The Workplace as a Learning Laboratory: The Winding Road to E-learning in a Norwegian Service Company

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ABSTRACT
Over a 1 1/2 year period, we have participated in the introduction of E-learning in a Norwegian service company, a petrol station division of an oil company. This company has an advanced computer network infrastructure for communication and information sharing, but the primary task of the employees at the petrol stations is serving customers. We identify some challenges to introducing E-learning in this kind of environment. A primary emphasis has been on using participatory design techniques in the planning and early implementation phases of a system prototype. The system development process was evolutionary, starting bottom-up (user participation) and ending top-down (centralized initiatives). We describe a conceptual framework for analyzing the adoption process. The framework has three dimensions: technology, pedagogy and organization. We use video recordings and interview data in the analysis. Preliminary findings indicate difficulties with respect to appropriateness of new technology and lateral cooperation. This paper provides insight into the successful co-existence of old and new technologies and multiple information seeking strategies.

Categories and Subject Descriptors
D.2.2 [**Software Engineering**]: Design Tools and Techniques – *evolutionary prototyping*. H.4.3 [**Information Systems Applications**]: Communications Applications – *information browsers.* K.3 [**Computers and Education**]: computer uses in education – *collaborative learning*. K.4.3 [**Computers and Society**]: organizational impacts – *computer-supported collaborative work.*

General Terms
Design, Experimentation, Human Factors, Management.

Keywords
Workplace learning, E-learning, learning-on-demand, role-playing, organization of work.

1. INTRODUCTION
During the past decade, E-learning has attracted a great deal of interest in the Norwegian service industry, and many companies are now pursuing this form of training for all or part of their staffs. Previous studies have shown that when successfully implemented E-learning can reduce travel costs and the time spent on learning job-specific tasks and procedures [22]. Furthermore E-learning can strengthen the integration of working and learning when part of the work is computerized [10]. On a broader scale one can identify technological, pedagogical, and organizational dimensions that impact the introduction of E-learning in an organization. New inventions in high-speed network technology, multimedia delivery, knowledge management (KM) and learning management systems (LMS) represent technological factors [2, 9]. Pedagogy in an E-learning context is about company-specific teaching programs, theories of workplace learning, and conceptual frameworks for evaluating individual and organizational learning [6, 17, 28]. Organization is about new ways of working and new ways of learning, as well as participation from multiple levels in an organization when decisions about E-learning are made [3, 4, 12]. The complexity of introducing E-learning is to a large extent a result of the complexity of the interdependencies among these three dimensions.

Unfortunately, E-learning is often introduced based solely on its technological dimension, supported by frequently-issued claims that learning management systems can deliver learning material to employees' desktops and PDAs at the right time and right place and vice versa, allowing employees to search for job-specific information in order to complete required tasks with performance support systems. These claims can be realized in specific situations and successful implementations have been reported [22], but more often they remain slogans for management. The reported studies are not easy to duplicate in other settings.

We define E-learning in the broadest meaning of the word, as a technology as well as a strategy that must take technological, pedagogical and organizational concerns into account. E-learning can also be used to deliver information and tools automatically to users when accomplishing work tasks, even though learning is not an explicit goal of the activity.

In the company we report on in this paper, technology has been a necessary driving force for introducing E-learning, but it has not been sufficient. Technological decisions need to be informed by user participation and supported by decision-making power, so that the technology addresses real needs and the company acknowledges these needs as important. Second, pedagogical frameworks are needed for sorting out E-learning functionality and assessing its impacts on individual and organizational learning. Pedagogical theories of workplace learning have been absent from the E-learning literature; we therefore pay specific attention to this dimension and how it relates to the other two. In particular, we have identified situated learning [24, 16], master-apprenticeship [7, 21] and learning-on-demand [10, 23] as promising pedagogical models and techniques for analyzing the phenomena surrounding the introduction of E-learning in service-oriented, computer networked organizations. To the best of our knowledge, however, none of the current approaches takes the complexity of the interdependencies of the three dimensions into account.

The context of our study is a Norwegian project, Learning and Knowledge Building at Work (http://www.nr.no/imedia/lap/). This project is organized as a consortium, consisting of three industry partners (two large companies and the Federation of Norwegian Commercial and Service Enterprises) and three research partners (including one academic institution represented by the authors of this paper). A goal of the project is to implement a web-based learning system in the two companies. One of the companies is the petrol station division of an oil company (hereafter called ServiceCompany). It is ServiceCompany's case that we report on in this paper.

The work at the petrol stations is for the most part manual labor. Serving customers is the primary task of the attendants. Computers are used in the cash registry and the back office. To involve employees in the design of a future workplace, we have made extensive use of participatory design (PD) techniques in the planning and design phases of a system prototype. We conducted a one-day design workshop with user representatives at the company site, ranging from petrol station attendants to regional managers. The goal of the workshop was to design a future workplace that would make use of new technology and allow for improved learning opportunities. Additional goals have been to find new ways to integrate learning support with work tools (such as the cash register) and to conceptualize workplace learning as a natural extension of everyday work.

ServiceCompany views E-learning as a new strategy to help reduce the high turnover rate among its employees. The average worker at a petrol station stays in the company for about 12 months. It is thought that the addition of on-the-job training could extend this time by giving employees more enjoyable conditions in which to work. Another reason for introducing E-learning is to strengthen the employees' competence by giving them new and improved ways of accessing information. The motive for this is twofold: 1) to provide customers with better service; and 2) to make better use of digitized product information. The former is seen as an attempt towards increased customer-employee cooperative problem solving: that is, to better resolve ambiguities and difficult questions during customer interaction. The latter is a result of third-party vendors' efforts to make their products accessible online (via the Internet and Intranet) as a supplement to paper-based catalogues. However, as we will show later in the paper, this is a double-edged sword. Although it may lead to a more effective use of product information from the vendors' perspective, it may also impede the adoption of online systems in ServiceCompany until an agreement has been reached on a shared format for presenting product information.

2. CONCEPTUAL FRAMEWORK

We survey recent work on E-learning, identify pedagogical theories and models of workplace learning, and present lessons learned from past research on the adoption of shared information systems (groupware) in organizations. We later use this as a framework for analyzing interview data and video protocols from ServiceCompany, in order to assess the E-learning adoption process there.

2.1 E-learning Technologies

E-learning has been described as a merger of two previous technologies for computer-enhanced learning: computer-based training (CBT) and multi-media programs delivered on CD-ROMs [22]. The merger of these technologies was realized about 10 years ago, when multimedia-based training material could be delivered over the Internet and presented in web browsers (WWW). E-learning systems today typically consist of a subset of the following six components:

A high-speed computer network that allows training material and information to be instantly updated, distributed and shared with a potentially large group of users;

Delivery platforms that make use of standard Internet technology (web servers, URL access), allowing training materials and information to be presented on desktop interfaces as well as on the screen of smaller devices, such as PDAs;

Instructional applications and learning objects that make use of multiple data types (text, pictures, video, sound, animation), so that training materials can be presented in their most suitable form depending on the topic to be taught, the delivery platform and the learner's individual preferences;

Tools for managing learning objects, enrolled participants and online courses. This is supported by learning management systems and often accomplished at the auspices of the organization's competence or human resource (HR) department [9];

Tools for accessing learning objects and related information. This is associated with representing information in knowledge management systems and supported by various techniques for organizing learning material and retrieving it by search mechanisms in the user interface [2];

Tools for automatically bringing learning objects to the learners' attention by activating KM systems and providing alternatives to learner-initiated queries. A technological approach to activation is software agents [20], while a human approach is "super users" [29]:

technologically skilled users who provide help to regular users.

E-learning is not appropriate for all organizations. For example, work that is predominantly manual, a characteristic of many companies in the service industry, poses many challenges to computer-based learning systems. In these organizations the employees rely on mechanical tools and customer interaction to perform their jobs. Nevertheless, computerization has increased the relevance of E-learning in this sector as well, the combined result of employers' familiarity with new technology from other spheres of life (e.g. mobile devices for communication) and company-wide initiatives to introduce communication and information sharing systems for all employees.

We define E-learning in its broadest sense, as both a technology and a strategy that go beyond continuing the tradition of CBT and multimedia delivery [22]. E-learning can also be used to deliver information and tools automatically to users who are accomplishing work tasks, even if learning is not the goal of their activity [10]. In such a context it makes sense to distinguish two types of work: *primary* and *secondary*. Primary work is the tasks to be accomplished during a workday, which could be anything from customer interaction to working with job-specific products and tools. The tools may range from mechanical tools (automobile equipment) to computerized tools (cash register, PC, PDA, etc.), and a generic term we use for both types of tools is *performance support system*. Secondary work, on the other hand, is explicitly focused on learning and training. It is about the knowledge building that goes on in an organization and the knowledge needs of that organization's individual employees and work teams. This is closely associated with E-learning and knowledge management and the ways individual performance support systems can be integrated with a company's knowledge management system.

Several studies on computer-supported workplace learning stress the importance of work-learning integration, so that learning (as secondary work) will be meaningful for employees. When E-learning appears irrelevant to primary work tasks, it is often not prioritized [27]. Training (secondary work) needs to take place within a context that resembles that of primary work, or else training may not have a learning effect. There are other benefits of non-contextualized training, such as a chance to meet colleagues in a neutral (non-work) setting. This factor should not be underestimated when identifying success criteria for more enjoyable working conditions.

2.2 Workplace Learning Models

The need for learning at work in the service industry is evident. Previous studies have shown that customer interaction situations provide a rich setting for learning the ropes of the trade [17], and offering good service to customers has competitive advantages for a company. The combination of high demands on quality of service and the rise in number of products and tools an employee needs to know about to successfully interact with customers have given rise to new demands on workplace learning. Indeed, the petrol stations we studied are also effectively small supermarkets, fast food snack bars, and outlets for automobile products. The employees in these multi-purpose service centers are faced with a large inventory that contains many different products.

Workplace learning in ServiceCompany has until now been organized as a combination of informal, on-the-job apprenticeships and top-down corporate training (the classroom-based teaching of required skills and new product information distributed by company mail to the employees).

Apprenticeship can be illustrated by the following hypothetical situation. A customer is asking an attendant for help measuring the car's antifreeze level on the liquid cooling system, but the attendant cannot answer the customer's questions. He or she then asks a more experienced colleague to demonstrate the procedure for the attendant. However, ServiceCompany is open 24 hours a day, with work periods organized into 8-hour shifts, which means that there will be times when no experienced colleagues are on site to help an inexperienced attendant resolve this type of situation.

One characteristic of the above situation is that the need for learning is grounded in a real concern, but this need may not always coincide with an opportunity to sit down and study the problem to resolve it optimally (conventional learning). A theory/model that addresses this type of learning is apprenticeship learning [7, 21]. Apprenticeship learning originated with the enculturation of laymen into a craft. Masters of the guild gradually taught their apprentices the tasks, tricks and routines they needed to know to function as members. In our context, enculturation would mean becoming a member of the ServiceCompany culture, which entails knowing how to serve customers and to access necessary information when a customer request is outside the scope of one's current knowledge.

Apprenticeship is about bridging the gap between conceptual knowledge and practical problem solving in day-to-day work, and this gap is evident in ServiceCompany. On the one hand there is a corporate training program, which defines generally useful information every employee should know. On the other hand, practical concerns and local problem solving occur in the petrol stations on a daily basis, and cannot always be planned for in advance. Learning in this context can be seen as a by-product or side effect of practical action, not as an end in and of itself. The training programs provided by the HR department of the company can identify these learning needs and provide programs to support it, at a general level.

According to Collins, Brown and Newman [7], apprenticeship proceeds through stages, including *situated modeling*, *coaching* and *fading*. By modeling their strategies for executing a task in authentic activity, the master (coach) provides scaffolds to support the learners' problem solving. In the beginning the coach is at arm's length of the apprentices and will assist at every impasse. In the end he will fade away, leaving the apprentices empowered to continue independently.

We are interested in various ways this model can be enhanced with computer-support to bridge the gaps between primary and secondary work, and practical problem solving and conceptual knowledge building. Furthermore, in information-rich, multi-service companies there are few people who know everything there is to know because knowledge has become increasingly specialized (in terms of the amount of products and routines to know) and fragmented (in terms of the amounts of services offered). Less experienced employees may benefit from using information systems to assist with specific automobile products or

routines for preparing hot food. The expertise to answer his questions may not be at arm's length of the employee, but located at a different petrol station. For example, there are not automobile maintenance experts at every station, but an information system could help the employee to find a service station that provides this particular expertise.

An approach to computerized apprenticeship learning is learning on demand [6, 10, 23]. Learning on demand is how a computer can be utilized to find information to resolve a difficult situation associated with the task at hand. This could be by connecting the attendant in the above situation with a more experienced colleague, or automatically by the system itself, supporting the retrieval or automatic delivery of relevant information from the company's knowledge management system. This approach has previously been associated with computer-based coaching, critiquing and pedagogical software agents [10, 11, 20], as well as knowledge management systems that assist answer seekers in finding expert answerers [1].

The conceptual foundation for learning on demand [10] is rooted in the social sciences, and situated learning in particular [24, 16]. Situated learning has a strong organizational component, and is concerned with learning in a practical, social context, which occurs at the user's discretion. Situated learning situations are common in the workaday world. A typical ServiceCompany example is a customer asking for information about a specific product the employee does not fully understand, and therefore can only partially answer. The employee may need to consult a secondary source (a colleague, a paper-based catalogue, or a computer system) to find the answer. During this process the employee learns new information that is relevant to his job, for example that the information he found was not optimal, that there are multiple ways of solving the problem.

On the other hand, workplace learning is not only about situated problem solving and human development in small teams. It is also about how an organization as a whole learns and evolves. When putting these two together the combined approach can be described as the interplay of social competence and personal experience. Organizations supporting this combined approach have been referred to as *social learning systems* [28]. The employees are the central actors in evolving the social learning system. Participation is measured according to the degree of closeness to daily tasks and vice versa, according to distance from the shared values of the organization. *Engagement*, *imagination* and *alignment* [28] are three terms used to differentiate among the types of participation in a social learning system. Engagement is learning that is close to the task at hand, whereas alignment is learning that is associated with the shared goals of the company. Imagination is representations on the local situation for the purpose of reflection and self-regulation. These three modes of learning activity are associated with different kind of work at different levels in the company, but they will always coexist, often in uneven combinations. For example, using imagination one can gain a good picture of a problematic situation, which in turn can help to fine tune alignment so that one can better understand the reasons behind the procedure for a specific work task, which in turn can help to resolve the situation [28].

2.3 Organizing Learning and Working

Koschmann [15] has suggested that learning should be organized according to a strategy he calls 'learning *with* computers', as opposed to 'learning from computers' or learning through computers'. By this he means that E-learning should be treated as equal to and as an alternative to other learning resources such as textbooks and classroom-based instruction. This strategy has the advantage that E-learning allows discretionary use, but has the disadvantage that previous technologies need to be maintained in parallel (books need to be printed, seminars held, etc.). This is not always an attractive feature for a company, but costs could decrease if the previous technologies are provided in low volume and on a needs-basis, serving as back up when technology-enhanced learning breaks down. Thus in many companies, E-learning will serve as a supplement and extension to traditional training programs.

In the "office of the future," E-learning may take on a more prominent role. Bjerrum and Bødker [4] have studied many workplaces that are organized to increase learning and cooperation. In these environments the physical and computational infrastructure is open and flexible (open offices, transparent walls, wireless LAN) so that the employees and managers can tap into the company's knowledge assets and information repositories at any time. The potential for legitimate peripheral participation [16] is high in this kind of environment, supported by an improved awareness (over-hearing and over-seeing) of the activities of others [4]. However, the envisioned potential for increased learning was not realized in the companies studied, and the authors found patterns of conformity and anonymity rather than cooperation and creativity. The technology, artifacts and new physical spaces by themselves did not promote learning.

The E-learning environment developed in this project is an example of a shared information system (groupware). Previous studies of groupware adoption have identified critical factors that need to be taken into account when introducing shared information systems in large organizations [12, 13, 18]. These factors include:

> *Mandated use* during the initial phases of adoption to assure sustained use of the system. This is particularly critical in large organizations, because there are many different users, not all of whom may benefit or like the system [12];
>
> *Critical mass* is the stage a newly introduced system reaches when it has enough mandated users to sustain use without further mandate. At this stage *peer pressure* takes over, which means non-adopters feel a pressure from the early adopters to also start using the system [18];
>
> *Pleasure and fun* are powerful factors associated with a system when it needs no mandate to inseminate use because using it is a reward in itself [12]. Such systems are often not directly related to work (e.g. computer games, chat rooms and the Internet), but there is no intrinsic reason why they cannot support work related tasks as well;

Appropriateness of functionality. A frequent cause of groupware failure is providing new functionality as an alternative to previous functionality and requiring one to learn something new without providing perceived benefits for the users. Unless such systems are mandated or fun to use, they will not succeed [13];

Usability. A technological requirement for successful adoption is that the system works (no major bugs), is easy to use, employs a common data format that allows seamless transition from one system to another, and delivers information quickly and accurately;

Counter-cooperative behavior. Dependent users of a shared system provide counterintuitive results to each other because they are not aware of each other's interdependencies, or they deliberately decide not to cooperate [13].

In summary, we have identified a set of factors that can impact the success or failure of the E-learning adoption process. These factors have technological, pedagogical and organizational dimensions and include: identifying the components of E-learning technology that users expect, creating models of learning that caters to both individual and ServiceCompany needs (direct access to information; engagement and alignment), and addressing the concerns associated with organizational interfaces to shared systems. These issues will come up again when we analyze findings from a case study later in this paper.

3. USER PARTICIPATION

The title of this paper reflects our perspective on workplace learning: it is a "laboratory" where learning is seen as an improvisation of everyday work. We have experimented with various ways to involve workers in the design of learning scenarios and in identifying situations for which technology-enhanced learning could improve work tasks. We have made extensive use of Participatory Design (PD) techniques during these phases, combined with exploration of design alternatives at multiple levels of detail (from mock-up to installed prototypes). This has led to some degree of decentralized decision-making, at least in the early phases of the project, as well as extended time for reflection upon the implementation process.

In the spirit of the Scandinavian PD tradition, we opted for a high degree of user participation and cooperation at multiple levels of decision-making power [3]. A reason for this is to give ownership of ideas to workers and to include the knowledge of their work in the design of new work and learning environments. Based on a survey of research in PD [19] we identified three techniques we could use in our setting. These include mock-ups with "family resemblance" to tools and materials of the work setting [8], supplemented with specific techniques of workshop organization [14] and dramaturgy [5]. In the following three subsections we describe how we employed these techniques in greater detail.

3.1 Design Workshop Organization

During the initial phases of the project we conducted a one-day design workshop at the company site, with participants ranging from petrol station attendants to regional managers. The goal of the workshop was to design a future workplace that would make use of new technology and allow for improved learning opportunities.

The design workshop served as a structuring technique for organizing the other events within the umbrella of its format. Kensing and Madsen [14] suggested that design workshops be organized by dividing them into three phases: *critique*, *fantasy* and *implementation*. The critique phase is brainstorming in order to identify problem situations in the current work practice. In the fantasy phase, the participants search for solutions to the problem situations. Finally, in the implementation phase, the ideas are discussed and unworkable solutions are filtered out.

The design process we created can be summarized as follows, in the following order[1]:

1. All participants[2] were given practical lessons in theatre techniques from an experienced dramaturgy teacher;
2. The participants were split into smaller groups (four members in each group) with the goal of brainstorming around a specific work situation that could be improved;
3. Each group created a scenario to illustrate a typical work situation. The scenarios were acted out and presented to the other workshop participants;
4. The groups made mock-ups representing new artifacts to be used in the work situations;
5. The scenarios from step 3 were modified to include the new artifacts. The resulting examples of new work practices were acted out and presented to the workshop;
6. The scenario from step 5 was acted out once more, but this time with interruptions (freeze spots) at forks (decision points) in the task execution to explore workarounds for tasks that might go wrong;
7. All participants took part in a discussion about the relevance of the workshop and the quality of its outcome.

The workshop we organized made use of all of Kensing and Madsen's [14] phases, plus a few more (Sections 3.2. and 3.3). However, our step 2 (brainstorming) was slightly different from their critique phase in that problem identification was not explicitly on our agenda; rather, it was to find a typical work situation that could be improved. The groups brainstormed around current practices at their respective petrol stations, identifying typical situations such as serving customers and finding product information. They were free to do this in their own way and their suggestions were written on post-it notes on the wall. The discussion and printed notes were documented on camera (still pictures and video).

3.2 Mock-ups

The use of low-fidelity mock-ups for rapid prototyping has been an integral part of the PD tradition since it was pioneered in the

[1] The term "participant" includes both employers (end users) and researchers.

[2] Participants were divided into two groups. Each group had a random mix of attendants and managers.

UTOPIA project [8]. It is widely recognized that communication with end users must be done through concrete instantiations of product ideas, and that such models nurture the creativity of both researchers and end users in cooperative design activities.

For this workshop we had prepared foam models of different sizes to mimic some of the computer devices available on the market [26], from "digital watches" and "PDAs" to "tablet PCs" (Figure 1). During the design phase of the workshop, the participants were allowed to pick models that fit their needs, and to use these as props in the acted-out scenarios. Screen content and interactive behavior was modeled with the use of post-it notes that were glued to the models.

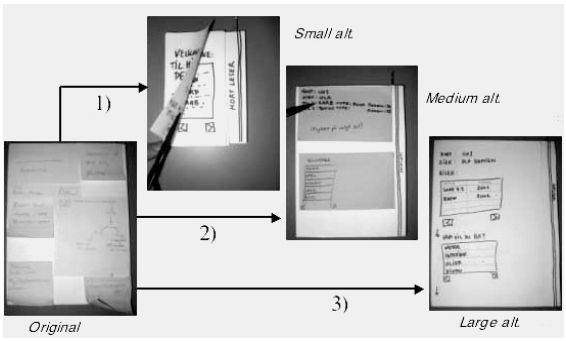

Figure 1. Mock-up information displays with post it notes and hand drawings. The "original" was created by one of the workshop groups. The numbered alternatives represent intermediate abstractions created by the researchers afterwards.

The resulting mock-ups provided valuable insights into the participants' ideas for new technologies they wished for in the workplace. The mock-ups also worked as a common reference point in the discussions between the end users and researchers.

3.3 Drama Techniques

A professional theatre instructor gave the participants an introduction to basic dramaturgy. We started with a 'warm up' acting exercise (playing roles in collaboration with each other) and were given instructions for how to create work-oriented scripts (Figure 2). The scripts were later executed and played in two sessions. The first session was to dramatize the current work situation, which basically meant a simulation of today's work. However, the audience (those who did not act) was told to identify potential breakdowns (e.g. someone pumping gas and leaving without paying), and write them down as comments on 4x6 index cards. The theatre instructor incorporated these cards in the second round as instructions.

Figure 2. Playing a work-oriented script with the aid of a mock-up to resolve a breakdown (customer waiting in line is helping himself by consulting an information display).

The second session was dramatized in two acts: the first showed a future situation at the petrol station, and the second was a rerun interrupted by "freeze spots." A freeze spot breaks up an act into two parts: before and after, in order to join "repair actions" with the interrupted "before" actions. This allows breakdowns to be resolved in creative ways. The instructor called the freeze spots and decided on the breakdown by selecting one of the index cards. When the players were told to resume from the interruption, they would join the before-act with a workaround to resolve the breakdown, resorting to the mock-ups they had previously created. Examples of freeze spots could be someone leaving a long line, or an information display that does not work.

We have adopted this technique from frozen images [5], a theatre technique in which the actors are directed by the audience and have to complete an interrupted situation with a creative continuation. When we dramatized the future situation with the aid of mock-ups, breakdowns, and freeze spots the employees were able to realistically see to what extent they were able to improve upon their current work situation.

In summary, both employees and researchers considered the workshop entertaining and useful. It was not difficult to get the employees to participate constructively. The petrol station attendants gave examples of real learning situations, and the regional managers were able to see what kind of learning support system the attendants needed.

After the workshop we detailed the mock-ups in various sizes to create a set of intermediate abstractions (see Figure 1). The largest alternative was selected as the preferred model, because the smaller sizes could easily be stolen or misplaced in the store. Based on these requirements the ServiceCompany IT department created the first computer-based prototype (Figure 3): a touch screen-mounted terminal display facing the attendant. The system contained product information about car batteries and windshield wipers, which could be accessed by a few finger touches. The prototype was placed in a pilot station for a period of two months. During the trial period, all employees at the petrol station explored the prototype's features at least once. They were eager to tell us what they thought about it and how it could be improved. The feedback we received gave us the impression that the employees really needed detailed information about

automobile products in their daily work. They were enthusiastic about having a computer tool that could supply this information.

Figure 3. First prototype (touch screen) created by the IT-department of ServiceCompany based on the mock-ups created in the design workshop.

Based on the positive feedback on the first prototype, the company decided to implement a second version. This time the focus was less on usability and more on the kind of information it should contain and the extent to which it could support communication between petrol stations, since cross-station communication was a common practice supported by telephone. The second prototype was installed at three petrol stations, located less than 15 kilometers from each other.

The decision-makers of the company (the IT department in collaboration with HR department managers) opted for an intranet portal on a laptop installed at one end of the counter (Figure 4). In addition to automobile product information, news and product campaigns from the central administration and a bulletin board for station managers to provide local information were added. The aim of the bulletin board was to support communication among employees at the three pilot stations with the option that the other stations later would be able to use this feature as well. However, there was no mandated use.

Figure 4. Second prototype (laptop interface) created by the IT-department in response to demands for integration with the company's intranet portal.

4. ANALYSIS OF RESULTS

From an evolutionary prototyping point of view, we see a shift from E-learning as work support toward E-learning as communication and information sharing for the entire company. This is primarily a result of the company-wide initiative (intervention) launched by ServiceCompany to provide a shared portal for the organization. The end result could be seen in at least two different ways: 1) as a (partially completed) web-based learning on demand system supporting secondary work (training and learning), and 2) as a centralized information-sharing system emerging as a new form of work [4]. At this point we can only speculate as to what extent these two views are accurate descriptions of the current situation and whether or not they are converging or diverging. Our current best estimate is they are converging.

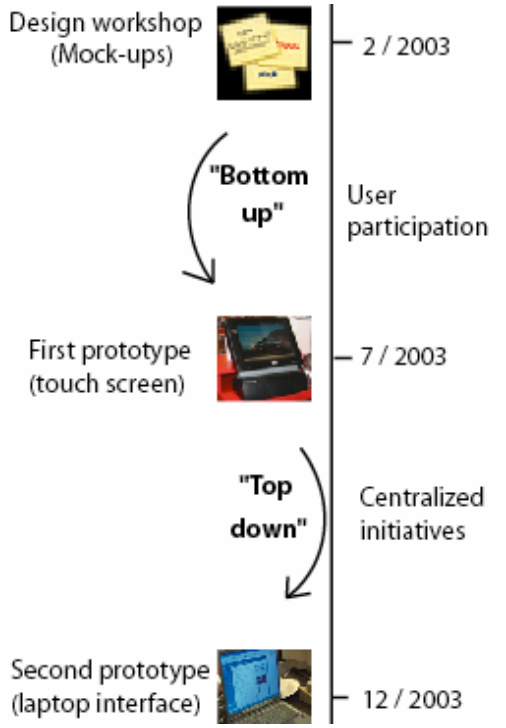

Figure 5. ServiceCompany's E-learning adoption process is marked by critical events. A bottom-up approach (user participation) is followed by top-down (company-wide) initiatives.

From a user participation point of view, we see a shift from local ("bottom-up") engagement to an alignment with the company's overall profile and shared values [28], as depicted in Figure 5. The hands-on, work-oriented material of the mock-ups and dramaturgy sessions created a close connection with the operations of first prototypes, thus resulting in a higher level of engagement than we have seen with the second prototype. On the other hand, the second prototype has more durability due to corporate backing. If it is allowed to evolve over time it may

eventually lead to a system that will meet with enthusiasm and engagement by the employees.[3]

We were unable to maintain the close loop between technology adoption and user participation after the second prototype was introduced, because the users were not as personally motivated as they were with the first prototype. Therefore, company guidelines and strategies also influenced the further design process. On a more technical level, it seems that ServiceCompany was keen on keeping the project within the same framework as the other application packages it supported.

Preliminary findings based on the employees' reactions to the second prototype can be grouped into the following categories:

Appropriateness of technology;

Co-existence of old and new technologies;

Information-seeking strategies;

Lateral cooperation.

The HR department of the company created and periodically updated the web pages for the second prototype. Station managers and employees at the three petrol stations provided information for the local bulletin boards. The employees who were familiar with web browsers perceived the system as easy to use, but it has not been in frequent use since it was installed, and some employees have not used it at all. As one employee said:

> *I don't find it flexible enough. It is very time consuming to use. It is much easier for me to - and customers become impatient - it's easier to just go out and measure it.*

The petrol station attendant was referring to a situation in which a customer asks for help in picking out the right windshield wiper for her car. We asked if he could use the system to find out about the different models and sizes of windshield wipers, but the system simply does not support the task [13]. On the other hand, the system does provide the answer in one of its databases. It is an open question as to whether or not the employee's use of the system would increase if ServiceCompany provided a better interface for it and made it more interesting to use, possibly followed up by mandated use [12].

It is not likely that ServiceCompany will encourage mandated use. Their strategy seems more in line with seeing new technology as a way of working that will provide an alternative to current ways of working over time, replacing them in certain situations when the older ways become too cumbersome. The employees we spoke with acknowledged this by providing us with examples to illustrate specific use situations. For example, they preferred paper-based catalogues to the computerized information system in order to find product information. As one employee said:

> *I am not very good with computers. Most of the time it is much faster to use the paper catalogues.*

[3] At the present stage of the project (5/2004), the second prototype has been in continual (sporadic) use since 12/2003. The user interface and product database have been improved and the system has been installed at 22 new petrol stations.

Even thought some of the employees are not skilled with using computers to find information, they are familiar with using paper-based catalogues. Suchman [25] calls this phenomenon "artful integration," which she defines as a hybrid combination of technology and practice comprised of multiple layers of heterogeneous devices, each associated with a specific generation of technology to support work. In our case, this would mean the coexistence of multiple technologies and practices associated with helping employees to serve customers and find information: face-to-face communication, contacting colleagues, checking customers' automobile malfunctioning parts, paper-based catalogues, computerized information systems, etc.

An example of a constructive transformation of one technology to the next was identified in one of the stations. This station had established a routine for using a book leaflet to exchange useful information among the attendants between the various shifts on consecutive days. This routine was transferred over into the new medium and was ultimately made a mandated practice at that station. Interestingly, its use was not limited to internal communication, but it became a communication channel with the two other stations as well. However, this feature has only been operational for a short period, so it is too early to have conclusive evidence for its adoption by ServiceCompany.

The new information system and accompanying learning resources have not yet been integrated into daily work practices; employees therefore rely on other information-seeking strategies they are already familiar with, such as paper-based catalogues, information on product tags, and communication with colleagues. We asked the employees how they would get access to the relevant information if none of the above strategies applied:

> *We just pick up the telephone and call a nearby company petrol station.*

The employees had already established information-seeking strategies that worked well and supported a kind of "learning on demand". Although it is premature for us to conclude whether or not they would learn anything with the new information system, learning does occur on a daily basis with current technologies and practices. The new information system was implemented more or less in competition with already well-functioning technologies and established social practices. Therefore, at the current stage in the project, several information-seeking strategies are available that outperform computer-based information retrieval. Whether or not this will also be the situation in the future we can only speculate. Certainly information browsers will evolve and improve over time, making them more efficient for job-specific tasks; but at the same time, older technologies may be harder to replace or update, and may be serviced less frequently. Critical mass, peer pressure and mandated use [18, 12] will be important social factors for successful adoption at specific petrol stations. On the other hand, if older technologies (such as the telephone or paper-based catalogues) continue to be sought after so that the market for periodic updates and service remain, these technologies will persist as well.

For shared information systems to succeed without mandated use they must be fun to use [12] or support lateral cooperation within the organization and with its cooperating partners [13]. In our case, two stakeholders influenced the outcome in unanticipated ways, which we attribute to lack of lateral cooperation. The

ServiceCompany IT department implemented and installed the two prototypes and the product suppliers provided content to supply the automobile information databases. A factor impeding the usefulness of the two prototypes could be attributed to the fact that an agreement on a shared data format for presenting product information was not established. The three interdependent partners have not (as of this writing) resolved this issue. A workaround we opted for was to operate directly with the vendors' public Internet pages. The result of this is two ways of classifying automobiles (one organized to ease the retrieval of car batteries and the other to ease the retrieval of windshield wipers). This has impeded the use of the system. The same discrepancy is also manifest in older technologies like the paper catalogues, but not to the same extent.

5. SUMMARY AND CONCLUSIONS

We have participated in the introduction of a web-based learning environment for a group of employees at a large Norwegian service company, the petrol station division of an oil company. During the early phases of the project we made extensive use of participatory design techniques to involve future users (employees) in the process of designing their future workplace. They created mock-ups and scenarios that suggested new ways of doing work, simplifying some of the current work routines. To extract the "E-learning potential" from this, we asked the participants to reflect on the process from which we produced a first prototype. After the introduction of the first prototype the focus changed from user participation to company-wide initiatives at selected pilot stations. The systems were improved with more features, but use of the systems did not improve.

Preliminary findings indicate difficulties with respect to the appropriateness of the new technology and lateral cooperation with interdependent partners (product information suppliers). We also provide insight into the functioning of the co-existence of old and new technologies and the use of multiple information-seeking strategies during work tasks.

During the analysis we made use of a conceptual framework that takes three dimensions of E-learning introduction in the workplace into account: technology, pedagogy and organization. The balance among these three dimensions changed during the course of the project as the prototype evolved. It started with apprenticeship and learning on demand as a pedagogical model and bottom-up organizational grounding and switched to information sharing and collaborative learning (asynchronous bulletin board) and top-down grounding in the organization. In the future, top-down grounding may be able to resolve the difficulties associated with lateral cooperation due to the decision making power it entails. On the other hand, the new prototype seems less appropriate for supporting employees' work tasks. The bottom-up grounding process that led to the first prototype made use of PD techniques in order to address real user needs. We believe this has been an important contributor to its usability. Furthermore, it served as a trigger for the company to be more active with proving more effective learning support to its petrol, station attendants.

An open question raised by previous readers of this paper is whether the results we report could have been obtained by other means. For example, could the results have been foreseen in the early phases of the project when we conducted the PD workshop, and could conventional software engineering methods more effectively bring out the fact that E-learning would be replaced with a company-wide information sharing system.

We have no definite answers to these questions. Our approach is unconventional compared to the standard way of introducing E-learning in large corporations, which is to deliver pre-designed systems, or author tools for super users. The PD techniques we employed gave us room for experimentation and user involvement, which was partly rejected and partly accepted by the management. The parts that were accepted were incorporated into the second prototype. The parts that were rejected served as arguments for excluding non-working alternatives. We also know that the ServiceCompany previously attempted to introduce E-learning the conventional way, and that attempt failed.

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