Chapter 9

Design and use of an integrated work and learning system

Information seeking as critical function

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Introduction

Since the introduction of the World Wide Web in the mid-1990s, online (web-based) learning has attracted a great deal of interest in the Norwegian service industries and many companies are now pursuing web-based training for their staff. We use the term "web-based learning portal" and "web portal," to refer to the technology that aims to *mediate* work and learning. We show that this form of technology can strengthen the integration of work and learning when part of the work is computer-based, which is increasingly becoming commonplace in many organizations.

We extend the previous research with a focus on *socio-technological contexts* within the service industry area. This includes a design approach of web portals and a conceptual framework for analysis of the adoption process. In such a dynamic context, as the service industry represents as a result of frequent customer interaction, it makes sense to distinguish among types of work: here, we make a distinction between *primary work* and *secondary work*. Primary work refers to the compulsory tasks to be accomplished during a workday. Secondary work is work that is focused on training and learning. This ranges from organization-wide knowledge-management practices on one end to that organization's individual employees and project groups on the other (see the introduction in this book about the social organization of learning). A contribution of this chapter is to treat learning as a form of work that is associated with gap-closing primary and secondary work, participate in the design and implementation of an integrated work and learning system, and study its adoption and use in terms of specific secondary work characteristics: adaptation (Gasser, 1986), articulation (Strauss, Fagerhaugh, Suczek & Weiner, 1985; Suchman, 1996), and information-seeking.

Background and context

This chapter presents and analyzes data from a three-year Norwegian project, Learning and Knowledge Building at Work, carried out between 2001 and 2004. This project was organized as a consortium of two companies in the service

industry, the Federation of Norwegian Commercial and Service Enterprises, and three research institutes. A goal of the project was to introduce web-based learning technology in the two companies. A primary emphasis has been on using participatory design techniques during the planning stages and evolutionary application development during the system-development stages. One of the companies was the petrol station division of an oil company (hereafter called Service Company) and the other was an accounting company (Åsand & Mørch, 2006). We will report on the Service Company's case in this chapter. Preliminary findings were reported in (Mørch, Engen & Åsand, 2004). This chapter analyzes data six months after the portal was first put to use on a large scale (Skaanes, 2005).

From the Service Company's point of view, web-based learning is a way to organize work 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. Although the work at the petrol stations is, for the most part, manual labor, it is thought that the addition of web-based training could extend this time by giving employees more enjoyable conditions in which to work. It was estimated that this could be achieved in at least two different ways: (1) by improving the interaction between customers and attendants; and (2) by providing online access to product information in a uniform way (for all product categories). Both of these goals are challenging. First, the work is not computerized. Computers are integrated in the cash registry and through a single computer in the back office of the stations. Second, there are, to the best of our knowledge, no established theories of technology-enhanced workplace learning to guide our analytic efforts. In the analysis we draw on articulation work (Strauss *et al.*, 1985), computerized work (Gasser, 1986), learning on demand (Fischer & Ostwald, 2001), situated action (Suchman, 1994), and situated learning (Lave & Wenger, 1991).

The rest of the chapter is organized as follows. We start by identifying the learning needs of modern organizations in their effort to define new ways of working and learning. Next we describe techniques for involving users in the design of technology (participatory design), and an approach to end-user development to incrementally deliver a web-based learning platform. Then, we present a conceptual framework for analyses of the adoption process in an organization, and we make use of this framework to analyze findings from a field trial of a web portal introduced into a national chain of petrol stations. Finally, we discuss our findings and compare our results to related research.

Technology-enhanced learning at work

The learning situations we discuss are different from most learning situations in educational institutions. Learning at work is, to a large extent, driven by situational demands, which means that employees' learning needs vary over time and depend on the goals of the company they work for. To address varying learning needs, multiple learning strategies have to be supported, ranging from just-in-time "fix-it" strategies to in-depth tutoring of domain-specific skills (Fischer *et al.*, 1998),

with and without computer support, and catering to both old and young employees. Furthermore, the mandated use of a learning platform, which is common in educational institutions, is not a viable option for most commercial organizations because teaching and learning is not their business goal. Where a teacher can require all students in his or her class to use a certain educational technology, we could not rely on that in our study because web-based learning is not high priority (mission critical) and it competes with other more established forms of training support (lectures, seminars, self-directed learning, etc.) organized by the human resources (HR) division of the company.

In the "office of the future." web-based learning has been envisioned as a tool that will assume a prominent role as a technology that can be tapped into at any time to provide information that is relevant to an employee's task. Bjerrum and Bødker (2003) have studied modern workplaces with institutionalized practices that promote learning and cooperation with new technology. 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 access the company's online knowledge-base at any time. The potential for legitimate peripheral participation (Lave & Wenger, 1991) is high in this kind of environment, supported by an improved awareness (over-hearing and over-seeing) of the activities of others (Bjerrum & Bødker, 2003). When this is supplemented with context-aware computer applications (Dey, Abowd & Salber, 2001) and computational awareness mechanisms (Mørch, Jondahl & Dolonen, 2005), it provides a technical framework for learning on demand (Fischer & Ostwald, 2001). However, the envisioned potential for increased learning was not realized in the companies studied by Bjerrum and Bødker, and they found patterns of conformity and anonymity rather than new forms of cooperation and creativity. The technology and new physical spaces, by themselves, did not promote learning.

By treating technology as *mediating artifact* rather than stand-alone innovation or discrete IT-solution, it takes on a different role that broadens the application context and integration with older technologies (Eklund, Mäkitalo & Säljö, this volume; Ludvigsen, Rasmussen, Krange, Moen & Middleton, this volume). Instead of "learning from computers" or "learning through computers" one can "learn with computers." By this it is meant that technology-enhanced learning should be treated as equal to and as an alternative for other learning approaches, such as textbooks, lectures and seminars. This approach to mediation might increase the acceptance of web-based training in organizations because it allows learners to choose their preferred learning approach from a range of alternatives (from computerized to conventional). This is more in line with company strategies and objectives for institutionalizing learning at work. In the context of educational technologies this is sometimes referred to as *blended learning*, which means to combine online and face-to-face approaches (Fjuk & Kristiansen, 2001). In the context of computer-supported cooperative work (CSCW) it has been associated with *discretionary use* of new technology, which has been identified as an important principle for successful introduction of groupware in working-life organizations

(Grudin & Palen, 1995). It means that employees should have the right to choose among alternative technologies to support their business goals. A shortcoming of this approach (as well as blended learning) is that older (alternative) technologies need to be maintained in parallel with the latest technological tools (books need to be printed, courses held, etc.). This is not always an attractive feature for a company that wishes to promote advanced learning technology, but costs will decrease if measures are taken to anticipate future use situations and to design for it in such a way that the older technologies are gradually phased out or continued for special needs and niche markets (printing on-demand, older technology as workarounds during repair of primary work support, etc.). Thus, in many companies web-based training will be introduced to cater to two needs: (1) to provide an alternative to existing competence initiatives and (2) to strengthen the company's technological image to the outside world. This means enriching and spearheading, rather than supplanting traditional human resources (HR)-based training programs.

Design and development of a web-based learning portal

To plan for the challenges associated with institutionalizing web-based learning in a large organization we opted for a design methodology that combined participatory design (PD) and end-user development (EUD).

Participatory design

One of the primary goals of the Learning and Knowledge Building at Work project was to involve the workers at the petrol stations in the design of their future workplace. By making the employees "owners of the problems" (Fischer, 1994), and "champions of the project" (Åsand & Mørch, 2006) they helped us: (1) to identify situations for which technology-enhanced learning could improve existing work practice and (2) to sustain the project after it was completed. This was accomplished using participatory design (PD) techniques (Bjerknes & Bratteteig, 1995). We made extensive use of PD techniques, including the exploration of design alternatives, and the design of learning scenarios. This broadened the design space and led to some degree of decentralized decision-making (empowering the actual users) as well as extending the time for reflection throughout the implementation process.

Mock-ups and design alternatives

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 UTOPIA project (Ehn & Kyng, 1991). It is widely recognized that communication with end users must be done through concrete representations of ideas, and that such representations nurture

the creativity of both end users and researchers in cooperative design settings (Svanæs & Seland, 2004).

The mock-ups the employees created were not merely representations of their collective understanding of their workplace. The materials employed are inexpensive and readily available, which meant that the participants could create different versions in a brief period of time, thus empowering all those who wanted to take part, including those without the background for or interest in using computers. When the employees had modeled their ideas, the mock-ups needed some polishing before they could be presented to the developers in the IT department (who later developed solutions). The researchers made new mock-ups by varying the size and refining the interactive behavior of the user-generated models. This is what we refer to as design alternatives (Mørch & Solheim, 2005). Design alternatives are intermediate abstractions that have "family resemblance" (Ehn & Kyng, 1991; Mørch, 2003) to both workplace materials and computer interfaces. They can function as a platform for end-user development, which we illustrate by an example later in the chapter.

The mock-up that was chosen by the Service Company was a large-sized information display. The deciding factors in the selection process were the envisioned location in the store of this mock-up and its size; it was thought that the smaller sizes would more easily be misplaced by attendants or stolen by customers. Nevertheless, the employees definitely contributed to the decision-making process through their constructive participation in the workshop. They generated ideas, made clear what they wanted, and understood the consequences of intermediate abstractions.

Simulating the future with role-playing techniques

We employed a technique we called "learning scenarios," which are PD scenarios depicting future integrated work and learning situations at the petrol stations. We

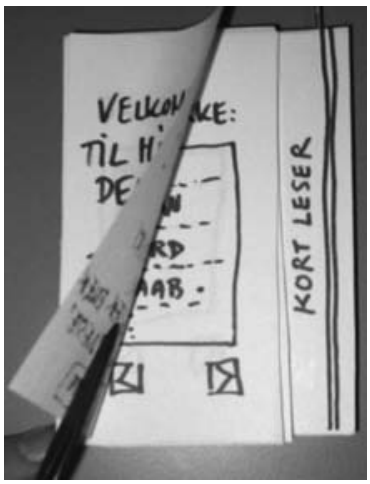

Figure 9.1 Alternative information displays: mock-up with Post-it notes and hand drawings to enable simulation of desired interaction with a handheld device

both created scenarios and we executed (played) them, similar to how role-playing is done in dramaturgy. We hired a professional theatre instructor to provide the participants with an introduction to dramaturgy for the purpose of creating convincing scenarios (to fuel interest and acceptance in the company at large). The participants (selected station attendants, regional managers and researchers) in collaboration created scripts that were later enacted in two situations. During the first simulated situation (current workplace) the audience (those participants that waited for their turn to play) was told to identify potential breakdowns that could occur (e.g. someone pumping gas and leaving without paying), and write them down on 4 × 6 inch index cards. The theatre instructor incorporated a selected set of these as prompts in the second round of role-playing.

The second situation was to simulate future work, which was dramatized in two acts. The second act incorporated and resolved the breakdowns identified in the first act. This was accomplished by a technique called "freeze spots," which stops the action and creates an interruption of the situation. The actors continue with a self-directed recovery that takes the situation in a different direction than originally planned (Brandt & Grunnet, 2000). When we dramatized the future work situation with the aid of recovery props (mock-ups, workarounds), the employees were able to see, in a semi-realistic way, the extent to which they were able to improve upon their current work situation with innovation.

End-user development

Transforming users' concrete ideas into software prototypes is not well supported in participatory design. The problem is related to the fact that software artifacts are abstract objects (Kramer, 2007). They are not easily learned and to modify them is even harder. We propose transitions to bridge PD representations (informal, inexpensive) and software representations (hardware platform, software design, program code) by end-user development (EUD). EUD consists of methods, techniques and tools for modifying software artifacts by non-professional software developers (for an overview, see Åsand & Mørch, 2006). We focused on supporting evolutionary application development (Mørch, 2003; Mørch, Dolonen & Nævdal, 2006).

Evolutionary application development (EAD) entails that ICT tools (software and hardware) can evolve along numerous paths, driven by user needs and end users' active participation. To design for EAD application, professional-systems developers must provide options (alternatives) or open points (hooks) for initiating further development. To the extent that users know about these options and open points, it provides them with various degrees of design opportunities. As well, to the extent that users can make use of them constructively, for example, when they are associated with domain-oriented design environments (Fischer, 1994), they will be able to contribute to the design process with (modifications to) designed artifacts. Furthermore, when domain-oriented design environments are aided by techniques for transforming informal (non-computerized) representations

into formal (computational) representations, they are surprisingly useful. In sum, evolutionary application development suggests many small steps carried out by end-user developers in collaboration with professional developers, rather than a few big steps carried out by professional developers. This is demonstrated in the remainder of this chapter with an example.

The Service Company's IT department created the first computer-based prototype based on one of the refined mock-ups. This prototype was a touch-screen-mounted terminal facing the attendant and placed in a pilot station for a period of two months (Figure 9.2). The system contained product information about car batteries and windshield wipers. 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 of it and how it could be improved. The feedback we received gave us the impression that the employees had a real need for access to detailed information about automobile products due to the complexity of this type of information and the frequent request from customers. The employees were enthusiastic about having a web-based tool that could supply this information.

Although initially intrigued by the system, the attendants only sporadically used it. Its design was criticized for various reasons. For example, the information was organized from the perspective of the system's builder (IT department) and not from the perspective of the users' problem situation (i.e. several menus had to be traversed to retrieve the necessary information). Furthermore, the attendants misunderstood the use of color-coding to differentiate the various models and types of automobile products, and in some instances they found it difficult to understand the written explanation on the screen. Based on these findings (revealed during a

Figure 9.2 First prototype (touch screen) created by the IT department based on the mock-ups created in the design workshop. It is located next to the cash register, facing the attendant

usability test), we decided to improve the user interface by using a simpler navigation structure, more intuitive symbols and a uniform organization of information for all automobile products. The second prototype was created with the rapid application development platform ColdFusion (Mørch & Solheim, 2005).

In the next round, a third prototype was developed. The decision-makers of the company (the IT department in collaboration with the HR department) saw the potential of the previous prototypes and opted for a web portal developed on a laptop (Figure 9.3). In addition to automobile product information, hot food procedures, news and product campaigns from the central administration were incorporated. The rationale for the new information was to integrate the portal with the company's existing communication and information-sharing system. Finally, a bulletin board was added as an extra tool. The aim of the bulletin board was to support communication among employees at the three pilot stations with the option that the other stations would be able to use this feature at a later date. However, there was no mandated use of the system. After another usability test, the system was improved and its database increased by adding more information, eventually making it a pilot web portal, supporting realistic usage. The latest version (completed one year after the project ended) has been installed at 230 petrol stations, and outside Norway as well. It continues to exist after the project ended as of 2009.

Research questions and data collection

Before the portal was introduced nationwide, the employees at the petrol stations used non-computerized methods to support information-seeking. The research question we set out to address was: (1) how does the portal integrate with existing ways of seeking information, and (2) how can we conceptualize learning at work in terms of primary work?

Data was collected by observation, survey (online questionnaire) and interviews (Table 9.1 shows evaluation techniques for the various prototypes). The questionnaire was sent to 25 retail stations, representing the 230 stations. Interviews

Figure 9.3 The third prototype installed in a petrol station. The IT department developed it as a response to an evaluation of the second prototype

Table 9.1 The series of prototypes and corresponding evaluation techniques (HQ = headquarters)

Version	*Installation*	*User interface*	*Data collection*
Simulation	January 2003 (scenario at HQ)	Mock-up	Design workshop
Prototype 1	June 2003 (HQ pilot station)	Touch screen	Observation, walk-through
Prototype 2	July 2003 (HQ demonstration)	PC/horizontal prototype	Demonstration and feedback
Prototype 3	August 2003 (three pilot stations)	Laptop	Usability evaluation
Pilot web portal	November 2003 (25 retail stations)	Laptop (enhanced functionality)	Observation, interviews
Integrated web portal	January 2005 (230 stations)	Integrated in cash register	Questionnaire and interviews

were used to cross check (triangularize) the data. The majority of the respondents were attendants in the age group 20–29. (Three station managers and a regional manager were older.) The average number of years working for the company was three. The items in the questionnaire concerned information-seeking approaches employed during daily work as this was judged to be an important method for learning at work. Thirty-four respondents completed the survey. On average, one or two persons from each of the 25 retail stations filled out the form. This is about half of the total population. We did not notice any bias according to educational background or work responsibility among the respondents, but the age difference made an impact on the data.

Conceptual framework for analysis

We propose two basic concepts for learning at work, *primary work* and *secondary work* and we understand the integration of primary work and secondary work as a "gap-closing" activity in line with findings reported in other chapters in this book (e.g. Engeström & Toiviainen, this volume; Eklund, Mäkitalo & Säljö, this volume). We do not employ an activity-theoretical discussion; we focus instead on identifying the mechanisms at work and illustrate how they interact at a relatively detailed (meso) level. Primary work refers to the main tasks to be accomplished during a workday and these tasks are often written in a work description. Secondary work supports and augments primary work and comes to the foreground when complex work is analyzed in detail or is otherwise disrupted and becomes an object of reflection.

We draw on some early computer-supported work to identify concepts for

analysis that relate to primary and secondary work. Gasser was the first to study computerized work as secondary work and defined it (without using the term) as composed of articulation work and adaptation work. *Articulation work*, first proposed by Strauss (e.g. Strauss, Fagerhaugh, Suczek, & Weiner, 1985), is the work involved in coordinating interactions between "social worlds" of people, technology and organizations, and, at a more detailed level, to "smooth out inconsistencies" in primary work tasks (Gasser, 1986). It applies to a wide range of application domains, ranging from interactive customer service (Hampson & Junor, 2005) to air traffic control (Suchman, 1996). Suchman describes the articulation work of air traffic controllers in their effort to coordinate the arrival and departure of planes at an airport. She found that many of the details of air traffic controllers' work were glossed over in job descriptions (Suchman, 1996).

Gasser identified three types of *adaptation work*: fitting, augmentation, and working around. *Fitting* is the strategy of modifying a computer system or changing the structure of work to accommodate a mismatch between worker and technology. In the context of modifying computer systems, this is referred to as end-user tailoring (Mackay, 1990; Mørch, 1996). *Augmentation* refers to undertaking additional work to make up for an inconsistency in primary work (Gasser, 1986). As such, it can be seen as an extension to primary work. *Working around* refers to using a computer system in ways it was not intended, or avoiding its use and relying instead on alternative, suboptimal means. One example is *backup systems* (Gasser, 1986). They are older technologies one relies on when the main work support fails or becomes temporarily unavailable. They can be manual or computerized and may even be redundant in functionality and duplicate data across systems. An example is the use of Post-it notes around a computer display in order to remember difficult operating system commands.

In addition to analyzing a special kind of secondary work (information-seeking), we discuss some issues related to the integration of primary work and secondary work in the case we report below.

Findings from early adoption and use of the portal

The portal adoption process lasted for about 14 months, and the data collected represents a three-month period during which the portal had been installed at 25 stations, three to six months after the first installation. The use of the system was not mandated, but the station managers encouraged the attendants to use it and the attendants were informed about its introduction well in advance. To support local use the portal had local champions (super users) (Åsand & Mørch, 2006) at selected stations, a training session for all station attendants, and several early adopters (Mørch & Solheim, 2005).

Primary work in petrol stations involves serving customers by using the cash register and periodically ordering out-of-stock items (automobile parts, food items, etc.). Secondary work is work that supports primary work, such as making sure that serving customers and ordering out-of-stock items can be carried out without

major disruptions in workflow. Information-seeking was identified to be the main secondary work method. It was used to find required information to carry out primary work tasks. Secondary work is also in-depth learning about specific products and services periodically introduced by the Service Company. The HR division organized these initiatives.

Before the introduction of the portal, the attendants made use of a range of non-computerized (manual) methods for accessing information to support primary work. Figure 9.4 gives an overview of these methods, ranked according to frequency of use. In the questionnaire data we report below, the number of respondents is 34.

Results from the survey show that 81 per cent of the respondents reported that asking a colleague was the most useful approach to seeking information. This method would be used when an attendant received a difficult request from a customer. In addition, 38 per cent of the respondents said they would call a colleague at home if he or she encountered problems that no one present could answer. The station manager and the assistant manager were the two people most likely to be contacted in this way. They could be accessed by mobile phone any time of the day.

The other frequently used methods for information-seeking were paper

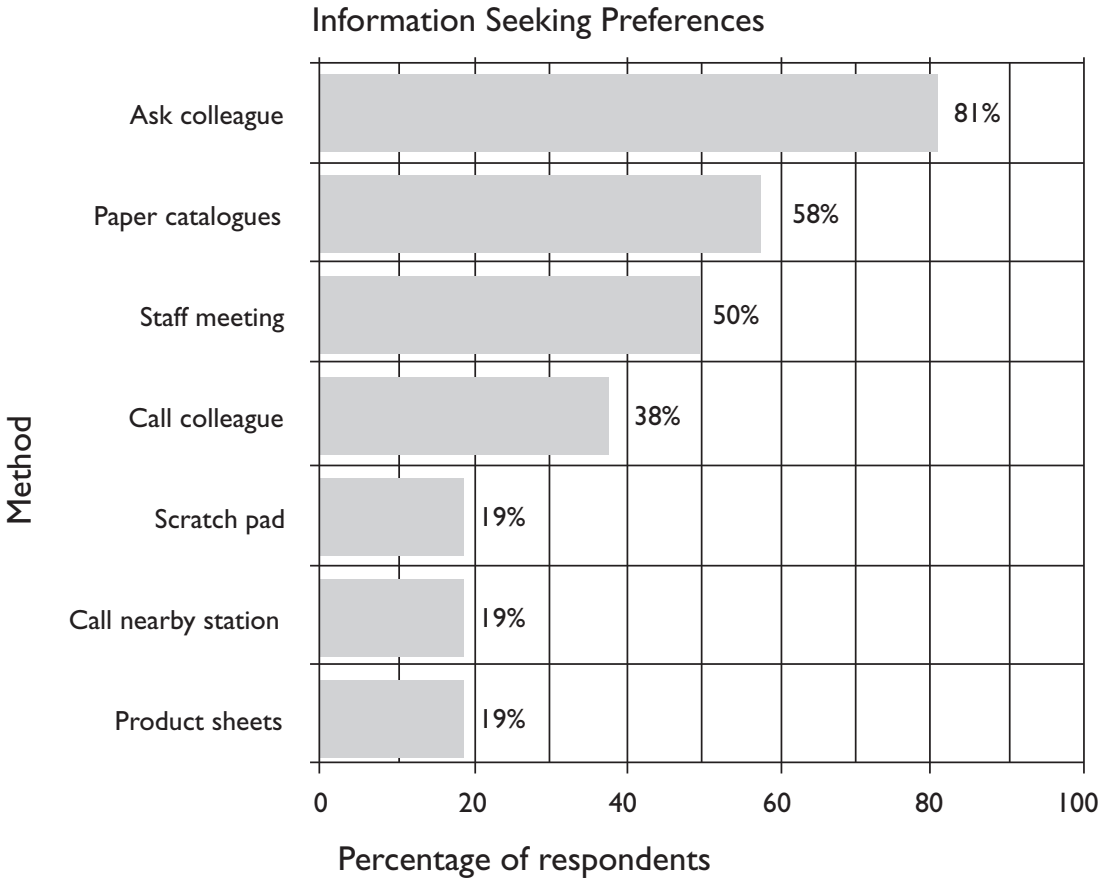

Figure 9.4 Information-seeking methods before the Portal (N = 34)

documentation (58 per cent) and staff meetings (50 per cent). Paper documentation refers to vendor-specific product catalogues containing automobile parts information. The catalogues were consulted when an attendant needed specific information about a product. The staff meeting was a weekly forum for information exchange where questions could be asked. When new products were introduced, the attendants would be informed about them at a staff meeting.

The HR division of the company periodically sent out product sheets that provided information concerning new products or service in the regular (snail) mail to the station attendants. In total, 19 per cent of the respondents said this information was useful. Finally, 19 per cent of the respondents relied on a scratch pad (Post-it notes) to jot down important reminders for interacting with customers and operating the cash register. These notes were placed on the side of the computer screen.

After the portal was introduced, 46 per cent of the respondents said they stopped using one or more of the older methods. We have no data that indicate which specific method(s) was replaced by the portal, but we have anecdotal evidence the "Post-it" notes and "calling colleagues" were seen to be redundant and no longer needed.

Regarding use of the portal, one of the respondents said: "It simplifies work to get rid of all the papers scattered around the cash register and to get all this information in one place" (respondent #23). Paper-based methods that are costly to produce (e.g. product sheets and automobile parts catalogues) or those that tend to mess up shared workplaces, like Post-it notes, may eventually disappear when web-based methods take on a more dominant position. New innovations tend to make older technologies obsolete (for example, the mobile phone has made coin-operated public phones obsolete in many parts of the world, and online yellow pages have replaced paper-based yellow pages, etc.).

The remaining 54 per cent said they continued to use the older methods despite the availability of the portal. In fact, several employees preferred to use the paper-based catalogues instead of the computerized information display in order to find product information. As one employee said in an interview: "I am not very good with computers. Most of the time it is much faster to use the paper catalogues."

The senior attendants and older employees were among those who preferred the older methods. They had less exposure to use of computers from other spheres of life (at home, previous jobs). Even though some of the employees were not skilled computer users, they were familiar with using paper-based catalogues to find information. We analyzed these findings in terms of the socio-technical conceptual framework we have outlined above (Suchman, 1994; 1996; Lave & Wenger, 1991; Fischer & Ostwald, 2001; Gasser 1986; Strauss *et al.*, 1985), which provides a theoretical account of two under-theorized areas of technology-enhanced learning, namely, blended learning and discretionary use of a learning technology.

Analysis of findings

Learning at work is a form of secondary work, which, as in the case we have presented here, means making sure customers are promptly serves and all other required activities are carried out without disruptions in workflow. Secondary work includes all the types and strategies that were identified by Gasser (1986): articulation (Strauss *et al.*, 1985) and adaptation (fitting, augmenting, working around). In this section, we discuss three implications of this: (1) Combining old and new methods for information-seeking, (2) integrating primary and secondary work, and (3) the distance principle for primary and secondary work support.

Combining old and new methods for information-seeking

The following dilemma was observed. On one hand, the management of the Service Company would like to make the work as efficient as possible. They plan to terminate the production of some of the older methods, which are costly (e.g. paper-based manuals). On the other hand, many employees at the petrol stations believe it is important to have alternative means for accomplishing work, even if some of the alternatives are sub-optimal.

Therefore, removing the sometimes sub-optimal alternatives may complicate recovery from a difficult situation and prevent work completion altogether. It seems that older methods have a well-defined role as back-up systems (Gasser, 1986) in the Service Company. There were plenty of back-up systems at the petrol stations and they provided recovery when the recommended method failed. Furthermore, the duplication of data across information systems did not cause any difficulties for the employees (as it did for management). Indeed, it may have helped them in certain situations.

We suggest a term introduced by Suchman to describe the situation as seen by the employees. She used the term "artful integration" to define a hybrid of technology and work practices where technology is comprized of multiple layers of heterogeneous devices, each associated with a specific generation of work support (Suchman, 1994). In our case, this would mean the coexistence of multiple technologies and practices associated with helping employees find information to help with the work at the petrol stations: cooperative problem-solving with customers, contacting colleagues, staff meetings, Post-it notes attached to computer, paper-based catalogues, and computerized information displays (web portal).

Integrating primary and secondary work

We do not have complete records in our data set to map out the tangled web of extraneous secondary work that was necessary to resolve problematic situations in primary work. Secondary work at the petrol stations include a combination of adaptation, articulation and information-seeking. For example, attendants used to adapt to customer-interaction situations and they worked around many problems

by choosing back-up systems to gain access to required information (Gasser, 1986). The back-up system could be a non-computerized method, such as browsing a parts catalogue, contacting a colleague, using a map book (for finding travel routes), or jotting down a reminder on a Post-it note. The attendants would frequently find a way out of a difficult situation. Some of the alternatives would slow down work; others would require on-the-spot problem-solving.

We see a continual shift between primary work and secondary work. Seen from the perspective of the Service Company, primary work is periodically updated to reflect the demands of society in terms of increasing customer service and to provide a certain image to the outside world about its priorities. Secondary work is often the source for updates to primary work because it is more responsive to new innovations from the outside and less rigid than explicit work descriptions. Furthermore, access to information to answer everyday challenges has increased a result of the Service Company's continual effort to expand into other market segments. To stay abreast, employees must continually adopt the new methods and practices, mainly because they are more efficient, but also in case the older ones become unavailable for further use.

This can be seen as gap-closing activity, which for the employees means to gradually extend the scope of their repertoire of working methods while simultaneously evaluating the relevance of the existing methods. This was accomplished when reflecting on what methods to choose. Some of the employees were more skilled in this than others, mainly the younger attendants and the new employees. Learning in this context is seen as a form of work, which is associated with secondary work (adaptation, articulation, information-seeking). The relationship between primary work and secondary work is complex and characterized by tensions and contradictions. Further work ought to study this dynamic relationship in more detail.

Distance design principle for primary and secondary work support

As mentioned earlier, the portal had been through a series of iterations before it was integrated with the cash register. The version immediately preceding it was a laptop with a similar user interface, but placed at the end of the cash register counter. Based on an evaluation of this configuration, it was concluded that its adoption as combined work and learning support was unsuccessful (Mørch & Solheim, 2005). The portal was barely used and one reason for this was that it was located too far away from where the "action" (primary work) took place.

The developers of the latest (current) version of the portal learned from this and brought the portal closer to the cash register (see Figure 9.3). This resolved the problem, but with the unanticipated consequence of bringing the portal "too near" to where the action is. Based on observation and interviews, it became clear that some of the attendants avoided the portal because it could interfere with the operation of the cash register. They were concerned that the cash register would stop working if they crashed the portal. The two systems were running on the

same computer (with separate screens and keyboards). This was an unacceptable solution for some of the attendants, since primary work is more important to accomplish, even though avoiding the portal could lead to sub-optimal customer experiences.

When secondary work interferes with primary work, the employees often switch to another secondary work strategy and resort to (sometimes sub-optimal) alternatives. All of the existing information-seeking seemed to follow the same pattern: "nearby without interfering." This is what we mean by the *distance principle* between primary and secondary work support. It is featured as a technology design principle for technology-enhanced workplace learning in its capacity to provide a heuristic for determining the relative positioning of two types of technological tools (for work and learning; primary and secondary work). The heuristic suggests they should be near enough to each other to allow for easy access from one to the other, but not too close in order not to infer with each other's internal workings.

Summary and conclusions

Over a three-year period, we have participated in the introduction of a web-based learning portal in a Norwegian service company, a petrol station division of an oil company, and analyzed the results. The overall aim has been to participate in the design process and help sustain the resulting system-building efforts beyond the project lifetime, and to conceptualize the results in terms that can improve the understanding of technology-enhanced workplace learning.

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. Learning scenarios were incorporated to envision the integration of primary and secondary work. It resulted in the creation, usability testing, and field deployment of a web portal.

The findings from the study are based on early use of the web portal. It focuses on situations that require learning on demand (Fischer & Ostwald, 2001), and it reports on the emergence of web-based information-seeking as a type of secondary work. Although information-seeking is already supported by existing (non-computerized) methods, the new web-based portal was preferred by half of the users we surveyed. In this regard, we provide new insight into the successful co-existence of old and new technologies and we provide an initial picture of the tangled web of multiple information-seeking strategies the employees make use of in their everyday work as they alternate between them and aim to bridge the gap between primary work and secondary work to accomplish required tasks.

This type of working shares characteristics with forms of learning associated with teaching communication (Wegerif, 2002), information-sharing (Netteland, Wasson & Mørch, 2007), and categorization (Ludvigsen & Mørch, 2005). Our tentative hypothesis is that it seems to be a convergence of working with large-scale information spaces (information-seeking) and the type of learning for the

knowledge society presented by other authors in this volume and elsewhere. We plan to explore the conjecture in more detail in further work.

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