for dealing with customer-focused solutions in a flexible and multi-disciplinary manner, which is particularly desirable in today's dynamically-changing, highly-competitive environment (Cheng et al. 2005), they also create a host of organizational learning challenges (e.g., Lindkvist et al. 1998). These learning challenges pertain to the articulation of knowledge gained within a given project and the transfer of such knowledge to not only other projects, but also the larger organization in which they reside (Brady and Davies 2004).

IT solutions that support learning in project-based organizations include project management tools (Orlikowski 2002), which embed codified knowledge and automate tasks to some extent, as well as lessons-learned or best-practices databases (Prencipe and Tell 2001), which support knowledge capture and transfer. However, the idiosyncratic nature of projects casts doubt on the value of developing technologies that focus on the outcome of learning, e.g., lessons learned and codified knowledge that can be transferred from one project to another; instead, using technology to support the process of learning is more fruitful (Prencipe and Tell 2001).

There is considerable IS research on how IT can help project teams effectively handle complex tasks (see e.g., Jarvenpaa and Ives 1994; Weiser and Morrison 1998). However, a limitation of many prior studies is that they tend to overlook the role of technology in organizational learning. Two exceptions are Boh (2007) and Kotlarsky and Oshri (2005), who explain how various social and technical aspects of collaborative technology affect the relationship between employee learning and knowledge sharing in project-based environments. Yet these studies pay little attention to the issue of designing systems that support learning in project-intensive organizations. This is unfortunate given the need for effective learning technologies (Alavi and Leidner 2001; Robey et al. 2000) and the significance of theory for design and action (Gregor 2006; Gregor and Jones 2007).

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In this paper, we develop a design theory for technology-mediated learning (TML) systems targeting project work. A TML system is an "environment in which the learner's interaction with learning materials (e.g., readings, assignments, exercises), peers, and/or instructors are mediated through advanced information technologies" (Alavi and Leidner 2001, p. 2). Presenting the development of an IS design theory in line with Walls et al.'s (1992) framework, the paper addresses the following research question: What are the design principles that lead to a TML system that effectively supports learning in project-based organizations?

To answer this question, we rely on action research, which is recognized as being highly suitable for the development of IS design theory (Cole et al. 2005; Lee 2007; Lindgren et al. 2004). The creation and empirical assessment of an IT artifact (i.e., a system prototype), whose development is informed by a kernel theory, lie at the heart of our design-oriented approach to action research. In effect, the IT artifacts created during an action research study embody assumptions about design principles and/or development methods that are hypothesized to respond effectively to a set of user requirements (Markus et al. 2002; Gregor 2006). These artifacts thus encapsulate the theory that is then tested empirically in an organizational setting.

Given that projects are more reflective of collectives of temporarily interdependent participants than of communities of practice whose members are acculturated over time into a shared set of practices and understandings (Lindkvist 2005), our kernel theory is significantly shaped by the literature on distributed cognition (Weick and Roberts 1993; Boland and Tenkasi 1995), which emphasizes the role of reflecting, interacting and interrelating in organizational learning. As a result, our design principles and prototypes focus on cognitive processes such as reflection, knowledge articulation and representation.

The paper will proceed as follows. We outline our kernel theory, which seeks to address the unique characteristics and learning challenges of project-based organizing by leveraging theories of learning and distributed cognition. From this kernel theory, we derive three design principles that were implemented in three prototypes as part of a 30-month action research study. We then describe the two action research cycles that made up our study and report on the results of each prototype's empirical assessment. We conclude with a discussion of what our research results mean for our design principles and our kernel theory.

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2 Kernel Theory

2.1 Learning Challenges in Project-Based Organizations

While projects, as task-oriented and trans-disciplinary structures, hold great promise for learning and knowledge creation at the level of the individual participant, their transient nature offers little support for the sedimentation of such learning within the organizational fabric (Grabher 2004). Sydow et al. (2004) identify three interrelated learning challenges in project-based organizations: (a) within-project knowledge articulation, (b) project-to-project knowledge transfer, and (c) project-to-organization knowledge transfer. As these challenges address different organizational levels, both the challenges and their solutions are interrelated. For instance, solutions to higher-level challenges are dependent on solutions to challenges at the lower level.

Within-project knowledge articulation is made difficult by the learning-vs.-doing dilemma (Sydow et al. 2004). Project work is action- and problem-solving oriented, and therefore relies extensively on applied knowledge, which also has a high tacit component (Poell and Van der Krogt 2003). Articulation of such taken-for-granted knowledge requires individual reflection, i.e., thinking about one's own role in a project, one's theories in use, and assumptions that guide one's action (Ayas and Zeniuk 2001). However, in the deadline-driven and time-pressured environments that characterize projects (Lindkvist 2004), time for such reflection is rare.

Project-to-project knowledge transfer is dogged by the autonomy-vs.-integration dilemma (Sydow et al. 2004). Projects are typically idiosyncratic with respect to their goals, activities and composition. This makes it difficult to routinize project work and to integrate it into a shared practice (Bresnen et al. 2004), especially as governance is typically distributed to the teams, meaning that project work relies more on individual agency than on common practices, rules and routines (Lindkvist 2005). The idiosyncratic nature of project work raises questions about how much knowledge can and should be transferred between projects (Lindkvist 2004). Nevertheless, projects have quasi-genetic traits, e.g., project management and reporting practices, whose inter-project transfer should be valuable (Prencipe and Tell 2001).

The challenge of project-to-organization knowledge transfer relates to the organization's ability to embed, in the standing organization, knowledge gained in projects. In the absence of project-to-organization learning, it is difficult for a project-based organization to develop capabilities that endure

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beyond the life of individual projects, and that ensure reliable and effective project delivery in future (Brady and Davies 2004). As idiosyncratic and autonomous ways of working are often not neatly aligned with those of the rest of the organization (Lindkvist et al. 1998; Bresnen et al. 2005), local knowledge that has been gained at the project level needs to be adapted to the more global concerns of the larger organization. Given the tension between the routinization of the standing organization and the flexibility of projects, achieving the alignment necessary for smooth project-to-organization knowledge transfer presents a challenge.

2.2 Design Principles for TML Systems in Project-Based Organizations

Using a social learning perspective, we developed design principles to address the learning challenges in project-based organizations. Specifically, we sought guidance from situated (Lave and Wenger 1991) and organizational learning theory (Senge 1990) in the formulation of our design principles. Furthermore, given that project organizations resemble collectives more than communities of practice (Lindkvist 2005), our principles were also informed by theories of distributed cognition (Weick and Roberts 1993; Boland et al. 1994). Due to the hierarchically intertwined nature of our three learning challenges, we do not tie our design principles to a specific learning challenge outlined above. Instead, we view the design principles as an interlocking complex capable of addressing the three learning challenges in a holistic manner.

Situated learning theory highlights that all knowledge is situated, implying that knowledge, or the meaning that is made of experiences and events, is dependent on the interplay between practice and the social context in which an individual finds him/herself. While in relatively stable organizational structures the transfer of such situated knowledge and shared meaning can occur through behavioral learning mechanisms in which knowledge remains largely tacit, e.g., socialization (Nonaka and Takeuchi 1995), experience accumulation (Prencipe and Tell 2001) and legitimate peripheral participation (Lave and Wenger 1991), cognitive learning mechanisms such as reflection, articulation and representation are more effective in project-based organizational settings marked by impermanence, heterogeneity and distributed cognition (Boland et al. 1994). Thus, while individual learning is situated and embedded in action, cognitive learning processes such as thinking, discussing and confronting are necessary to develop the learning capabilities needed in project collectives (Prencipe and Tell 2001).

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In order to make the situated knowledge that individuals gain during project work accessible, TML systems need to support reflection in and on authentic action (Schön 1983; Lave 1988; Orr 1996). Critical reflection on action involves questioning and uncovering flaws in fundamental assumptions about how to structure and perform work (Senge 1990). To be effective, the critical reflection process should be grounded within the context of work-specific challenges with individual and organizational relevance (Marsick and O'Neill 1999).

However, since learners frequently encounter learning barriers such as defensive reasoning, which screens out criticism on their own thinking and behavior and instead places blame on external factors (Argyris 1991), mechanisms that create some distance between the practitioner and the object of reflection need to be incorporated into TML systems. This is especially important when the object of reflection is a work situation that involves the learner him/herself. Realistic scenarios and role-playing have proved to be effective in overcoming practitioners' defensive-reasoning learning barrier (Senge 1990; Rosenorn and Kofoed 1998). Thus, our first design principle reads:

Design principle 1: 'The principle of reflection on sufficiently authentic project work' specifies that TML systems must foster critical reflection on simulated action in a way that limits the effects of defensive reasoning.

In addition to supporting individual-level reflection and thinking, TML systems need to support dialog and conversation (Boland et al. 1994), as well as discussion and confrontation (Prencipe and Tell 2001). It is by comparing and contrasting their own assumptions, interpretations and meanings with those of others (especially if the others belong to different communities of knowing), that individuals gain a deeper and richer insight into their situated understanding. By supporting social interactions and collective interpretation and meaning making, TML systems enhance learning in project-based settings. To the extent that individuals in project teams represent different communities of knowing, such dialog plays an important role not only in the creation of knowledge through perspective-making and perspective-taking (Boland and Tenkasi 1995), but also in creating the conditions for mindfulness and heedful interrelating (Weick and Roberts 1993).

Design principle 2: 'The principle of dialog within and across diverse communities of knowing' stipulates that TML systems must enable social interaction among a diverse set of project workers so as to support the articulation of situated, tacit knowledge.

While design principles 1 and 2 focus on knowledge articulation, design principle 3 captures the need for representation in learning (Boland et al. 1994). While knowledge representation can take many forms, e.g., diagrams, narratives and texts, it serves as an important extension of knowledge articula-

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tion in that it further externalizes situated knowledge by turning it into an object. As a somewhat independent object, the represented knowledge becomes mobile, thus facilitating its transfer across social, organizational, geographic and temporal boundaries. Furthermore, as a mobile object, the represented knowledge becomes a trigger for ongoing learning and sense-making as it is read, revised and re-interpreted in a multitude of situated contexts.

Design principle 3: 'The principle of knowledge representation' stipulates that TML systems must capture the outcome of the learning process in order to support knowledge transfer and learning through the ongoing re-interpretation of the represented knowledge.

	AR cycle 1		*AR cycle 2*
Design concept	E-roleplay: IT-supported role-playing in small, co-present groups		E-discussion: IT-supported discussion in small, co-present groups
Research site	Volvo Parts	Ericsson Microwave	Volvo Parts
Prototype	Global	RICE	LetsTalk
Development method	Participative design workshops • Initial prototype evaluation (3 participants in 1 group) • Document review • 7 interviews	Participative design workshops • Initial prototype evaluation (4 participants in 1 group) • Document review	Participative design workshops • Initial prototype evaluation (4 participants in 1 group) • Document review
Evaluation method	Final prototype evaluation (84 participants in 11 groups) • 84 surveys • 68 surveys • Seminar discussions (11 groups) • 9 interviews • Follow-up meetings • Document review	Final prototype evaluation (14 participants in 2 groups) • 14 surveys • Seminar discussions (2 groups) • Follow-up meetings	Final prototype evaluation (99 participants in 22 groups) • 97 surveys • 10 interviews • 26 surveys • Follow-up meetings • Document review

Table 1: Overview of the AR study

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3   Method

An action research (AR) study (Baskerville and Wood-Harper 1996; Avison et al. 1999) that took 30 months and involved researchers from the Viktoria Institute and practitioners from Ericsson Microwave and Volvo Parts (based in Sweden) was used to develop and evaluate three prototypes of TML systems that reflected our design principles. Table 1 outlines our two-cycle AR study.

4   Cycle 1: The E-Roleplay Design Concept

In the first AR cycle, we instantiated the design principles in the e-roleplay design concept, which consists of four activities.

Activity 1 consists of participation in a 2-3 hour IT-supported roleplay, which is conducted in a small, co-present group. Participants are seated around a table and the scenario is displayed on a large, shared screen. One of the participants operates the keyboard and mouse to control the navigation through the roleplay scenario. Navigation consists of clicking on hotspots and completing forms. Each participant is assigned a role, e.g., controller or sub-project manager, to enact during the roleplay. While participants are given brief role descriptions, they rely mainly on their personal experiences and creativity to act out their role. During the session, the participants face different problems. In order to make decisions, they are required to discuss, negotiate, and exchange ideas with their fellow players. The roleplay scenario is representative of a typical and problematic project work situation and is intentionally designed to end at a time when the project is failing. Both the roleplay experience and the reflection on actual experiences in project work stimulate individual learning.

Activity 2 is a week-long period of individual reflection during which participants ideally relate situations they have encountered in their everyday work life to the e-roleplay scenario and their e-roleplay experience.

Activity 3 involves participation in a 2-hour debriefing seminar in which the e-roleplay experience is discussed and explicitly related to the participants' experience on actual projects.

Activity 4 consists of ongoing learning interventions, e.g., seminars and workshops, based on learning needs identified in the group debriefing session. The aim is to nurture the initiated learning process and to encourage attention to and improvement of project work practices.

For a more extensive description of the design concept and the Global prototype introduced below, see Hardless et al. (2005). In the following, we

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present how the key features of the e-roleplay design concept reflect our design principles for TML systems.

- *The principle of reflection on sufficiently authentic project work:* E-roleplay enables an experience of semi-authentic project work by providing problems in the scenario that reflect typical problems in practice and that have to be debated and solved in cooperation with organizational colleagues. Critical reflection on project work practices is triggered by several aspects. First, participants are confronted with semi-authentic experiences of project work practice in the scenario, where they reflect on problematic aspects and articulate knowledge in joint decision making. Second, role-playing helps participants view things from an unfamiliar perspective, as well as discuss issues undefensively under the guise of their roles.

- *The principle of dialog within and across diverse communities of knowing:* Activities one and three raise practice-relevant questions that can trigger interesting discussions. The face-to-face setting offers full social interactivity and expression in the discussions. In activity one, the scenario raises questions mainly in the form of decision making situations. Negotiating the decision, the participants articulate situationally-contingent opinions and stories. In activity three, the overall scenario problem is discussed and explicitly related to the organizational practices. This provides an opportunity to negotiate the key challenges of actual project work practices and ways to deal with them. The discussions in activity one and three do not only shape but also provide access to participants' interpretations. While the groups are composed of participants from different functional backgrounds, the problems raised are general enough to be relevant for all participants. Both joint decision making in activity one and sense-making in activity three are intended to stimulate heedful interrelating among participants. Further appreciation of others' perspectives is developed through adopting such a different perspective in the roleplay.

- *The principle of knowledge representation:* Issues raised in the discussions in activities one and three are noted by observers. Content analysis and anonymization of the notes provides a summary of viewpoints that informs interventions in activity four.

In our study, we implemented the e-roleplay design concept in two prototypes, Global and RICE. We will now describe each of these AR interventions in turn.

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4.1 The Global Prototype

Volvo Parts wanted to improve project management practices in light of difficulties associated with performing integration projects in a global context. The organization had extensive experience of project work and its difficulties, but ad-hoc learning from this experience fell short of achieving the needed project improvements. Thus, the aim of the Global prototype was to ensure necessary experience-based learning at all levels by addressing the three learning challenges of project-based organizations, i.e., within-project knowledge articulation, project-to-project knowledge transfer, and project-to-organization knowledge transfer.

Development Method

The Global prototype was developed over a three months period (summer to early autumn 1999). A participative design approach, which involved three researchers, three members of the Human Resource team, and one project manager was chosen to develop the e-roleplay scenario. Furthermore, interviews with seven highly-experienced middle managers who had experience of projects from different functional areas within Volvo Parts were conducted in order to develop organizationally-grounded project situations, stories, and anecdotes that could be incorporated into the e-roleplay scenario. Subsequently, the researcher-and-practitioner design team iteratively developed the story line and multimedia components for the scenario. During this scenario development, an initial prototype was reviewed by three experienced project managers.

The Global scenario portrayed a fictitious corporation that was integrating two of its globally distributed divisions: video-recorders (VCR), which focused on the European market, and personal computers (PC), which focused on different locations in Asia. The two divisions had been independent organizations but were about to integrate their purchasing operations. Thus, the project team in the scenario included representatives from both divisions. The problem that the role-playing team had to address was the integration of the two divisions' purchasing functions.

Below is an example of a scene from Act III of the Global scenario. In this scene, the project team requires information about the current purchasing routines and the systems used in the PC division. The group has to make a decision whether to send either a system analyst to gather this information, or to send an email to the division to request this information. Figure 1 shows, first, the decision alternatives presented to the group, and second, a video sequence

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of the analyst reporting a failure to acquire the needed information from the PC division in Asia.

The systemsanalyst returns ....

One of the challenges in the PurNow project is to integrate and globalise the purchasing strategies of VCR and PC.

To do this you have decided to gather all information about PCs purchasing routines and their computer system. You must decide upon whether to request the information by mail or to send a person to collect it.

The tight time schedule urges the project to get a quick response. The alternatives are either to mail the purchasing director of the Hongkong office and ask for details, or to send a systemsanalyst to go through the system structure.
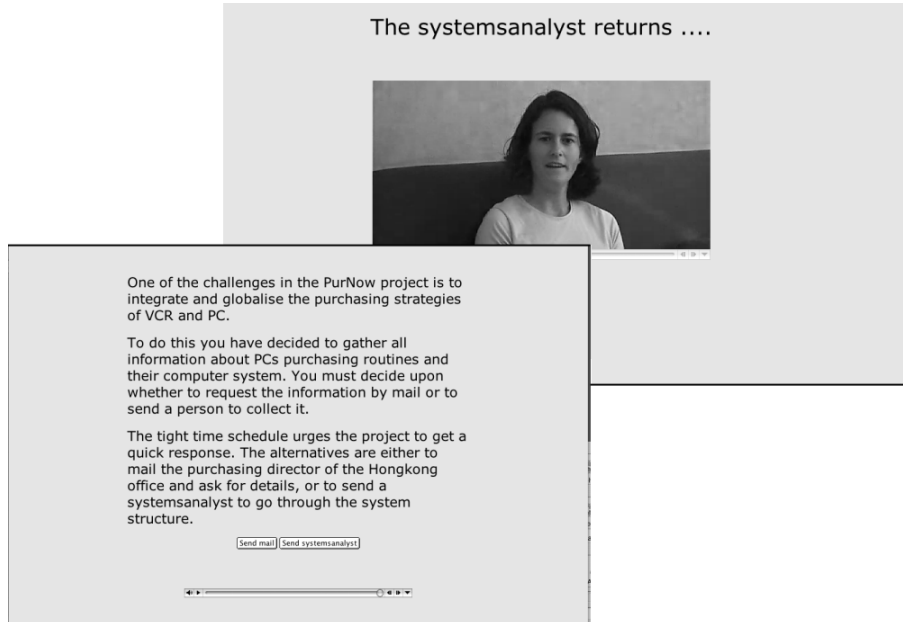
[Send mail] [Send systemsanalyst]

Figure 1. Pages from a scene in Act III

Evaluation Method

Over a 3 months period (late autumn to early winter 1999), the Global proto-type was evaluated in 11 groups of 5-8 participants. The personnel managers and the Human Resource department were instrumental in identifying poten-tial participants. In total, 84 members of Volvo Parts participated in the evalu-ation of our Global e-roleplay prototype. While their titles were as varied as project manager, controller, technical writer, function manager, and analyst, all participants were involved in project work in some form. They also repre-sented different levels and functions of the organization. For the e-roleplay, group membership was designed to maximize diversity with regard to the par-ticipants' functional backgrounds, project roles, age, gender, and experience.

The discussions in activities one and three were observed by Human Resource (HR) staff who took notes of the participants' viewpoints mainly concerning difficulties and improvement needs in the organization's project work. These notes were content analyzed and anonymized to provide a sum-mary that guided further HR initiatives aimed at supporting project-to-organi-zation knowledge transfer.

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Participants' feedback on the Global e-roleplay prototype was collected through observations, a short survey administered immediately after the e-roleplay session, a long survey immediately after the debriefing session, and telephone interviews with nine participants after the debriefing session.

Evaluation Results

Reflection on sufficiently authentic project work. Global employed a multimedia scenario that reflected the participants' reality and highlighted difficulties that existed in their projects. This enabled participants to relate the experience and discussions to their own project experience. As an illustration, one of the participants expressed that "this could have been our corporation" (survey quote). One indicator of the fact that participants drew on their real experience during the Global e-roleplay was that participants referred to projects that they had worked on, even by their real names.

The role-playing helped participants to view things from an unfamiliar perspective: "Fun to be forced to think differently" (survey quote). Furthermore, it was interesting to note that participants seemed to alternate between their actual work roles and their fictitious roles during the Global e-roleplay. Thus there was considerable ambiguity surrounding their actions in the roleplay. As the following survey quote indicates, this ambiguity was regarded as liberating and useful rather than problematic:

> It might be so that those involved do not want to expose their own opinions. If so, it is a good thing to be able to hide behind a role. It also becomes a little bit more playful.

Thus, this ambiguity helped to avoid defensive reasoning.

As illustrated by the following survey quotes, the role-playing session stimulated reflection:

> Certainly, the scenario works well in terms of stimulating creative thinking and identifying important future discussion topics

> I really felt a need to come to the second meeting and discuss everything.

Based on the issues raised during the debriefing session in activity three, the individual-level reflections were largely concerned with identifying problems in project work practices. Such problems included poorly conducted feasibility studies prior to project initiation, for instance.

Even though most participants felt that the issues raised through the scenario were relevant to them, some perceived the scenario as being too removed from their everyday practices. They pointed out that this lack of proximity between the role-play and their real experience restricted their ability to relate to and participate in the learning experience:

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> In those situations where the group members were familiar with the problem to deal with, it was clear that they became much more active and committed (survey quote).

Presumably, lack of active engagement in the role-playing exercise also undermined participants' ability to learn through critical reflection and articulation.

Dialog within and across diverse communities of knowing. A critical dimension of the learning process was that Global engaged the participants in a dialog where they articulated their perspectives and experiences related to the highlighted project dilemmas. This was expressed by one participant in our survey:

> As you acquire more experiences of doing project work, it would be very useful if you would be able to share your experiences with others in this way.

The fact that the role-playing in Global dealt with practice-relevant dilemmas contributed to a productive and interesting dialog. Bringing their knowledge to bear on the dilemmas, the participants articulated and negotiated understandings through a form of storytelling about project problems and solutions:

> Good way to educate, to illuminate problems and start a 'neutral' dialog between the participants to find common solutions (survey quote).

As the groups were cross-functional, the discussions allowed participants to confront different perspectives on project issues. Several participants highlighted that Global had provided them an opportunity to reflect upon project processes, roles, and tools across their organization. In our survey, one participant wrote:

> This is a very interesting development tool for increasing communication across departments in the corporation.

Moreover, as illustrated by the following survey quote, the role-playing further enabled participants to develop their understanding of others' perspectives:

> More exciting to have a role. It is important to put on 'other glasses' and see from others' viewpoints.

As asserted by the participants, Global offered a discussion arena that was not commonly available in day-to-day practices. Indeed, recognizing the potential of the e-roleplay concept to help organizational members exchange perspectives on project work, several participants declared their willingness to be part of future attempts to design and evaluate learning environments similar to Global.

Knowledge representation. HR personnel sorted the issues raised by participants into five categories: (1) Risks in projects, (2) Important issues in projects, (3) How should project work be rewarded?, (4) What is bad today in

projects at Volvo Parts, and (5) How should we proceed with project improvement efforts after Global? Guided by the summaries, the HR department arranged five seminars about various project work issues. It also promoted a new project management methodology, which had been developed previously but not adopted. They also evaluated a system for composing project teams, and communicated various norms (e.g. about team composition). All of these initiatives are indicative of project-to-organization knowledge transfer and Volvo's efforts to embed the insights gained through the Global prototype in the organization's practices.

4.2 The RICE Prototype

Even though the empirical evaluation of the Global prototype lent support for our design principles, we sought to test them more broadly. Ericsson Microwave, the other organization in our AR study, wanted to enhance its project management training through an experiential learning exercise. They envisaged a project management simulation that exposed novice project managers to a situation characterized by such time pressure and complexity that they would experienced a "loss of holistic perspective". This simulation was intended to complement the conventional project management courses, which emphasized ideal project models instead of the problematic nature of projects. The prototype simulation was called RICE, which was also the name of the project that the e-roleplay participants had to manage.

   The top-down, training-oriented approach to learning that Ericsson Microwave sought to pursue with RICE differed substantially from Volvo's bottom-up and emergent orientation to learning. Given its planned, training focus, the RICE prototype incorporated neither ongoing learning interventions (activity 4), nor the principle of representation. Nevertheless, Ericsson's objective was to address the learning challenges of project-based organizations, namely transferring effective practices for project management from the organization to the project level, fostering project-to-project learning, and encouraging individual-level articulation of situated knowledge about project work. For this reason, our first two design principles seemed relevant to this organizational context.

Development Method

Using a participative design approach, the RICE prototype was developed over a nine months period (late autumn 1999 to early autumn 2000). The design team consisted of two researchers, one project manager, and two directors of project management functions. The team's main task was to construct a

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roleplay scenario that was fictitious yet reflective of Ericsson Microwave's high-tech electronics business. The team thus developed RICE, a scenario in which participants had to develop a new electronics product.

Even though both RICE and Global were informed by the same design principles and instantiations of the e-roleplay design concept, the prototypes differed in a number of ways. First, RICE emphasized problem-solving under time pressure. This was accomplished by presenting the participant with a large number of problems and decisions, many of which were displayed simultaneously, by providing them voluminous amounts of information (both on-screen and paper-based), and by incorporating countdown timers to simulate time pressure. Hence, the RICE scenario was more complex in both its content and its structure than was Global.

Second, the types of problems encountered in RICE were mostly of a technical nature, dealing with issues such as acquiring instruments, choosing component suppliers, selecting circuit board design, selecting construction techniques, and making resource prioritizations. In Global, the problems focused more on social issues such as approaching workers from a different culture.

Third, the roles in RICE were mostly subproject managers (e.g., mechanics, software, systems). In contrast, the roles in Global (e.g., process owner) were more broadly defined and expressly linked to an area of responsibility and accountability.

Evaluation Method

The RICE prototype was evaluated over a 2 months period (early to late autumn 2000). The purpose of the evaluation was to assess whether RICE worked well enough to be adopted in the project manager training program. This assessment was based on two groups consisting of six and eight participants respectively. Even though the groups' members were mixed in terms of functional affiliation and competence levels, all were experienced project managers.

The participants in the prototype evaluation found their experience disappointing and the initiative was halted. Nevertheless, the feedback we collected from the participants in RICE's evaluation provides useful data for testing our design principles. Evaluation data was collected through observations of the e-roleplaying sessions and a short survey administered at the end of each session. Also, at the debriefing session (activity 3), participants were given the opportunity to elaborate on their thoughts about the prototype. After each debriefing session, we had individual conversations with two participants.

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Evaluation Results

Reflection on sufficiently authentic project work. The feedback indicated that the participants distinguished between different types of authenticity in the role-play scenario. On the one hand, the experience of the failing project resonated with some participants: "Realistic. I could recognize myself in the problems that occurred" (survey quote). On the other hand, participants noted that the decision-making tasks in the scenario were unrealistic, in that they lacked controversy, 'edge,' and trade-offs:

> The scenario was too uncontroversial. It lacked an edge,

> It was very easy to make decisions since there were no trade offs,

> It feels a little too simple.

> There are no real challenges.

Furthermore, some participants pointed out that the scenario did not capture the complexity of real project work because

> There were no consequences [to the decisions]. In the beginning it feels like one controls the scenario.

While we can interpret these participants' responses as an artifact of the participants' experience with project management or their expectations of an effective simulation for training purposes, our interpretation of these responses focuses instead on the type of realism and authenticity that enhances (rather than inhibits) critical reflection on the individual learner's situated knowledge. Based on our kernel theory, roleplay aids critical reflection when the scenario resonates with the participant and the participant can see him/herself in that situation. This raises questions about the efficacy of using a highly technical decision making task as the basis of the roleplay scenario. How easily can participants find their role within the scenario, especially if they are not experts in the technical details (as we would expect the intended target users to be)? Furthermore, how likely is it that technical details will resonate with their project experience? It seemed that the participants in Global, whose decisions were more of a social nature, had an easier time connecting their role-play experience to their lived, project work experience.

While the time pressure and information overload that was simulated in RICE through countdown clocks, simultaneous decisions and parallel information displays, made the prototype more realistic, it also undermined participants' ability to reflect on their role-playing and project work experience. This again raises questions about how authentic and realistic a roleplay scenario has to be in order to trigger critical reflection and the articulation of situated knowledge. It seems that in the case of RICE, there was too much realism to

stimulate emergent learning and too little to meet Ericsson Microwave's training goals.

Dialog within and across diverse communities of knowing. Our observations of the role-playing sessions and subsequent conversations with participants highlighted that the prototype failed to stimulate dialog, discussion and confrontation among the participants. In fact, the role-playing groups were silent at times and their role-playing seemed strained and boring. There were a number of reasons for this, most of which had their roots in the prototype's simulation of time pressure and information overload.

In situations where groups encountered three parallel scenes, they became quiet as they were forced to read the scenario details quickly and carefully. One participant wrote in the survey: "It was messy with parallel clocks. I did not have the time to read." One consequence of the combination of parallel problems and time pressure was that the participants divided problems among themselves. In turn, this division of labor created a situation where participants focused more on decision making and less on collaboration and discussions, even though the problems that had been selected for the scenario were designed to require collaboration and joint decision making.

The individualistic orientation towards the roleplay was further exacerbated by the way the roles were designed in RICE; most were sub-project managers. This created boundaries around problems and decisions, and incentives for participants to focus on optimizing their own subprojects. Thus, dialog, cooperation and confrontation with participants was undermined by the role design.

In this context of individual rather than collective play, even the prototype's central display and input mechanisms, which were intended to create a point of commonality among the participants, became problematic. One of the participants noted in the survey: "The multimedia scenario did not invite much cooperation but rather more a focus on the screen." As the prototype lacked the capability of individual interactivity with the scenario, the participants found themselves being too passive in the e-roleplay. In the survey, participants noted: "Just to follow the scenario did not give anything," and "There were no discussions… participants were not involved."

5   AR Cycle 2: The E-Discussion Design Concept

One of the expectations of the Global prototype was that it would improve Volvo Parts' project management practices at the organizational-level through

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project-to-organization knowledge transfer. However, 6 months after the Global evaluation, project management practices remained largely unchanged. The lack of Global's organizational impact prompted us to embark on another AR cycle with Volvo Parts. The second AR cycle addressed what we considered to be reasons for the failure of Global, namely the lack of top management's commitment to improving project work. One contributing reason was that knowledge representation in Global was an activity limited to the Human Resource team and failed to reach and involve other departments. Another contributing reason was that discussions and representations in Global were problem-oriented and thus lacked an in-depth solution-orientation that could produce constructive guidelines for how to solve the problems. We also assumed that a second learning intervention involving many project workers would help to sustain organizational attention on project improvement and thus stimulate bottom-up change.

In the second AR cycle, we developed and evaluated the design concept e-discussion. In a typical setting for e-discussion, a small group of co-present participants is seated around a table and the IT application is projected on a large screen. There is one common input device, i.e., keyboard, which is controlled by a facilitator.

The discussion is initiated by presenting a question on screen requiring common attention. Various forms of questions can be used to stimulate discussions, for example a written question statement, case study, or video documentary. Question scenes are kept modular, i.e., one focused question at a time. Questions should be carefully constructed with regard to common relevance for participants and ability to create discussion that encourages collective reflection. The discussion focus is sustained by ensuring the ongoing visibility of the question together with an associated answer form. The group is required to produce a written answer to each question. Their answer is collaboratively constructed during their discussion and then captured into the system through a single point of input. By requiring an agreed-upon response, the design creates a situation of negotiation and argumentation that forces participants to engage one another in debate.

The IT application captures the documented answers and stores them in a database. This enables future retrieval and thus forms part of the organizational memory. An e-discussion session lasts two to three hours, with 15 to 30 minutes spent on each question. The role of IT should be minimal so that attention is focused on the discussion rather than the technology. Below, we explain how the key features of the e-discussion design concept reflect our design principles for TML systems. For a more extensive description of Lets-Talk, see Hardless (2007).

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- *The principle of reflection on sufficiently authentic project work:* E-discussion is a form of meta project work with a high degree of authenticity. Critical questions about typical problems that occur in practice are used to trigger participants' critical reflection and articulation of situated knowledge. Emphasizing reflection upon how to solve project problems gives the activity a constructive orientation. Since the learning intervention is sanctioned by higher management, it legitimizes the participants' engagement in critical and constructive reflection, and is thus likely to reduce defensive reasoning. Also, focusing the questions on typical problems rather than specific incidents should also limit defensive reasoning, as no given individual is implicated in the question. Furthermore, small group settings, which afford trust and openness in knowledge articulation, should further keep defensiveness in reasoning at bay.

- *The principle of dialog within and across diverse communities of knowing:* E-discussion presents practice-relevant questions that can trigger interesting discussions. Knowledge is both articulated and shared through negotiating the key challenges of actual project work practices and ways to deal with them. The face-to-face setting provides full social interactivity. As such, it is a medium that gives access to participants' interpretations and meanings in the richest mode possible. The groups are composed of participants that represent diverse yet interrelated organizational perspectives. Discussions are oriented to reach agreements based on negotiated understanding and heedful interrelating.

- *The principle of knowledge representation:* The documented answers are content analyzed and anonymized to create a resource that reflects organizational views on project work problems and suggestions for improvement. This resource is utilized in a way that focuses organizational attention on improvement needs, and in particular ensures that the top management studies and responds to the documented needs.

5.1 The LetsTalk Prototype

The e-discussion design concept was instantiated in the LetsTalk prototype at Volvo Parts, which sought to improve project management practices with a focus on globalization and integration concerns. The prototype LetsTalk was developed for use by a large number of organizational members who were engaged in project work. The primary goal was to improve project-to-organization knowledge transfer and to achieve more effective links between the

learning activities occurring at the individual level and project levels, and the organization as a whole.

Development Method

Over a period of 6 months (spring to autumn 2000), the LetsTalk prototype was developed for Volvo Parts through participative design workshops, which involved the first author, three human resource employees, and three business/ project managers. An initial prototype was evaluated informally by three project managers and one business manager.

The overarching question the team selected to guide the LetsTalk design was: "How can we increase the completion rates and tempo of our projects?" This question was perceived as sufficiently broad to encompass a myriad of project challenges including making better decisions, eliminating mistakes, and creating a more supportive project environment. The design team composed eight question scenes, some of which we describe below.

Securing resources for projects. The group was presented with a project situation, in the form of a cartoon, in which securing resources was problematic. The scene summary read: "A project is dependant on getting resources (people) from the organization when needed. But a common problem is that the project does not get the necessary resources." After reviewing the situation, the group was confronted with the associated question (Figure 2): "Why do these problems occur? How can we improve the securing of resources for projects?" The group was then prompted to enter its responses to these questions into the online form.

Project manager qualities. The second question scene focused on the characteristics of a good project manager (Figure 3). Different types of personalities were described using a descriptive label (e.g. pioneer) and a summary of such a project manager's positive and negative traits (e.g. +result-oriented, -challenging). A more complete description of each project manager type was also available. Using a five-point scale, the group was asked to attribute each trait pair to an idealized, good project manager.

Tips and tricks. The fifth question focused on sharing personal tips and tricks related to project work. One at a time, participants were asked to enter one piece of advice (see Figure 4).

Hotline to management. The seventh question scene focused on relaying the group's primary suggestion for project improvement to top management. Specifically the group responded to this prompt: "What is the one thing that you want the management in your organization to improve in order to create better possibilities for increased tempo in your projects? Your input will be
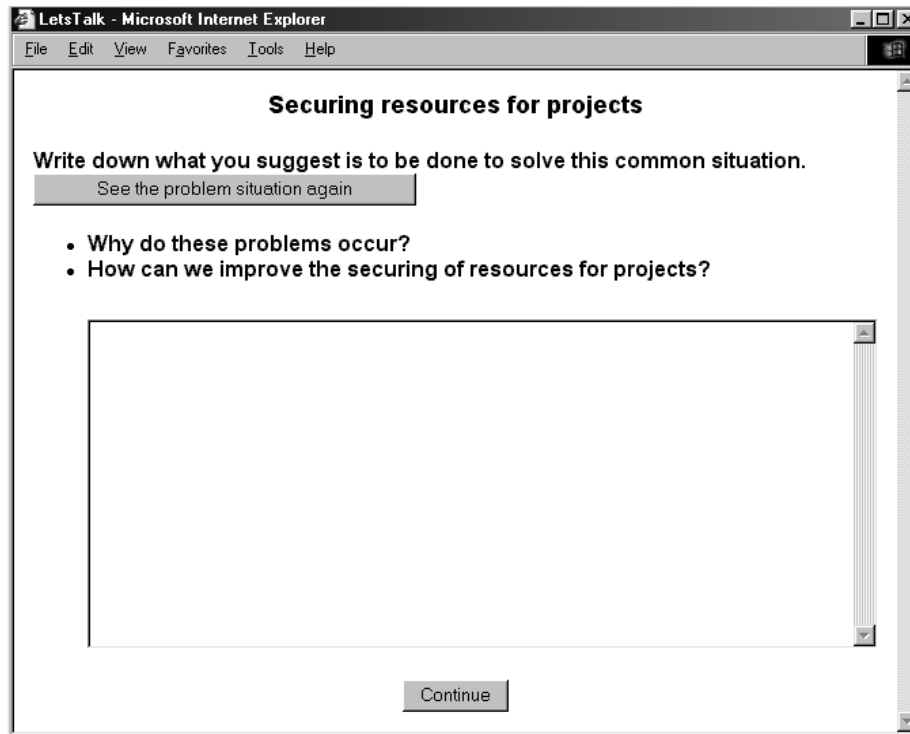
Figure 2. Securing resources for projects

given directly to the management, who are required to respond. The more concrete your suggestion is, the easier it will be to consider and implement."

Own question. The final question was only addressed by those groups that had moved through the prototype quickly. This question gave the group an opportunity to formulate its own question to discuss and answer.

In addition to the above, LetsTalk included question scenes about project team composition, cultural differences in global cooperation and studying project feasibility.

Evaluation Method

The LetsTalk prototype was evaluated over a 6 months period (autumn 2000 to spring 2001). In total, 99 members of the organization, organized into 22 groups, participated in a LetsTalk session. While the group selection sought to maximize diversity of professional and functional specialization, and experience level, we also attempted to identify team members with interrelated inter-
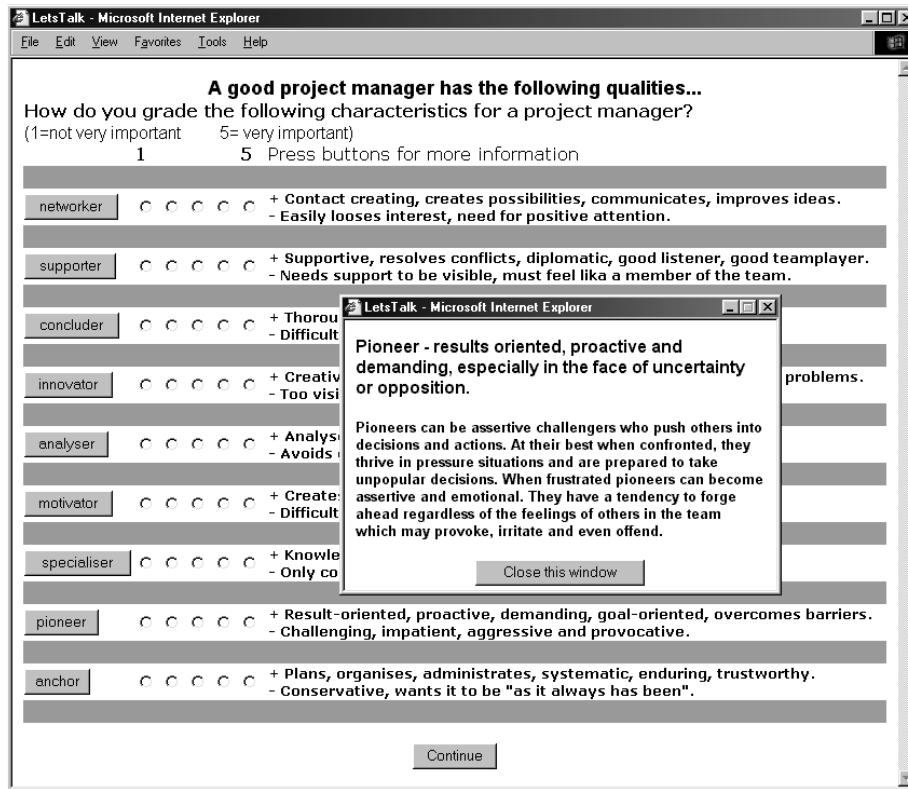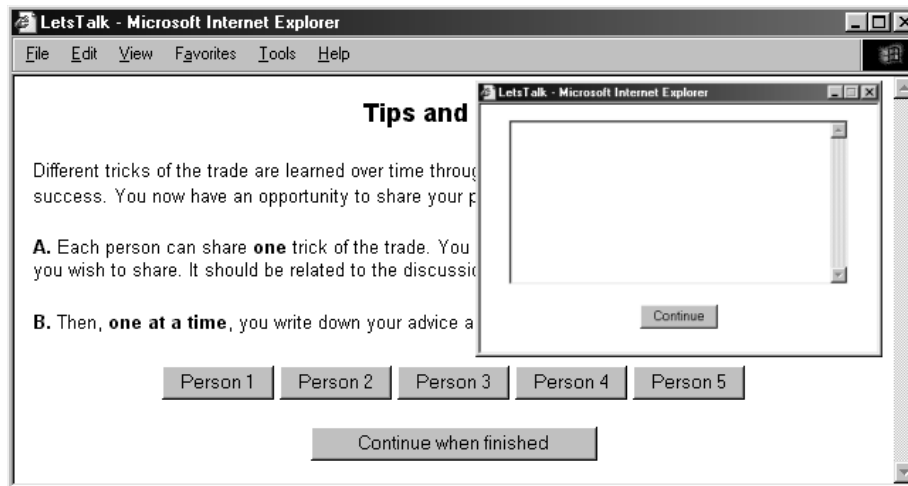
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Figure 3. Input page and pop-up window

Figure 4. Question presentation page and pop-up window with an input field

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ests. The group selection was performed by the HR team on the basis of their knowledge about employees.

Given that the LetsTalk sessions captured the participants' answers, a number of follow-up activities were devised to take advantage of this data. First, each group received a document with their answers. Second, all groups' answers were anonymized, sorted into themes, and made available on the organization's intranet. Third, there was a follow-up seminar to deliver on the promise made in Question seven, namely that management would respond to the suggestions made by the participants.

In preparation for this seminar, the answers to Question seven were anonymized and sorted into categories based on the improvement areas indicated in the answers (e.g., "Improve the prioritization between projects!"). The resulting document was presented to top management and made available on the intranet. The seminar in which this document was discussed was attended by 73 employees (mainly LetsTalk participants) and 4 senior managers (the CEO, the CIO, the HR manager, and the product support manager). The purpose was to provide a response to the issues raised in LetsTalk and engage the participants in a discussion about how to improve project work at Volvo Parts. The seminar lasted 4 hours and incorporated a number of presentations (e.g., summary of LetsTalk, project model presentation, inspirational talk). Forty-five minutes were allocated for the discussion. The discussion was recorded, transcribed, and made available on the intranet.

Evaluation data was collected in the following ways. Complementing our observations of the LetsTalk sessions, a survey including questions about both LetsTalk and Global was answered by each participant at the end of each LetsTalk session. We also conducted follow-up interviews with 10 participants. In the early spring of 2001, we observed the follow-up seminar and administered a short survey. Further, ongoing conversations with the design team have informed our overall understanding of how people at Volvo Parts perceived both prototypes.

Evaluation Results

Reflection on sufficiently authentic project work. Participants' feedback suggested that LetsTalk indeed facilitated reflection and knowledge articulation about how to generally deal with different types of problems that exist in the organization's projects: "It contributed to reflection" and "… creative discussion and good reflection." According to the feedback, this reflection was aided by three aspects: the authenticity of the scenes, the legitimacy of time spent on reflection and the requirement to write down their reflections. We discuss each of these in turn.

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A number of participated noted that the authenticity and relevance of Lets Talk's content contributed to their engagement in and learning from the discussion forum. During an interview, one participant said: "I think all questions were relevant… that is why it was so good." This was echoed by the following survey quote: "Familiar problems were discussed and concrete suggestions were created."

In addition, participants recognized the capability of LetsTalk to raise questions that were typically neglected in everyday work life due to lack of time for reflection and knowledge articulation. This was expressed by one of the participants who wrote in the survey: "[It is useful] to face questions that we may not always reflect upon."

As the following responses show, the requirement to generate written answers further stimulated reflection and knowledge articulation: "Requires reflection to put answers concretely in writing" and "One has to think a little extra if one has to write something" (survey quotes).

We had expected defensive reasoning to be minimized through the organizational legitimization of the LetsTalk prototype and the small group size. The following survey quotes suggest that these design features were effective: "… It was prestigeless because of discussion in that format," "Open and good dialog", and "Small group, dared to discuss openly."

Dialog within and across diverse communities of knowing. By requiring the documentation of joint answers, LetsTalk forced discussion. One participant pointed out:

> Since written answers were demanded, one was forced to arrive at something. Otherwise (if written answers were not demanded) it is easy to just go on without really saying anything meaningful (survey quote).

This suggests that the joint answer requirement in LetsTalk can be viewed as a mechanism for heedful interrelating:

> That one had to produce written answers was very good. This 'forced' us participants to in a more 'open' way discuss towards a common solution (survey quote).

LetsTalk also provided a forum for exchanging and comparing different perspectives in cross-functional teams that most found lacking in everyday work life:

> The conversation with others was interesting… There are not so many forums for talks across borders (interview quote),

and

> Good to sit in a cross-functional group and discuss. One gets an understanding for others' problems and experiences (survey quote).

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Such boundary-spanning interaction provides the conditions for creating knowledge about interrelations and thus an infrastructure for heedful interrelating, as expressed in the following interview quote:

> In my normal workplace I work in a mixed group… and that is how it was in LetsTalk too… LetsTalk helped me understand the organization better. I can understand the other parts better. It is important to understand parts of the organization that affects me.

The few who were disappointed with the LetsTalk experience frequently cited that neither the questions nor the group configurations were relevant to them. With regard to the questions, one survey response read:

> Too general questions. Does it give anything then? Hard to answer how a project manager should be since I think it depends completely on the project to be managed.

Regarding group composition, one participant we interviewed said:

> I did not have anything in common with the group… I do not have a need for knowledge about subsidiary A. Our job is directed towards subsidiary B and its importers… A better group would give more, for example 4-5 persons from my department or close to me.

Knowledge representation. LetsTalk was successful in identifying issues that were perceived to be of high relevance to the organization, and contributed to focusing organizational attention on those issues. A Volvo Parts project manager we interviewed asserted:

> I participated in LetsTalk, not Global. I do not think it has been without effects. Previously one did not talk about that which we talked about at LetsTalk so it has clearly opened doors… Much of that which was raised in LetsTalk has been identified by the management in our bi-annual attitude survey. Now the question is on the table and everyone is talking about it…

The anonymization of the documented answers made available to the organization was perceived by participants to afford a higher degree of openness and honesty in the discussion and output document. While some participants did not think they would find time to study the documentation, many participants did view it as a resource for their learning: "Interesting to see if other groups have the same opinions or come with something completely new" (survey quote).

Participants hoped that the output of the LetsTalk sessions would play an important role in the organization's ongoing efforts to improve project work. Some saw the output document as a potential tool for developing education on project work: "Create some form of project education based on the groups'

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conclusions." Others placed their hope on the document's ability to get top management's attention:

> Good that management becomes aware of at least one of these questions

> Important that this is followed by feedback. Otherwise it becomes easy to point and say that the management does not take this seriously.

Top management expressed that the LetsTalk sessions were valuable and they highlighted the importance of responding to the improvement needs that the sessions highlighted. However, this positive energy soon died down, and management's response was limited to the official follow-up seminar:

> Immediately afterwards [after the LetsTalk sessions], everyone was positive, but after that there has not been so much feedback between management (interview with top manager).

At the follow-up seminar, the senior managers came well-prepared and addressed all the improvement areas highlighted by the LetsTalk documentation. The managers' viewpoints were often realistic and nuanced, referring to the ambiguities, complexities, and trade-offs of organizational processes and decisions. However, some participants felt that the senior managers were defensive and indecisive.

Our data collection at Volvo Parts was terminated six months after the LetsTalk sessions. By this point, the CIO had implemented some project initiatives, including the formation of a new, albeit small, project management support office, the development and use of project status reports, and a policy to use a customized project management methodology. However, we were unable to measure the effects of these initiatives. Nevertheless, the organizational use of reflection, dialog and representation in LetsTalk helped gain commitment and action from the top management, thus lending support for our design principles.

6 Discussion

While IS research regards the issue of how IT may help project teams to effectively handle complex tasks as an important topic (see e.g., Jarvenpaa and Ives 1994; Weiser and Morrison 1998), prior work has largely overlooked the role of technology in supporting the learning process in project-based organizational settings. Explaining how various socio-technical aspects affect the relationship between employee learning and knowledge sharing in project-based environments, the few studies that exist, point to the capability of collaboration tools to support organization-wide development and learning (see Boh

2007; Kotlarsky and Oshri 2005). Yet little IS research has specifically developed design theories for systems supportive of learning in project-based organizational settings, which are characterized by collectives rather than communities of practice (Lindkvist 2005). Given the need for effective learning technologies (Alavi and Leidner 2001; Robey et al. 2000) and the significance of theory for design and action (Gregor 2006; Gregor and Jones 2007), our research attempts to fill this knowledge gap.

In this paper, we propose a design theory for TML systems targeting project-based settings. Presenting the development of an IS design theory à la Markus et al's (2002) adoption of Walls et al's (1992) framework, the paper has addressed the following research question: What are the design principles that lead to a TML system that effectively supports learning in project-based organizations? Our 30-month AR study has generated a set of design principles for TML systems, which were instantiated through two design concepts (e-roleplay and e-discussion), and then implemented in three prototypes.

Our approach to using technology to support the process of organizational learning in project-based organizations is less focused on using technology to mediate the communication between participants, than on using the technology's multi-media capabilities to enhance the richness and authenticity of the learning (e.g., role-playing) situation. Furthermore, the technology was used to create a shared information space, i.e., a shared screen as output and a shared keyboard as input.

Consistent with the design-oriented action research methodology (Lindgren et al. 2004; Markus et al. 2002), we adopted a participative dialectical prototyping approach and sought to balance the specific organizational objectives of our participating firms with academically-motivated goals of contributing to IS theory and research. This did mean that we needed to be somewhat flexible in the instantiation of the design principles in each of our prototypes. Thus, given Ericsson's desire to take a top-down, training-oriented approach to its project-based learning initiative, we found it difficult to incorporate design principle 3 into the RICE prototype. Nevertheless, the peculiarity of each organization's objectives and situation provided a valuable experimental setting, which allowed us to test the hypotheses underlying our design principles within a diverse set of contexts.

We view the design principles as an interlocking complex intended to address the within-project, the project-to-project and the project-to-organization learning challenges. Our interpretation of the empirical assessments of the prototypes suggests that the principles effectively addressed the learning challenges in project work that the AR study set out to tackle. However, organizational members' negative experiences with the prototypes point to critical

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questions surrounding the theoretical assumptions underlying our design principles.

'The principle of reflection on sufficiently authentic project work' specifies that TML systems must foster critical reflection on simulated action so as to limit the effects of defensive reasoning. This design principle was brought to bear in the form of participants reflecting on practice-relevant problems in both e-roleplay and e-discussion. Most of the problems raised by the prototypes were perceived as authentic. However, while Global and LetsTalk successfully stimulated reflection among participants, RICE failed in this regard. A contributing factor was that the RICE prototype was too realistic in some respects, for instance, with regard to time pressure and information overload.

These findings suggest that authenticity alone is not enough to stimulate critical reflection on action in learning activities. Indeed, some degree of authenticity may need to be traded off in favor of stimulating reflection. Hence, a design implication of our study is that the overlap between participants' real-world experiences and the role-play's degree of authenticity must strike the right balance between similarity and difference for simulations to serve as a trigger for critical reflection.

The 'principle of dialog among project participants within and across communities of knowing' stipulates that TML systems must enable social interaction among project workers so as to support the articulation of situated knowledge. As the evaluations highlighted, the implementation of this principle facilitated dialog and conversation among participants engaged in Global and LetsTalk sessions. A contributing factor was that these two prototypes were successful in terms of their ability to afford much group interaction around relevant issues, thus creating a learning environment supportive of heedful interrelating. The TML systems brought the participants' different interpretations and perspectives together. For example, LetsTalk's documentation requirement forced dialog in that it demanded a certain level of consensus, which in turn, required participants with different specializations and organizational affiliations to compare and contrast their assumptions and interpretations.

However, the RICE scenario largely failed to support dialog and interaction. Participants were quite passive and silent during the sessions. This was due to long, non-interactive scenes that created a lengthy focus on the screen and the parallel scenes that required participants to concentrate on reading and making quick decisions (often through delegation) rather than discussing the decisions. Clearly, some features of RICE hampered collective interpretation and meaning making in that they obstructed social interaction.

These findings emphasize the importance of dialog and conversation in designing TML systems for learning in project-based organizations. Hence, a

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design implication of our study is that the technology's features need to foster cooperation, collaboration and dialog among participants so that knowledge can be constructed in a collective and emergent manner. Mechanisms such as the documentation of collective statements, reached through negotiated agreement, might help guide the development of such features.

'The principle of knowledge representation' prescribes that TML systems must capture the outcome of the learning process to facilitate knowledge transfer and learning through the ongoing re-interpretation of the represented knowledge. Building on the idea that individual reflection paired with perspective-making and perspective-taking among participants would form a necessary but not sufficient foundation for improved project work practices at the organizational level, Global and LetsTalk utilized knowledge representation to allow for the externalization of situated knowledge by turning it into an object. In view of Volvo's objective of improving organization-wide project work practices, transforming articulated knowledge into a somewhat independent object was expected to facilitate its transfer across social, organizational, geographic, and temporal boundaries, which in turn would trigger learning and sense-making at each reading, revising, and re-interpreting.

As representing knowledge in Global was an activity limited to the HR team, it failed to gain top management commitment. In contrast, the LetsTalk approach made the results accessible and visible to the entire organization. Whereas the discussions and resulting documents in Global were problem-oriented, they were solution-oriented in LetsTalk. Moreover, the knowledge representation in LetsTalk gained organizational visibility through intranet publication, which then made it necessary for top management to respond at the follow-up seminar.

Our assessments of the learning interventions provided us with valuable feedback on the issue of how to leverage organizational learning through IT-enabled knowledge representation. Global and LetsTalk were found to be supportive of much learning in terms of changed attitudes, awareness, and understanding among participants, i.e., at the individual level. However, while Global's organizational impact was limited to HR offering a number of workshops, LetsTalk managed to gain commitment and action from the top management. Even though we were not able to observe any significant organization-level changes, the CIO's initiatives were indicative of some efforts to improve project work organization-wide.

In general terms, the combined experiences from Global and LetsTalk teach us that the processes of knowledge representation and knowledge diffusion are equally important. Hence, a design implication of our study is that knowledge representation and knowledge diffusion are inseparable processes

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lying at the heart of organizational attempts to utilize IT as an enabler of organizational learning in project-based organizational settings.

7 Conclusions

The results from our empirical assessments suggest that our kernel theory provides valuable guidance for the development of TML systems for project-based organizations. Given the lack of TML design theories that address learning challenges in project-based settings, we view our theoretical framing of project-based organizations as collectives, rather than communities, as setting an important direction for future IS research on the role of IT in organizational learning. Furthermore, our design principles and design concepts can be readily adopted by practitioners seeking to offer learning intervention. Indeed, we note that our design concepts appear quite innovative in comparison to typical learning interventions provided by the project education industry, which usually focuses on teaching general and abstract project models and leadership techniques rather than addressing practice-oriented issues, such as project failure.

We also note that our development approach was effective in creating TML system content with a sufficient degree of authenticity and practice relevance. Therefore, in terms of the development process, we are confident that a participative dialectical prototyping approach is effective for the design and implementation of TML systems. With regard to future research, we expect that future collaborative industrial-academic research projects will further explore principles governing the development process of TML systems. Further research should investigate if our proposed design principles are valuable, in their current form or in an extended form, in both project-based and other organizational contexts. Thus, we anticipate that future IS research will extend and refine our proposed design theory for TML systems that support learning in project-based organizations.

Acknowledgement

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References

Alavi, M., and Leidner, D. E., "Research Commentary: Technology-Mediated Learning – A Call for Greater Depth and Breadth of Research", *Information Systems Research*, (12:1), 2001, pp. 1-10.

Argyris, C., "Teaching Smart People How to Learn", *Harvard Business Review*, (69:3), 1991, pp. 99-109.

Avison, D. E., Lau, F., Myers, M. D., and Nielsen, P. A., "Action Research", *Communications of the ACM*, (42:1), 1999, pp. 94-97.

Ayas, K., and Zeniuk, N., "Project-based Learning: Building Communities of Reflective Practitioners", *Management Learning*, (32:1), 2001, pp. 61-76.

Baskerville, R. L., and Wood-Harper, A. T., "A Critical Perspective on Action Research as a Method for Information Systems Research", *Journal of Information Technology*, (11), 1996, pp. 235-246.

Boh, W. F., "Mechanisms for Sharing Knowledge in Project-Based Organizations", *Information and Organization*, (17), 2007, pp. 27-58.

Boland, R., and Tenkasi, R., "Perspective Making and Perspective Taking in Communities of Knowing", *Organization Science*, (6:4), 1995, pp. 350-372.

Boland, R., Tenkasi, R., and Te'eni, D., "Designing Information Technology to Support Distributed Cognition", *Organization Science*, (5), 1994, pp. 456-475.

Brady, T., and Davies, A., "Building Project Capabilities: From Exploratory to Exploitative Learning", *Organization Studies*, (25:9), 2004, pp. 1601-1621.

Bresnen, M., Goussevskaia, A., and Swan, J., "Embedding New Management Knowledge in Project-Based Organizations", *Organization Studies*, (25:9), 2004, pp. 1535-1555.

Bresnen, M., Goussevskaia, A., and Swan, J., "Organizational Routines, Situated Learning And Processes Of Change In Project-Based Organizations", *Project Management Journal*, (36:3), 2005, pp. 27-41.

Cheng, M., Dainty, A. R. J., and Moore, D. R., "Towards a Multidimensional Competence-Based Managerial Performance Framework: A Hybrid Approach", *Journal of Managerial Psychology*, (20:5), 2005, pp. 380-396.

Cole, R., Purao, S., Rossi, M., and Sein, M. K., "Being Proactive: Where Action Research Meets Design Research", in *Proceedings of International Conference on Information Systems*, 2005, pp. 325-336.

C. Hardless et al. • 33

DeFillippi, R., and Arthur, M. B., "Paradox in Project-Based Enterprise: The Case of Film Making", *California Management Review*, (40:2), 1998, pp. 125-139.

Grabher, G., "Temporary Architectures of Learning: Knowledge Governance in Project Ecologies", *Organization Studies*, (25:9), 2004, pp. 1491-1514.

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

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

Hardless, C., Nilsson, M., and Nuldén, U., "'Copernicus': Experiencing a Failing Project for Reflection and Learning", *Management Learning*, (36:2), 2005, pp. 181-217.

Hardless, C., "'E-discussion': A Group Support System for Co-Present Knowledge Sharing", *Business Process Management Journal*, (13:2), 2007, pp. 173-192.

Jarvenpaa, S. L., and Ives, B., "The Global Network Organization of the Future: information Management Opportunities and Challenges", *Journal of Management Information Systems*, (10:4), 1994, pp. 25-57.

Kotlarsky, J. and Oshri, I., "Social Ties, Knowledge Sharing and Successful Collaboration in Globally Distributed System Development Projects", *European Journal of Information Systems*, (14), 2005, pp. 37-48.

Lave, J., *Cognition in Practice: Mind, Mathematics and Culture in Everyday Life*, Cambridge University Press, Cambridge, 1988.

Lave, J., and Wenger, E., *Situated Learning: Legitimate Peripheral Participation*, Cambridge University Press, New York, 1991.

Lee, A., "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.), Springer, 2007, pp. 43-60.

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

Lindkvist, L., "Governing Project-Based Firms: Promoting Market-like Processes within Hierarchies", *Journal of Management & Governance*, (8:1), 2004, pp. 3-25.

Lindkvist, L., "Knowledge Communities and Knowledge Collectives: A Typology of Knowledge Work in Groups", *Journal of Management Studies*, (42:6), 2005, pp. 1189-1210.

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Lindkvist, L., Soderlund, J., and Tell, F., "Managing Product Development Projects: On the Significance of Fountains and Deadlines", *Organization Studies*, (19:6), 1998, pp. 931-951.

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

Marsick, V. J., and O'Neil, J., "The Many Faces of Action Learning", *Management Learning*, (30:2), 1999, pp. 159-176.

Nonaka, I. and Takeuchi, H., *The Knowledge-Creating Company*, Oxford University Press, New York, 1995.

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

Orr, J. E., *Talking About Machines: An Ethnography of a Modern Job*, ILR Press/Cornell University Press, New York, 1996.

Poell, R. F., and Krogt, F. J. V. d., "Project-Based Learning in Organizations: Towards a Methodology for Learning in Groups", *Journal of Workplace Learning*, (15:5), 2003, pp. 217-228.

Prencipe, A. and Tell, F., "Inter-Project Learning: Processes and Outcomes of Knowledge Codification in Project-Based Firms", *Research Policy*, (30:9), 2001, pp. 1373-1394.

Robey, D., Boudreau, M., and Rose, G. M., "Information Technology and Organizational Learning: A Review and Assessment of Research", *Accounting, Management & Information Technology*, (10), 2000, pp. 125-155.

Rosenorn, T. and Kofoed, L. B., "Reflection in Learning Processes through Simulation/Gaming", *Simulation & Gaming*, (29:4), 1998, pp. 432-440.

Schön, D. A., *The Reflective Practitioner: How Professionals Think in Action*, Basic Books, New York, 1983.

Senge, P. M., *The Fifth Discipline: The Art and Practice of the Learning Organization*, Currency Doubleday, New York, 1990.

Sydow, J., Lindkvist, L., and DeFillippi, R., "Project-Based Organization, Embeddedness and Repositories of Knowledge: Editorial", *Organization Studies*, (25:9), 2004, pp. 1475-1489.

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

Weick, K. E., and Roberts, K., "Collective Mind in Organizations: Heedful Interrelating on Flight Decks", *Administrative Science Quarterly*, (38: September), 1993, pp. 357-381.

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Weiser, M., and Morrison, J., "Project Memory: Information Management for Project Teams", *Journal of Management Information Systems*, (14:4), 1998, pp. 149-166.

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