Designing Work Support Systems
– For and With Skilled Users

BY

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Dissertation presented at Uppsala University to be publicly examined in Room 1111, Hus 1, Polacksbacken, Uppsala, Friday, June 4, 2004 at 10:15 for the degree of Doctor of Philosophy. The examination will be conducted in English.

Abstract

Computer users often suffer from poorly designed support systems that hinder them from performing their work efficiently and with satisfaction. The evidence is found in observations of users at work, interviews, evaluations of systems, and numerous reports of systems with poor usability that fail from start.

Those who use the systems are proficient in their work, and those who develop systems are proficient in software engineering. These two groups have often little knowledge and understanding of each other’s worlds and their vocabularies are quite different. In systems development projects, users are often confronted with representations of their work that they hardly recognize. Systems designers compose these representations in an attempt to reduce the complexity of the work practices in a way that is appropriate for systems development. It is very difficult for users to appreciate the consequences fully on their future work situation from such representations, since they are removed from the social setting and often describe work in a fragmentized way. The unfamiliar view of their work may make the users less inclined to participate in the forthcoming design process.

This thesis presents research performed to increase the usability of systems in working life and to explore conditions that facilitate the design of systems that really support the users work. The research comprises field studies in different work contexts, e.g. health care, dentistry, public service, and transportation. Information on the essentials of work has been gathered and analyzed to learn how such findings can be translated into systems design. Another goal has been to explore how to make the most of users’ experiences and skills to assure systems that better fit their work. Along with a growing awareness of the importance of user involvement in design, a participatory design process including the analysis and design of work has evolved.

Keywords: human-computer interaction, user involvement, work analysis, work design, user-centred design

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ISSN 1104-232X
ISBN 91-554-5977-3
urn:nbn:se:uu:diva-4275 (http://urn.kb.se/resolve?urn=urn:nbn:se:uu:diva-4275)
Outline of chapters

Chapter 1 outlines usability problems, which are the starting point for my research within the area of human-computer interaction (HCI). I describe my research focus and the core values that have motivated my research, and describe the work domains where my studies have been conducted. The second part of chapter 1 introduces human-computer interaction with special emphasis on usability. Finally, it discusses views on users that may shape the systems that are developed.

Chapter 2 describes my holistic view on design, in which I argue that we must consider the user’s work environment as a whole to be able to develop systems that facilitate work. Style guides as facilitators of usability are reviewed. The chapter also introduces user-centered design, which I have adopted since it is a powerful approach to promote active user involvement in systems development. In that context, communication, common ground, and narratives play an important role. These concepts are also discussed in the chapter.

Chapter 3 addresses my views on work and skilled users. Moreover, it discusses the difficulties in revealing essential information about work, which often is tacit. Such information may be fundamental in preserving vital parts of work in work redesign, and in addition, to make future work both interesting and challenging for the user.

Chapter 4 introduces the research questions that have emerged from my experiences in research projects and from reflection on the research conducted. Furthermore, the qualitative research methods and the frameworks that underpin the conducted workplace studies are outlined and discussed.

Chapter 5 reviews the studies in the thesis through a brief summary of each included paper. The chapter ends with conclusions from my research.

Finally, Chapter 6 wraps up the thesis with a discussion on usability activities actually employed in working life and a suggestion on an alternative approach. A few ideas pointing towards future research end the chapter.
List of Papers


Permission to reprint the papers in this thesis has been obtained from the publishers.
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Terms and definitions

The following terms and definitions apply for the summary of this thesis.

Context of use – Users, tasks, equipment (hardware, software and materials), and the physical and social environments in which a product is used (ISO 9241-11:1998)

Effectiveness – Accuracy and completeness with which users achieve specified goals (ISO 9241-11:1998)

Efficiency – Resources expended in relation to the accuracy and completeness with which users achieve goals (ISO 9241-11:1998)

Interactive system – Combination of hardware and software components that receive input from, and communicate output to, a human user in order to support his or her performance of a task. NOTE! The term “system” is often used rather than “interactive system”. (ISO 13407:1999)

Method – A means or manner of procedure, especially a regular and systematic way of accomplishing something

Model – An image of an existent system that depicts essential characteristics of that system. Although the model resembles the system, it usually contains fewer components and relations than the system does. (Translated from Gustafsson, Lanshammar & Sandblad, 1982)

Process – A series of actions, changes, or functions bringing about a result. (The American Heritage® Dictionary of the English Language)

System – A group of interacting, interrelated, or interdependent elements forming a complex whole (The American Heritage® Dictionary of the English Language). The present purpose determines what we consider are the limits of the system and what we view as elements. (Translated from Gustafsson, Lanshammar, Sandblad, 1982).

Systems designer – A person who plans and structures work tasks and interaction of a system, sometimes the same person who develops the system. The term systems designer is used interchangeably with the term developer in the introduction to the papers, even though different people may have these roles.

Usability – The extent to which a product can be used by specific users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use (ISO 9241-11:1998)

User – Individual interacting with the system (ISO 9241-10:1996)

Work – Physical or mental effort or activity directed toward the production or accomplishment of something. Dictionary.com

Organization of work – The orderliness, timeliness, and structural decomposition of performed tasks.
1 Introduction

At this point, the technology, the programming languages, the sophisticated system concepts, are more than adequate to the purpose. It’s the purpose itself we need to comprehend. This comes through logic of conversation, the logic of situations, the logic of involvement – not mathematical logic.

Eleanor Wynn, 1991, p.63

If technology doesn’t work for people, then it doesn’t work.

Kim Vicente, 2004

How many times a week does the average user become frustrated and upset about lost information, the unexpected behavior of a computer system, the unexpected outcome of actions, or about not being able to do what he/she wants to? Most of the time, we curse the computer or bang the keyboard and just carry on. But, when people in working life are frequently exposed to these events, they feel ineffective at work, their stress levels rise, and they may eventually become ill/contract stress-related disorders, and various repetitive strain injuries.

The problems do not seem to decrease; there are frequent reports about systems that fail to deliver the expected functionality and force people to invent workarounds to manage their work, and systems that users flatly refuse to use due to their poor usability. In addition, many development projects fail to finish on time, and fail to implement the required functionality (Standish Group, 1995). The present situation is unacceptable from a human as well as an economic perspective.

Everybody experiences problems with their computer(s) from time to time, but these problems are not inherent in software. Computers are hard to use because we use the wrong process to create the software (Cooper, 1999). Initially, my research focused largely on the user interface and the measures needed to design an appealing interface that worked smoothly. Over the years, it has become increasingly obvious to me that there is a great deal more to usability than merely brushing up a system with a glossy interface design. Moreover, the replacement of an old computer support system with a

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new one does not in itself solve problems and make work more efficient. Design of efficient systems starts with an analysis of work as a whole, the complete work situation must be considered. Thus, it is not productive to analyze single work tasks in isolation. The analysis must also comprise the demands and constraints imposed by the surrounding environment that affect the task, requirements from the organization and collaborating colleagues, and differences in competency (Vicente, 1999).

Yet another important aspect is the potential of changes and improvements in the work organization to avoid a new system that preserves poor work conditions and inefficient work practices. The people and their experiences and skills, the work they do, the organization of work and their support systems are interwoven factors; a comprehensive picture of work is therefore required when new systems are developed.

The purpose of my research has been to shed some light on why support systems may distress users and how the usability of the systems can be increased. In this thesis, I discuss some of the factors that I argue result in systems with poor usability. Moreover, I also discuss early user involvement in systems analysis and design, and how user-centered design can lead to systems that fit work and to increased usability.

Through the work at the Department of IT/HCI, at Uppsala University, a participatory design process has evolved, which I argue is one way to develop more usable support systems. In the following sections, which are extensive, I will provide a background to the research and describe the concepts and ideas I have found essential, state the research problems and goals, present the papers included in the thesis, and finally present and discuss my conclusions. The reader who wants to skip the introduction and instead focus on the research questions should go to Qualitative studies of work.

1.1 Core values that drive my research

I am genuinely interested in meeting people engaged in different kinds of work, it is indeed exciting to explore new work settings and learn more about people’s work practices. Exploring the possibilities that innovative design solutions provide has also been a satisfying activity for me (see for instance paper no. 6).

Curiosity has motivated me to study the activities users perform, how they interact with computer support systems, and how they cope with demanding tasks that often include responsibility for other people’s safety. Through the different workplace studies, I have come to realize how poor computer sup-
port systems often are, and how great the need for increased usability really is.

The single factor that probably has surprised me most about work is the degree to which people are prepared to accept poor work conditions, how they are content with very little, and how they continuously invent workarounds to facilitate their work. An extreme example of this is a Chinese ferry captain (read more on studies of ferries in paper no. 5) who told me “If I have to use both hands and feet to control the ferry, I will, no problem.” The situation that caused his comment was that at departure he needed to use both hands to manage controls, so the helmsman had to assist with a hand on the steering wheel. It seems that if people are able to obtain the slightest utility of a system, they accept to use it, although many features may be inconvenient.

Since users often are experienced and knowledgeable in a work context, their participation in change and development work is essential. My experiences from the projects reported on below, demonstrate that if users are met with respect and appreciation for their knowledge, the significance of their contributions increases. Thus, my motivation to continue on the user participation track has grown, in concurrence with the wish to find better ways of analyzing work tasks and involving users in the design of new and improved systems.

To sum it up, my core values are derived from a perspective on users as skilled and motivated in line with previous research (e.g. Greenbaum & Kyng, 1991), and deserving respect for their choice of occupation. Such a perspective seems to be challenged by, for instance, systems designers that sometimes look down on users and find their work unsophisticated, see e.g. Beath & Orlikowsky (2001) for similar experiences.

1.2 Research focus

My research has been carried out within the area of human-computer interaction (HCI). It has been inspired by different disciplines within this vast multi-disciplinary field but my focus is on computer-supported work, user involvement, usability, and design. My main motivation behind this work has been the improvement of computer systems in a work context, in the sense that they help the users achieve what they want, and make them feel good about it, rather than hinder them from doing their best, and make them feel irritated.
My focus has been on the individual, i.e. on how to make a perfect support system for, e.g. a train driver or a tax administrator. Even so, these people communicate and share information with colleagues, distantly as the train driver communicating with the train traffic control, or down the corridor in the tax office.

The research is grounded in working life where the resulting benefits for users and organizations have high priority. The research has thus involved studies of work settings, analysis of work and measures that may lead to better systems. A characteristic of some of the studied workplaces is, moreover, the predominance of in-house systems development, which means that developers and users work under the same corporate roof (Grudin, 1991). The users are thus, or at least should be, well known. And since they exist and are accessible, it should be possible to involve the potential users of a particular system in its development, something that has been recommended for a long time (e.g. Gould & Lewis, 1985; Norman & Draper, 1986; Greenbaum & Kyng, 1991; Gulliksen et al., 2003; ISO 13407).

Early in my work, I was constantly reminded not to look at computerization as the first measure in improving work. This perspective is deeply imprinted and still serves a purpose, although computers are used everywhere and by everyone today. The important issue is that people and work matter and that the analysis of the context needs to be carefully performed before conclusions are made. Computer systems must according to Beyer & Holtzblatt (1998) “fit into the fabrics of everyday life” (p.1). The following section will outline the aspects I find essential in the analysis and design of software systems for working life, namely, the users, their work, and the prospects for improving the work situation and workplace. I will expand on the conditions that determine work and what happens at workplaces as well as prospects for positive development. Although attention is directed at development methods, the research has not focused on enhancement of formal development methods and tools, but on how to capture the essentials that inform design and on the design process in itself.

Work depends very much on the situation, and in line with previous suggestions that work should be studied in a context (Vicente, 1999; Klein et al., 1993; Hollnagel, 1993), my studies of work, technology, as well as practice, has been undertaken in a variety of actual work settings. The purpose has always been to study work as it takes place, since human action is situated (Suchman, 1987), and possibly also to find the fundamentals that later may inform design.

In general, I am interested in the actual work people are doing. Not on a detailed technical level, e.g. describing how many different braking systems
there are on a particular train and how they work, but rather on a more gen-
eral level:

- What is it that they really do, what is the core?
- What are their goals?
- What are their main skills and what characterizes a skilled worker?
- Which qualities of work are indispensable and need to be preserved?
- How can users preserve and develop their skills?
- What is the challenge in their work?
- What are the difficulties?
- What happens when things break down?
- How will work change in the future?
- How can the support system make work more satisfactory and safe?

However, even if the particulars of technology are far from the most interesting topic here, characteristics of present and potential future technical sys-
tems cannot be overlooked. Systems designers need to be familiar with the characteristics of present systems and the potential of new technology. Schmidt (2000) concluded that an uninformed designer would otherwise face an infinite space of possibilities and would even be expected to develop technologies from scratch to be able to give recommendations on solutions. As paper no. 6 shows, new technical solutions may enable completely new and promising solutions to multifaceted problems.

1.3 Studied work domains

Through my research I have studied a number of work settings with various support systems, both IT-support systems, for instance case handling in office environments (see Figure 1), medical records in dentistry as well as health care, and technical support systems such as control and information systems in driver environments in trains (see Figure 2) and on high-speed ferries. Over the years, I have also gained experiences from systems develop-
ment in practice in a few other domains, such as banking and defense sup-
port systems. Many features of the studied workplaces are similar. At first glance, the work may seem very simple, while in fact all work has in common that it is complex and involves highly competent judgment and decision making. Consequently, users must be skilled and experienced to cope.

Other mutual characteristics between these work domains are, for instance, that people enter and survey information, take actions and interact with support systems through, e.g. mice, joysticks and touch displays. They often have to incorporate and integrate information from other media, such as documents, letters, faxes, and telephone, to make judgments. On the ship bridge or in the train, the driver has to survey the surroundings and integrate
vital information in the maneuvering of the vehicle. There is often a time factor involved in work, the train must arrive on time, and the citizen must get a final decision from the authority handling their case within a period of three weeks. Users communicate with clients/customers/citizens as well as colleagues/management/superiors. The degree of routine work may be high, but exceptions may be complex. If information is maltreated, the outcome may be crucial.

However, there are differences between administrative work environments and control environments. Standard software may control the former kind of work, but large organizations often develop their own bespoke software. Since the majority of office work is performed using the computer support, users are often tied to their workplace, which may cause stress and health problems (Åborg & Billing, 2003a). The studied administrative work often involves document-oriented case handling, where the cases are associated with citizens, clients, customers, and patients. Here, cases have concerned different aspects of people’s health, their income, their fortune, and tax. Upon completion, a case is recorded in one or more databases; the information is often retrieved and reused when a new case concerning a certain person is initiated.

The main task for the users studied here, who control vehicles, is to maneuver from one point to another while safety is maintained, passengers are comfortable, and time schedules are kept. Unlike office work, control environments are dynamic. From the moment the user makes a decision until it turns into a physical action, the system might have changed. Every journey may also involve new and unanticipated events.
Control systems in vehicles typically involve an interaction between humans and machines that involves risk; mistakes may affect people’s health and can even be fatal. Furthermore, the computer support system has quite recently stepped in as an intermediary layer. Users are thus detached from direct interaction with the machine. The consequences might be exemplified with the crew on a ferry in Hong Kong, who considered the secondary control backup system too different from the regular control system they were using, and thus too difficult and risky to handle. Consequently, they would rather have the ferry towed to harbor than using that backup system in case of a primary backup system breakdown.

![Figure 2. The train driver environment in an X2000 train.](image)

Data that was previously directly transmitted from a sensor to an analogue instrument, has recently been transformed/translated/calculated and often displayed graphically, as for instance, when engine power exerted on water and corresponding water flow is indicated by arrows of different sizes, thickness and color on a graphical display (see Figure 3). If the information is visualized in a proper way, the translation may facilitate interpretation of information and thus reduce cognitive load. However, it may also induce a feeling of uncertainty of the accuracy of the presented information.
Finally, other aspects that are important to include in workplace studies are the way, e.g. crews collaborate on the bridge, their different roles at present, and how their roles may come to change depending on increased requirements on efficiency. Such demands may, for instance, reduce the number of crew members present on the bridge simultaneously. As a result, the number of tasks a single individual is responsible for may increase.

1.4 Human-computer interaction - a young multidisciplinary area

This research is carried out within the area of human-computer interaction (HCI) where studies of interaction between humans, computers, and tasks are brought together in multidisciplinary research. The abbreviation HCI has been used since the mid-1980s to describe the research field involving psychological processes, capabilities, and limitations of human users interacting with computers (Preece, 1994). In contrast to the design of systems based primarily on technological constraints and capabilities, theories and methods in HCI emphasize the design of computer systems intended to support user capabilities and task requirements. Dix et al. (2004) conclude that HCI involves “the design, implementation, and evaluation of interactive systems in the context of the user’s task and work” (p.4). The following more elaborate working definitions are offered by the ACM SIGCHI Curricula for Human-Computer Interaction:

Human-computer interaction is a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them. (p. 5)

Human-computer interaction is concerned with the joint performance of tasks by humans and machines; the structure of communication between human and machine; human capabilities to use machines (including the learnability of interfaces); algorithms and programming of the interface itself; engineering concerns that arise in designing and building interfaces; the process of
specification, design, and implementation of interfaces; and design trade-offs. Human-computer interaction thus has science, engineering, and design aspects. (p.5)

The fact that people increasingly work through a computer, not with a computer, to achieve something, and that they work in collaboration with other people also affects the view on HCI. The computer is perceived as a tool more than a target in its own rights.

Figure 4. The content of Human-computer interaction. From ACM SIGCHI Curriculum Development Group (1992).

Figure 4 above, from the ACM SIGCHI Curriculum, is an attempt to clarify the aspects of human-computer interaction and their interrelations. The components concerned mostly by my research are:

- **Use and context**, where the larger social organization and work environment are particularly interesting. The process of putting computers to work means that the human, technical, and work aspects of the application situation must be brought into fit with each other through human learning, system adaptability, and other strategies.

- **The human**, which includes information processing, language, communication, and interaction, and physical characteristics of users.

- **The development process**, which includes, e.g. design approaches, implementation and evaluation techniques. Each of the components of the development process is connected with the others in a relationship of mutual, reciprocal influence whereby choices made in one area impact on the choices and the options available in the others.
In some senses, HCI may be seen as too narrow a focus for research on work-related issues. Since this thesis touches upon workplace conditions that ultimately affect people’s health, I would like to briefly elaborate on an area of concern, which is included in Figure 4 but may be seen rather as encompassing HCI than just being a part of HCI.

Ergonomics is the body of knowledge about human abilities, limitations, and other human characteristics that are relevant to design; it includes anatomy, physiology, psychology, and design. Because of the urge to develop more effective weapon systems during the Second World War, studies of the interaction between humans and machines started to increase. The Ergonomic Research Society was thus founded in 1949. By tradition, ergonomists have been concerned with physical characteristics of machines and systems, and how these affect user performance (Dix et al., 2004). The ISO standard 6385 Ergonomic principles in the design of work system, defines ergonomics thus:

Ergonomics produces and integrates knowledge from the human and technology sciences to match jobs, systems, products, and environments to the physical and mental abilities and limitations of people. In doing so it seeks to safeguard safety, health and well-being whilst optimising efficiency and performance.

Human factors (HF) incorporate ergonomics and more cognitive issues as well, but both of the disciplines are concerned with user performance in the context of any system, whether it is computer, mechanical or manual, and thus the terms are often used interchangeably (Dix et al., 2004).

When the focus in systems design shifted from a system-centered to a user-centered perspective, the need for knowledge on human behavior increased. Questions such as how people understand and use information to reason and solve problems engaged the HCI research community. In cognitive psychology, human abilities, skills, and behavior have been studied extensively. The knowledge thus collected has contributed to HCI in areas such as functions of memory, perception, learning, problem solving, and decision-making.

1.4.1 Usability matters

The degree to which systems (or products) are usable seems to receive less attention by system designers than the number of functions they provide. When a group of my students evaluated their design solution on a few users, these experienced problems with the interaction. The students’ solution was simple, “we will add some help texts, and then they will understand how to use the application”. This way of thinking is probably more common than
one would wish, why else should we be burdened with thick user manuals for every simple product we buy?

The usability concept initially attracted attention to measurements of the degree of a system’s ability to comply with a user’s goals and requirements. In 1984, Eason criticized the lack of a definition of usability and no agreed upon operational form of measurement, which made it impossible to investigate the usability concept scientifically. According to ISO 9241-11, usability is:

…the extent to which a product can be used by specific users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use.

Applied in a work context, this wide approach to usability definitively clarifies that not only the user interface is involved; usability presupposes support to users in achieving their goals in their work.

In general, it seems as if usability has a negative ring to it, often related to poor systems and low acceptance of new systems. To get a feeling of how and in which context “usability” is used, I performed a quick survey on the Internet (in February 2004). Two search engines (see Table 1) representing regularly used internet resources show that usability occurs frequently, but only 8% of the papers referring to usability in the ACM electronic library relate to “usability problems”. However, the attention on usability concerns tests and evaluation to a much larger extent. In the ACM digital library, usability was related to testing in 17% of the cases and evaluation in 7%.

In my experience, the attention on evaluation of nearly completed systems and endeavors to find isolated minor usability problems has grown out of proportion. Since only minor problems may be solved in the final phases of systems development, the usability efforts need to be included in the process from the start in order to prevent usability problems.

Table 1. Usability on the Internet. Frequency of “usability” and a few “neighbors” to usability in some Internet resources

<table>
<thead>
<tr>
<th>Search engine</th>
<th>Usability</th>
<th>…problem</th>
<th>…test</th>
<th>…evaluation</th>
<th>…engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>google.com</td>
<td>1,910,000</td>
<td>4,610 (&lt;0%)</td>
<td>35,500 (2%)</td>
<td>165,000 (9%)</td>
<td>56,500 (3%)</td>
</tr>
<tr>
<td>acm.org</td>
<td>6,619</td>
<td>525 (8%)</td>
<td>1,154 (17%)</td>
<td>483 (7%)</td>
<td>660 (10%)</td>
</tr>
</tbody>
</table>

The ISO standard 13407 suggests a framework for increased usability, the Human-centered design processes for interactive systems, which provides...
guidance on human-centered design activities throughout the life cycle of systems development, regardless of design process chosen. The activities that should take place during a systems development project are to understand and specify the context of use, to specify the user and organizational requirements, to produce design solutions, and to evaluate designs against requirements. In addition, the process should:

...start at the earliest stage of the project (e.g. when the initial concept for the product or system is being formulated), and should be repeated iteratively until the system meets the requirements. (p.5)

1.4.2 Perspectives on usability in relation to my research

Within HCI research, there are a number of views on usability, which in turn influence how systems development is considered. Löwgren (1995) introduced a conceptual structure where the following five different perspectives on usability (see Figure 5) were identified and discussed in terms of implications for usability-oriented systems development:

- **General theory** - Accumulates knowledge about human interaction. Theories are developed to account for the accumulated data and to predict interaction with new systems. Of limited value for practitioners, originates in experimental psychology.

- **Usability engineering** – Focus on practical usability, operationalized to allow measuring. Development typically in three steps: user and task analysis; usability specification with measurable goals (e.g. user performance, degree of satisfaction); iterative design and evaluation process. Utility is excluded during system development. Löwgren (ibid.) cites Grudin’s (1993) explanation that this is because usability engineering emerged in product development, where services are decided on early in a project.

- **Subjectivity** – Usability is a quality that emerges when users start to use the system in their context. Utility and usability are inseparable. Exemplified with contextual design (Beyer & Holtzblatt, 1998), which comprises ethnographic field research, in order to ensure that developers understand users, work redesign, mock-ups and testing, where the growing shared understanding enables more detailed design. Löwgren (ibid.) parallels contextual design with participatory design, although the former grew out of the inadequacy of usability engineering to produce usable systems, whereas the latter originated in democratization, user empowerment, and skill enhancement.

- **Flexibility** – Usability must admit that ultimate use is dynamic and that the context is constantly changing.
• Sociality – Inspired by the computer-supported cooperative work area. A reaction to the perspective that one user is using one system in a vacuum.

![Diagram of usability perspectives]

Figure 5. Usability perspectives (adapted from Löwgren, 1995). The work in the thesis relates to some extent to all perspectives except Usability engineering.

My perspective on HCI and usability has progressed in line with experiences made during the thesis work, and I will use Löwgren’s (ibid.) conceptual structure (see Figure 5) to map out the areas that are the focus of this thesis. Initially I looked to General theory, since it seemed to provide a knowledge base and promising tools and methods that could inform design. Characteristics such as how people understand and use information to reason, judge, and act to solve problems, still engage the HCI research community. But, how can we apply this body of knowledge to user interface design? Standards and style guides, derived from the knowledge about human abilities and limitations, are used extensively to guide interface designers and developers, and to provide short-cuts to design solutions without having to go through more thorough HCI studies. The concepts of guidelines and style guides, together with their limitations of use, are reflected in papers no. 9 and 10 on guidelines and style guides.

Although experimental studies and usability measurements received much attention in initial post-graduate courses, I have only made a few experimental studies (for instance in paper no. 6). This has never become a prioritized area, primarily because of the need to study work in real settings. Laboratory studies can never bring about the same complexity and situatedness.

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It has been suggested that usability engineering does not address the whole development process; usability engineering techniques are rather added on to the software development process as single activities (Göransson, Gulliksen & Boivie, 2004), with the purpose of measuring and thereby controlling usability. In line with others (ibid.), I find it difficult to specify usability goals, in particular such goals that are meaningful to users. Therefore, I find the Usability engineering perspective disappointing, with the focus on development of systems, in time and on budget, that is to fulfill business needs, rather than developing usable systems with a high degree of utility.

My view on usability and utility is that the entities are inseparable and included in usability, in line with the Subjectivity perspective and the definition in ISO 9241-11. The classical engineering methods seem at least in some aspects unfit to produce the kind of systems that people need at work. Work in general is flexible, often interrupted, and it involves unexpected events (Sachs, 1995). Moreover it is social and situated (Suchman, 1987) and often involves collaboration with other people. It is difficult to see methods, which use, e.g. a highly structured and formal withdrawal from an ATM machine to exemplify their application, as effective tools for development of systems that fit work in general.

Over the years, I have developed a view on users as cognitive beings, socially active, skilled, and continuously developing their work. An important part of my work has become to spread awareness of the need for a new perspective on users as skilled at work, even if they are not proficient in systems development methods and vocabulary. If anything, a profession-oriented language, including multiple representations, as mockup-ups, scenarios etc., is needed to facilitate communication between all parties in the development project (Adler & Winograd, 1992 as cited by Löwgren, ibid.). Papers no. 1, 2, and 3 reflect a perspective on users related to the Subjectivity and Sociality perspectives according to Löwgren’s (ibid.) definitions.

Although I argue that this perspective does not immediately call for infinite resources and unpredictable deadlines, it instead demands a higher degree of commitment, patience, and respect for different professions and their needs, in replacement of the focus on classical engineering methods. The task to achieve in systems development is not for the designers to find their own solution to a problem, but to find a solution that is acceptable to the involved parties, which becomes theirs. The architect Ralph Erskine (Dagens Nyheter, 2004) recently expressed similar thoughts when he said that an architect’s prime thought must be with the “users”, not primarily to create something unique that brings about personal fortune and fame.
Flexibility is discussed in terms of users adapting programs to their own needs by, e.g. tailoring (Henderson & Kyng, 1991) their artifacts, and an evolution of a system throughout its lifetime. To me, this perspective feels somewhat dated; in my experience, it is not by tailoring as changing typeface, font size, and background color that users most efficiently use their systems. Such adaptations have even caused problems when people sometimes need to share displays and the information presentation is tailored to fit the preferences of a particular user. In my opinion, there is a need for another kind of flexibility, one that would counteract the sequential ways of performing tasks that often are imposed on people at work and instead allow natural ways of working, for instance with several tasks concurrently.

To sum it up, in my work I have assumed a perspective on usability that is more related to interpretation than quantitative measures. In my experience, it does not matter whether you need three or four milliseconds to click a button; the more important question is if the computer support system fits the work to be accomplished at all, and if it does so in a way that satisfies the users’ needs. Thus, I want to finish this section with Cockton’s (2004) logic that is nothing short of brilliant:

Quality in use can only apply to the capabilities and content of a system. What is not there cannot be made usable. (p.4)

1.5 Perspectives on users may shape developed systems

In this section, I briefly discuss some perspectives on users that I believe are important, and that may shape the systems being developed.

Who are the users? Are they objects to be studied, or are they subjects that should participate in a change process? It has been suggested that the object perspective would be sufficient in the analysis phase, while a perspective on users as subjects would fit better into the design and development phase. My position is that users do not benefit from being viewed as objects, regardless of the project phase. Users are humans that must be appreciated and respected, no matter how other people perceive their work.

In general, users are the people that really interact with computer systems (Shackel, 1984; ISO 9241-10, 1996). The expression “users” may itself convey the impression that one wants to detach oneself from the people who use a system. Michael Muller (Allen et al., 1993, p. 254) suggested that participatory approaches could help transform our view of users (and the users’ view of us!) from “other person as problem” into “other person as partner”.

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In her review of research on analysts and clients, Urquhart (1998) recounts that many differences have been found between the two groups in the areas of beliefs, attitudes, personalities and motivations. Such differences may naturally affect the quality of communication in user involvement. Dagwell & Weber (1983) reported that systems designers’ inadequate conceptualization of users might be a root cause of behavioral problems, absenteeism, and occupational stress that often occur when systems are introduced:

Designers may perceive users of systems to be individuals who need order and guidance in their lives and who are motivated by financial rewards rather than opportunities for personal growth. Thus, the designers may design tightly structured systems that lower the quality of working life and produce, as a consequence, the behavioral problems observed. (p. 987)

However, their study of designers in Australia suggested less categorical indications, more accurately that the designers did not fully understand the nature of their role as a change agent, and the ways in which they can facilitate change. But as Kuhn (1996) points out, systems design is an organizational intervention that can have powerful effects on how people work.

My research comprises several kinds of users and my experiences confirm that users are skilled, in line with previous research (Greenbaum & Kyng, 1991). While the early user of technology tended to be viewed as a perhaps error prone human, required to perform some tasks with a system, Karat & Karat (2003) maintain that the present view is that of a human in a social system in which the computer plays an increasingly important role.

Nevertheless, the following quote from the journal *Software Engineering* shows that the view on users seems to depend on the community one belongs to:

Users: These individuals do not write programs. Users inspire and apply the creations of software engineers and technicians. (Raccoon, 2001, p.83)

The illustration above may give the impression that the primary issue is the construction of programs, and that programs are best developed with absent users, only acting as a source of inspiration. Nevertheless, programs are constructed to support people in their work.

Bannon (1991) suggested that the limited perspective on what users can contribute in the design process complicate contacts between users and designers and thus impede on active user participation. He suggested that instead of viewing users as passive human factors to be studied in a laboratory, they should rather be viewed as human actors, that are active and in control. The users’ viewpoint must thus be added to the system perspective. However, the
view of users as knowledgeable, skilled, and active agents requires a radical shift in the way designers consider users.

1.5.1 Categorizing users

User profiles are useful as a complement in the design process, but they do not provide an accurate understanding of the context of use required for design. Karat & Karat (2003) suggest that while it is still common to rely on knowledge on users gathered through questionnaires, such as, average age and level of education, such data do not tell systems designer enough to reach detailed design decisions.

User profiles, which are frequently used today, may also give designers the false impression that user involvement is unnecessary. For instance, Personas as described by Cooper (1999) easily turns users into objects. Cooper (ibid.) wanted to see Personas as an instrument that helped developers realize that they are not the users, and instead focus on users as someone else with particular characteristics. The intentions are good; developers need to know that they are not representing users and that their typical characteristics are very different from those of the users. Nevertheless, Personas or any other kind of distancing instrument removes the designers from the users in a way that may have negative consequences for the developed system.

Furthermore, the images of users sometimes become caricatures, which is demonstrated by the typical image of a civil servant working with case handling, used in systems development: “Agda, 55 years, computer novice, senior high school degree at most...”. Such an image may invoke disdain and disrespect in young developers with a recent academic degree, where the only thing that matters is to master a computer to perfection. As a result, it may be difficult to look through the stereotype and see the skilled user behind it.

Instead of relying on user profiles or Personas, the complexity of social relations, professional identities and the conflicting values that exist in work settings must be acknowledged to a much higher degree than at present. We must consider users as people that have work to do and it is our concern to understand what that work is and how they need to be supported now and in the future.
Design is a central theme in this thesis, but the definition of design is extremely wide. In a lecture at KTH in 2003, Bill Buxton even suggested that design is a non-word since people have so many different opinions about the exact meaning. Jones (1980) described design as “a creative activity that involves bringing into being something new and useful that has not existed previously”, and suggested that design is difficult to carry out and hard to describe because the designer must use current information to predict a future state:

The designers have to work backwards in time from an assumed effect upon the world to the beginning of a chain of events that will bring the effects about. (p. 10)

According to Norman’s (1990) very basic principles design should make sure that (1) “the user can figure out what to do (2) the user can tell what is going on” (p.188). Considering design, I also agree with Gould (1988) who suggested that “good computer systems” are those that are easy to learn, allow people to do the things they want to, and that are well liked. Another definition that is in accordance with my own perspective on design is Winograd’s (1996):

Good design produces an object that works for people in a context of values and needs, to produce quality results and a satisfying experience. (p.xvi)

ISO 13407 offers a more explicit definition of the concept of human-centered design:

an approach to interactive systems design that focuses specifically on making systems usable. It is a multi-disciplinary activity which incorporates human factors and ergonomics knowledge and techniques.

Design of interactive computer systems is often mistaken for the system’s external features, a surface that more or less can be applied to the system. But, I argue that design includes significantly more than just the user interface. Work design, interfaces and usability are interwoven, it is impossible to first analyze work, then design interfaces and finally to add usability. It relates to those parts of design that affect work for a user of a system or a
product, aspects that have consequences for how tasks have to be carried out, the individual work, as well as work in a wider perspective involving shared work and collaboration around work.

In software development, the primary concerns so far have been function, construction, reliability, and efficiency (Winograd, 1996). Design may be done consciously, but it may also come about accidentally (ibid.; Boivie et al., 2003b). The challenge, in particular in a work context where poor design may induce health problems, is to find a design process that works and produces good computer systems.

In the following sections, I will go through the different aspects on, and approaches to design that I have found important throughout my research.

### 2.1 Design rules - using general theories to increase usability

The design principles and guidelines that make up standards and style guides are often based on psychological, cognitive, and ergonomic theories, and they may well have their roots in empirical evidence as well as practices (Dix et al., 2004). How then is this body of cognitive psychology useful for HCI? The application of design principles and guidelines will be discussed next.

The organization ISO performs work on international standardization through a consensus procedure where voluntary involvement is open to all interested industries. So far, a few standards on HCI have been published. Most of the statements in these standards are general recommendations, because with software it often depends, e.g. on whom the users are, on what they are doing, and in which environment they do it (Buie, 1999). Although, the ISO standard 9241 (Ergonomic requirements on office work with visual display terminals) comprising of 17 different parts, has become well-known and widely cited in research.

General style guides provide information on general principles of user interface design, and global rules that apply to the entire user interface. No knowledge on tasks or users is incorporated in a generic style guide. Since general style guides have not been designed with a particular task or a particular user in mind, there is often a gap between the guidelines and the target domain where they will be applied. Thus, before deciding that a guideline should be applied, the systems designer must consider if it is appropriate to the users and the work that the design is meant to support. The problem-
atic correlation between general style guides and the fear that usability issues cannot be adequately attended to, since these often are connected to a specific context of use, has been addressed in, for instance, Blatt & Zacherl (1993) and Simpson (1999).

Platform specific style guides contain environment specific design rules that represent e.g. an industrial standard, such as Microsoft’s *The Windows Interface Guidelines for Software Design* (Microsoft Corporation, 1995) or the *OSF/Motif Style Guide* (Open Software Foundation, 1993). The largest part of such style guides comprise the appearance and behavior of specific interface elements provided. Style guides are also often compiled for corporations or even specific development projects; see Buie (1999) for an extensive list of existing standards and style guides.

In my early research, I investigated whether or not style guides could be used as a tool that could be used to guide systems designers and to provide easily accessible design principles, a kind of short-cut to knowledge otherwise available only through more comprehensive HCI studies. The intent was twofold, to make the guidelines easier to understand and apply than previously, and to facilitate the development of more usable systems. My starting point was that the efficiency of guidelines was only a matter of phrasing and presenting the guidelines in a style that allowed people without HCI education to understand them, typically by using instructions like “do this”, “do not do that” and to accompany the instructions with plenty of graphical examples, preferably comprehensive examples from the target domain. These first attempts are described in paper no. 10.

2.2 Deployment of domain specific style guides

In the Helios project (paper no. 10), we had early recognized that designers needed more domain knowledge to design systems adequate for work. We maintained that general style guides were insufficient for developers seeking advice in particular design situations. The idea to include domain knowledge in style guides developed into a concept that we called Domain Specific Style Guides. The experiences from the Helios project also suggested that to become useful in practice, basic guidelines needed to be applied to interface elements collected in toolboxes or component libraries. The developer would thus be able to select interface elements tailored for an application, and in addition expand the toolbox with more advanced interface elements, constructed from the basic components. These suggestions were introduced at the Motif (window system on Unix) user conference (Olsson et al., 1993).
Further experiences from studies of work and reviews of a number of applications at the Swedish National Tax Board (RSV) confirmed that although their systems were in-house developed, the developers exhibited a lack of domain knowledge and awareness of how apparently unrelated systems were used simultaneously. We decided to investigate if a style guide that embodied both design principles and domain knowledge could enable systems with increased usability. The objective of the work was once again to assist systems designers in their development of more usable and consistent systems. The effort resulted in a corporate domain specific style guide with descriptions of low-level as well as more complex high-level elements that would make it easier for developers to produce efficient systems, where domain concepts and interaction were consistent. The development process is described in paper no. 9. An on-line version of the style guide was implemented, but the interactive component library suggested was never implemented.

2.3 Challenges in the application of style guides

Whereas style guides have gained moderate acceptance, in practice they have not provided developers with sufficient detail; it is still possible to produce systems with poor usability that comply with a relevant style guide. Most style guides and design guidelines over-emphasize general aspects or aspects relevant to novices (Gulliksen et al., 1993), and they often concern very small parts of the interface detached from their context, such as layout of buttons, menus, and dialogue boxes.

It may be problematic to decide when it is appropriate to apply a guideline. There are always situations when several guidelines apply to different parts of a design and sometimes they are in conflict. A systems designer always has to make tradeoffs. If knowledge is unavailable about the foundation for the guidelines, it is difficult to decide which one has the best potential benefit in the current situation. A deeper knowledge of the reasons underlying guidelines is needed, such as knowledge about human resources and limitations, to be able to identify when deviations from them are appropriate.

Guidelines may be problematic to apply, and the significance of style guides can be discussed. Gale (1996) reported that style guides might fail, for instance because they are difficult to use, not properly introduced in the organization, and never updated.

In a certain sense, there are too many guidelines for interface design. Smith & Mosier (1986) discovered that large portions of their classic collection of 944 guidelines were irrelevant to a specific design. Moreover, it has been
concluded that guidelines require tedious reading and memorization to be useful (Blatt & Zacherl, 1993). Lund (1997) argued that it is unlikely that anyone can retain a significant number of guidelines in mind while reviewing a design, even if it is exactly clear how to apply them to the design. Tetzlaff & Schwartz (1991) discovered that people have a tendency to apply the first guideline that seems relevant, probably in line with Simon’s (1993) theory on satisficing, which says that humans tend not to be exhaustive in their search for a solution - the first acceptable alternative will do. Thovtrup & Nielsen (1991) conclude that as developers have difficulties in interpreting standards, usability standards need to be tested for usability too.

Although no proper evaluation of the use of the domain specific style guide has been performed at RSV, the achievement does not seem to have been as successful as one would wish. A recent e-mail communication with the manager presently responsible for the style guide project (Eriksson, 2004) gives a few indications why this may be so:

- The recent approach within systems development aims at completely web-based systems. Since the style guide was developed with Visual Basic as reference development platform, the visual examples are not immediately useful to systems designers.
- Further development of the style guide has not been prioritized, thus it probably has become partly out of date. The designers have sent a number of questions to the on-line style guide system, but they have never been answered. If people do not get answers to their questions, they will naturally be less liable to continue to look for information in this forum.
- The style guide is not easily accessible; principles and practical advice are sometimes included in long coherent pieces of text that are experienced as inaccessible by those who want quick answers.
- Finally, there is a fear that the different work tasks place different demands on the systems, which makes it difficult to talk about general interface elements.

As this summary confirms, to be useful a style guide needs to be alive and continuously updated, something that may be difficult to maintain unless there are enthusiasts willing to act as driving forces in this work. The example from RSV displays how difficult this task is to accomplish. Furthermore, it can never be too simple; no one will ever read large bodies of text to find facts. Bullets and short instructions work best, findings that have been confirmed by others (Gulliksen, Harker & Steger, 2001).
2.4 Discount usability does not discover serious usability problems

Evaluation is the research area in HCI that seems to have had the largest breakthrough in practice. In particular, heuristic evaluation (Nielsen, 1993) has become one of the most widely used usability activities in practice (Vredenburg et al., 2002), probably due to simplicity and cost-effectiveness (Nielsen, 1994). This is unfortunate from a usability perspective, because heuristic evaluation is often carried out without users and not in the context of use. One of the advantages is that only a small number of evaluators are required to examine an interface, and judge its compliance with a set of recognized usability principles. The heuristics help these inspectors to focus their attention on aspects of the interface that are often trouble spots, making detection of usability problems easier (Baker, Greenberg & Gutwin, 2002).

Nielsen (1992) classified usability problems detected with heuristic evaluation as major or minor, where major usability problems would have a serious potential of confusing users or causing them to use the system erroneously, whereas minor problems could slow down interaction or inconvenience users. According to his description, minor usability problems are quite easy to adjust, and even if they mostly affect simple repetitive tasks, considerable time may be wasted on frequent workarounds.

Poor usability can result in low efficiency, as well as reactions that include stress, eyestrain, headache, muscular pain, and other general health problems. The widespread use of computers in all work tasks, resulting in continuous use of computers for eight hours a day or more, has involved a growing concern with usability issues. In Kuhn’s (1996) perspective, deliberate business objectives that cause negative effects for people at work make up the hard design problems. For instance, resulting fragmentation and routinization of work may lead to repetitive and mind-numbing jobs, and increased production, through an enforced faster pace and longer work hours, bring about negative consequences for worker health.

I argue that usability activities like heuristic evaluation and the like do not reveal all kinds of usability problems, if anything they smooth off rough edges. Serious usability problems in a work perspective do not only consist of interaction problems that are easy to detect with heuristics like “always give feedback” or “help users recover from error” (from Nielsen & Molich, 1990). Rather, they are more closely related to systems that are unfit to support the work people do, deficiencies that in turn may be related to faulty representations of what work is, that lie beneath the systems design.
Instead, I see usability activities, which include “early and continuous user involvement”, as one way to anticipate and capture serious usability problems earlier in the development process.

2.5 User-centered design

In line with what has been suggested elsewhere (e.g. ISO 13407) my view on design requires user involvement in systems design to increase usability. Users who have a comprehensive perspective on work must be actively involved in the design process and have a real possibility to affect systems development. Knowledge of the users, their tasks, and the requirements of the organizational setting are needed to form design decisions. The more knowledge that is available about the user tasks during design, the more it can be exploited when defining the system’s properties and features, which in turns leads to a higher degree of user acceptance and user satisfaction. This process starts with the analysis and modeling of the user’s tasks and uses the output of this modeling in the subsequent system design and evaluation phases.

Gould & Lewis (1985) introduced basic requirements on usability design with the design principle “early focus on users and tasks”. Norman & Draper (1986) developed the concept of user-centered design (UCD) further, and concluded that the design needed to start with and should be driven by the needs of the user. ISO 13407 has broadened the concept from user to human-centered design in the following definition that, as I see, it includes the whole system and emphasizes the user’s perspective:

An approach to interactive systems development that focuses specifically on making systems usable. It is a multi-disciplinary activity which incorporates human factors and ergonomic knowledge and techniques. The application of human factors and ergonomics to interactive systems design enhances effectiveness and efficiency, improves human working conditions, and counteracts possible adverse effects of use on human health, safety and performance. Applying ergonomics to the design of systems involves taking account of human capabilities, skills, limitations and needs. (p. iv)

Over the years, UCD has been criticized as being unclear and vague (e.g. Constantine & Lockwood, 1999). A recent attempt to clarify UCD suggests twelve key principles (Gulliksen et al., 2003) for user-centered system design throughout the entire development process and further throughout the system life. A focus on work organization and the actual tasks that users want to accomplish is advocated.
Naturally, the users cannot alone assume responsibility for how a future system will shape work; Boivie et al. (2003b) concluded that usability and occupational health issues need to be integrated in the systems development process. Furthermore, it has been suggested that a usability designer should maintain focus on usability issues through all activities in a development project (Boivie et al., 2003b; Kapor, 1996).

But to achieve usability, activities that involve users, needs to become more generally used in practice. Still, the false perception of user involvement as talking to users and asking for the users’ opinions from time to time must be eradicated.

2.6 Design as a participatory process

In my research, I have occasionally performed participatory design (PD) with users. My motivation has been that in the collaborative process, users may add their expertise to the system in a more efficient way in comparison with, e.g. traditional requirements analysis. The result is a more usable system than traditional information gathering and feedback on completed designs would have achieved. The possibility of a concurrent work redesign has also been an important component of the user involvement. Different strains of PD have additional motives, such as, for instance the Scandinavian approach, which call attention to empowerment of users and prevention of de-skilling from, e.g. inappropriate automation of systems (e.g. Greenbaum & Kyng, 1991). The North American practice of participatory design has added buzzwords to PD as efficiency, commitment and buy-in of the new system, referring to the acceptance of the new system (Muller, Hallewell Haslwanter & Dayton, 1997).

Thus far, PD is not common practice in industrial projects, and it is particularly absent in work environments where our research has taken place. The design of ship bridges has, for example, evolved out of custom (see paper no. 7). Usually, the ship building company suggests a layout that forms a basic bridge. In rare cases, the crews that will operate on the bridge have the possibility to suggest desired brands on, e.g. radar equipment, from experiences acquired on bridges they have worked on before. In the rail industry, the tradition is similar, with the difference that the supplier has even more power over the driver’s work environment; the requirements on the driver environment are completely disregarded, in comparison with engineering performance requirements.

An important prerequisite to PD is, in my opinion, field studies including observation of users at work. Without field studies uninformed systems de-
signers may draw attention to unimportant issues, draw false conclusions, and lead the work in an inappropriate direction. As a result, the discussions in the PD work run the risk of becoming inefficient. Field studies have previously been suggested (e.g. Beyer & Holtzblatt, 1998) as a method for information gathering, but a subsequent involvement of active users in the design has not been seen as equally essential.

The design process that has evolved in our work, outlined in paper no. 1, is not definite or prescriptive in terms of methods and steps, but under all conditions it requires that users are continuously involved to a high degree, in line with previous suggestions on PD (Greenbaum & Kyng, 1991).

The users that will participate must get a good start. They must be given time to reflect on their work as it is, preferably in discussions with colleagues, and become aware of potentials for change of work before they are exposed to the whims of systems designers.

Later on, interpretations of work must be shared and discussed in feedback sessions. Visualizations of design suggestions should be used in this process; they should be evaluated against the informal requirements that have evolved during the work. It is always too late to start the evaluation then the system is nearly finished; at that time, there is seldom neither time nor money left to achieve real change. Preferably, evaluation of several different solutions must take place before the system is developed, frequent iterations are wanted here, in order to find, maybe not the best solution, but a solution that will satisfy the users and their requirements on effectiveness, efficiency and satisfaction.

Since the people that participate in the design process have different perceptions of the design and the process, the design task is as much about the participants sharing a common perspective as agreeing on significant issues and shaping consensus (Bucciarelli, 1984). Schmidt (2000) suggested that shared goals do not exist until a design is complete; they are constructed in the course of the project. The designers arrive at an agreed-upon design primarily in the process of agreeing on a shared goal. Bødker & Iversen (2002) agree and say that:

Design is not a process heading towards a predefined goal, but a process of which the vision is shaped from continuous interaction with the use practices that it originates from as well as with other uses, other technologies serving as guiding lights. (p. 12)

There are indeed a number of difficulties to overcome in user involvement. Muller, Hallewell Haslwanter & Dayton (1997) reports on techniques de-
scribed as participatory where the users only constitute a source of information and therefore may become exploited, objectified or manipulated, the whole act of participation may even be an illusion. I fully agree with Buur & Bødker (2000) in that PD may require a serious change in attitude for many of the involved groups. We need to acknowledge how users best participate and what we can expect from user participation, as discussed in papers no. 1 and 2.

Furthermore, systems designers must become aware of how they shape the PD work and how poor communication between users and systems designers may disrupt the work. These issues will be discussed next.

2.7 Communication and common ground in design work

Our language or particular vocabulary helps us discuss and communicate with our colleagues, be it researchers or train drivers. Nevertheless, the same vocabulary may hinder effective communication between different groups such as systems designers and users. Bahn (1995) describes the problems that may occur thus:

> Indeed, users may well be occasionally mystified by some of the methods or heuristics described at project meetings by system designers since these might actually be myths of a particular subculture of systems designers. (p. 78)

Developers have a specific vocabulary, related to the development methods and tools in use, likewise users often talk about their work in a vocabulary that might be incomprehensible to an outsider. To overcome the initial problems someone has to succumb. A phenomenon equally observed by others (e.g. Boivie et al., 2003b) is that the users participating in design often become steeped in the language of developers. The reasons for this may be related to the users’ inexperience with design work; they may thus become dependent on the more experienced designers that run the show, as discussed in paper no. 2. Their resulting contributions under such conditions run the risk of being less valuable. Users have chosen the kind of work they do for a reason; it is their own choice. They should be able to concentrate on their work and spend their energy on developing work, and not be forced to become IT workers.

Bahn (1995) discussed whether a solution to the communication problem could be to train users to perform systems design tasks, to be able to comprehend systems designers’ shared mental models. To make users under-
stand how systems designers think, and learn the systems development process being used seems like an ill-advised investment. Today, with all this previous experience of development work in practice, I argue that there is much more to be gained by training systems designers in listening to and learning users’ vocabulary. In addition, as Alvarez & Urla (2002) suggested that they need to become more skilled at conducting and interpreting interviews. They must adopt the domain language and start to communicate with users and not only superficially, they must be able to assume the user’s perspective. Moreover, they need to acquire the tools needed to collect knowledge that is required in the development process.

Systems designers do already have what Boland & Tenkasi (1995) referred to as a strong perspective in their own group, which is required to be able to communicate with other groups. Systems designers rely for the most part on a set of well-known methods and practices, shared within their community, frequently used and seldom questioned. They design and develop one system after another; users are seldom even given one opportunity to participate in a systems development project.

Moreover, it is not equally evident that users have the same strong perspective within their group. As argued in paper no. 2, my understanding of design work involving users and systems designers is that the users need time to reflect on their own work before they are thrown into work with designers. Skilled and experienced users know all about their own work, but they might be less accustomed to talk about their own work with uninformed people. It is unfortunate if users discuss their work through simplifications, of concern for less informed designers. Users need to be prepared for the design work to come, consider and reflect on future change, focus on essentials, and finally get the opportunity to make their point.

Common ground, defined by Clark (1996, p.93) as the sum of two individuals’ “mutual, common or joint knowledge, beliefs, and suppositions”, is assumed to be the means with which communication can be handled. Recently it has been suggested that the application of a combination of communication theory and user-centered design might solve communication problems (Gulliksen & Lantz, 2003). The concept of common ground was developed for language interaction, nonetheless it is useful as a model of the shared knowledge that users and designers exclusively have developed in similar ways in their professions. The same kind of common ground needs to develop when users and systems designers are brought together, to initiate a process of change (Curtis, Krasner & Iscoe, 1988). To achieve this, both users and systems designers must be given proper time to discuss work and design together. Walz, Elam & Curtis (1993) recommended active promotion of the acquisition, sharing, and integration of knowledge within a design
effort, through team facilitation techniques and formal recognition of these activities, by allocating time for them.

The body of shared knowledge and shared understanding will grow and facilitate communication if the conditions are advantageous. However, care must be taken to avoid that users become steeped in the developers’ vocabulary; the common ground should develop around the essential issues in work.

2.8 Narratives may inform design

Story telling has been used to analyze users’ needs during systems development as for instance in scenario-based design (Carroll, 2000). Invented or created narratives typically describe a user’s state of mind, including goals, actions, and sometimes interactions with tools (Rosson, Carroll & Rudi, 2004). My use of narratives is closer to the original notion, a reproduction of a short story reporting on previous experiences made by the narrator or someone else. In my research, such narratives have become a central part in the process of building up requirements on systems. Narratives are plentiful in the participatory work with users, in observations of work, as well as in interviews. In line with Alvarez & Urla (2002), I have found that narratives offer insights into the ways systems are used and habitual practices of the work environment. Furthermore, the users convey both the problems they face and their creative workarounds. Alvarez & Urla (ibid.) also concluded that the narratives reveal the situatedness of information systems in the organization and the social context.

In work, narratives are often used for a purpose, not just storytelling for the fun of it, even if there is a part of social bonding involved in the practice. Without providing a complete description of all occurring usage of narratives, I will list a few examples from my experience with observations, interviews, and participatory work.

They may serve as reminders, such as:

- don’t forget this, because it has an impact on the work that needs to be considered in the future system
- look what happened when the system clashed with unforeseen real-life problems

They may serve as a means for knowledge growth/teaching:

- in the English channel we encountered…
on that ferry with the Decca radar system we could…

Between colleagues, they may serve as confirmation of the veracity with which a situation is understood:

This looks like the situation we experienced two weeks ago (*implicitly, if you disagree, then tell me so*). I think I will solve the problem in this way.

They are often induced by events and situations, e.g. when a ship passed dangerously close to the bow of a ferry, the captain told the helmsman of a similar situation when he had reported the ferry that intruded on his safe passage to the Marine Department, and the intruder was fined. With such stories, the crews reflexively educate each other and make their common ground grow.

Analysts² may find narratives as messy or undecodable and therefore dismiss them (Alvarez & Urla, 2002). Even if I find the narratives both informative and interesting, that is not their only accomplishment. The kind of information that is revealed may have implications for design. Moreover, this may be the only way this particular knowledge is revealed. Consequently, it is important to be prepared to listen to such stories and learn to identify essential information in narratives.

2.9 Exploring new design with users through prototypes

Ehn & Kyng (1991) suggested prototyping as a tool for users to explore and evaluate design. Encouraging experiences were made within the Utopia project (Bødker et al., 1987), where simple means such as sketches, and cardboard mockups, were used to iterate on design solutions. On each iteration, the subset of unexplored possibilities should ideally decline, and ultimately, the distance between fundamental work constraints, and the actual practices in the new design, should diminish (Vicente, 1999).

In my research I have used prototyping in a number of projects, for instance in the work on medical records and dentists’ patient records, the train driver system described in paper no. 3, and the augmented reality system for ships described in paper no. 6. The approach has been successful in terms of exploration of design solutions and acceptance by the participating users. The gathered experience is convincing.

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2 The concept used by Alvarez & Urla.
Although users have participated in the design process, they have not developed executable prototypes. But, we have had the users’ best interest in mind in our decision. Users and systems designers do not have equal access to prototyping software technology (Miller, Smith & Muller, 1992). Moreover, users should not be forced to turn their attention to design tools or programming languages, and thus become detached from their work and work related skills.

Greenbaum & Kyng (1991) discussed how participatory design could be transformed into a trap for the participating future users. They do not have the possibility of delivering the appropriate demands on the design upfront since they do not know all possibilities. But, this is part of the design process; it would be impossible for users to state all requirements on a new system upfront. As we have found in our work with the participatory design process, the participating users grow with the task, and they begin to see their work in a new light. When the possibilities and outcomes of earlier requirements are iterated, additional requirements are bound to appear. But with extensive field studies and user involvement, the chances are better that the late requirements have less severe consequences for the system as a whole than would otherwise have been the case.

When is a prototype completed? Vicente criticizes prototyping in that it may become akin to “a dog chasing its tail” (p. 103), his point being that each new interaction introduces a new set of possibilities, and thus leads to new requirements, and new design. In traditional systems development according to the waterfall model (e.g. Dix et al., 2004, p. 228) there is a final date when the requirement specification is due, although it seldom corresponds to the actual time schedule. The ISO standard 13407 on human-centered design processes suggests that the design process is finished when the user requirements are met.

To sum it up, time spent on analysis and design with users facilitates development of a common ground, which is crucial in systems development projects. Prototyping in the sense of exploring future work, and especially with the purpose of exploring alternative solutions is used far too seldom in my experience. It is more common that users only get the chance to view completed display designs, or occasionally are offered a walkthrough by the systems designer. Disappointingly, the recommendation by ISO 13407, that users should try out prototypes in a realistic context, seems to have been overlooked most of the time in reality.
2.10 Interfaces that focus on the user’s work are required

The days when computer users were only technical engineers, devoted to operating systems and programming languages are behind us. Nowadays, computer users are to be found in all occupations. Still, the systems designer, who often develops the system, has a strong bias towards basing the interface on an engineering model; the result is often an interface that reflects the underlying mechanism (Thimbleby et al., 2002). The user, who has a conceptual model of the task to perform, must consequently interact with an application that mirrors the implementation of the system. Gentner & Grudin (1990) argue that since a user primarily wants to complete a task, an interface should rather be based on the task model, since an interface based on an engineering model will be a hindrance to most users. In line with these arguments, Waern (1989) contrasts the main task to be performed, with the subsidiary task of handling the computer, and concludes that if both these tasks require attention, performance in one or the other is likely to suffer.

The guidelines (Microsoft Corporation, 2001) below confirm the widespread misconception that tasks should be divided in subtasks on separate pages, displays, or tabs, to facilitate work:

As a new way of designing software, IUI's goal is to reduce the amount of extraneous thinking users must do to successfully move between parts of a product and use its features.... In the Web environment, pages have to be simple and task-based because each piece of information has to be sent to a server over a relatively slow connection. The server then responds with the next step, and so on. Good Web design means focusing on a single task per page and providing navigation forward and backward through pages. Similarly, inductive navigation starts with focusing the activity on each page to a single, primary task.

A well-designed inductive interface helps users answer two fundamental questions they face when looking at a screen: What am I supposed to do now? Where do I go from here to accomplish my next task? (emphasis added by the author)

This way of thinking about users as being less knowledgeable and less understanding is awkward. Besides, the effects of slow communication seem to be more important than concern about user satisfaction.

The users studied at workplaces and reported on here typically have major responsibilities, and perform work that demands efficiency and expert knowledge. Natural work is flexible and often fragmented due to disturbances from patients, customers, and colleagues. This does not mean that the support system should be fragmented. Previous findings on concurrent in-
formation presentation indicate that users need to see all the relevant information simultaneously to make a correct decision (Lind, 1991). However, the computer support system may prevent them from acquiring the “big picture”, to maintain control over all the things for which they are responsible.

Unfortunately, concurrent methods and tools encourage the development of fragmented interfaces. To simplify the system development process, complex tasks are subdivided in smaller parts that are easily translated into separate screens. The support systems become fragmented and ill-suited for maintaining overview and control of the entire work. Besides, the so-called “windows disease” (Nygren, 1993), which force the user to constantly resize and rearrange windows to achieve something, is still commonplace.

Fragmented support systems give rise to stress and may at worst jeopardize safety. If you for instance cannot survey the status of a patient and be sure that important information is considered, you run the risk of making a decision that might have severe consequences for the patient’s health. Likewise, it is easy to anticipate critical consequences when a sea-pilot in the middle of a narrow channel, facing weather conditions with fog and ice, diverts focus from the steering task since the radar system requires the user to go through five separate steps to adjust the display (Accident investigation board, 1998). Accidents have also happened when navigators in the course of events likewise have been preoccupied with, e.g. adjustment of radar screen clutter (Justis- og politidepartementet, 2000).

The workspace metaphor presented in paper no. 8 became a central issue in our efforts to provide users with overview and efficient user interfaces. The workspace aimed at supporting users with everything needed to accomplish a complete work task, for instance to survey an entire tax case, information from different systems was required, along with e.g. a browser for legal information, and supporting tools to manipulate the information. The intention was that a user should be able to accomplish all sub-tasks belonging to a complete task in a specific workspace, instead of wasting cognitive effort on jumping between applications and a large number of fragmented displays, memorizing pieces of information or jotting things down on Post-it notes, as was currently the case. During a typical workday, a civil servant would thus use only need a few workspaces to handle the different kinds of cases that occurred. The next chapter continues the discussion on the essentials of work and focus on aspects that are particularly important to study at workplaces.
3 Appreciation of work

What people can do is usually more important than what they know, for knowledge is only useful if it is applied. (Mumford, 1998, p. 450)

3.1 Work is always complex and actions are situated

In my experience, and in that cited by other researchers (e.g. Plowman, Rogers & Ramage, 1995), every workplace is unique, and work practices are highly situated (Suchman, 1987). Furthermore, the work we have studied always proves to have a hidden complexity that often is difficult to recognize for an outsider. Typically, it does not consist of a number of detached tasks; they are interwoven, dependent on the situation and performed in collaboration with other people.

On the surface, the work settings are different, but they also share many features, e.g. people that are skilled, happy, and proud of their work and are willing to discuss their work. These people display a deep commitment in their work and, surprisingly often, they have thought a great deal, about how tools and practices at work could be improved. For instance, a sea-captain told me that, in the process of the design of a new bridge on a ferry, he and a group of other captains used a CAD program on their own initiative to develop drawings of their ideal bridge. Disappointingly, they got no feedback from the management on their proposal. One can only assume that since the drawings were not requested from management, they went into a wastepaper basket.

Skilled people are not only confined to the computer, they use other means simultaneously that need to fit in with the computer support. For example, they survey surroundings from the bridge, even if they have support for such tasks like the radar at sea, signaling systems on the train, etc. They perform these actions because technical systems are not foolproof. The radar may, for instance, be unable to differentiate between ice-floes and an approaching vessel. Moreover, there are aspects such as noise and vibrations that technical systems do not capture, at least not at present, that human may find informative e.g. in failure detection.
People rarely work in isolation; they work together with other people, even if these people are located in distant places, like the train traffic controller who communicates with the otherwise rather isolated driver through a radio device or lately a cell phone.

3.2 Taking an inside or outside perspective on work

How systems are designed is largely dependent on how work is described. Since people’s roles determine their perspective on, and their descriptions of, work, the author of a particular message also needs to be identified in order to interpret the information correctly. Sachs (1995) has described two common conceptions of work; on one hand the organizational explicit view, and on the other, an activity oriented tacit view. Holmqvist & Bøgh Andersen (1991) convey similar thoughts with the expressions talking “in work” and “about work” to describe different perspectives on work, typically held by users and management, respectively. They suggest that management’s view of work often is related to how work ought to be, and accordingly such a description is typically normative. Users, on the other hand, have a descriptive language when they talk about their work; they are experiencing the reality and therefore talk about how work is actually performed, including mistakes and deviations from the expected, as well as short-cuts and work-arounds to tedious procedures.

Since these differences in work descriptions co-exist, it is important to capture both the inside and outside perspective of work when conducting work analysis, and bring both perspectives out in the open.

3.3 To reveal practices and tacit knowledge

For the most part people can easily explain on an overall level what they do at work and the goals they have in their work. But Schön (1991) suggested that competent practitioners usually know more than they can say; they exhibit what he called a kind of “knowing-in-practice” (p. viii). When humans learn to do things, a lot of small tasks that were evident from the beginning soon become inherent, we are not aware of these things any more. The practices become unarticulated, or tacit (Polanyi, 1958). The same phenomenon is related to tacit knowledge, of which we are no longer aware that we have. If users are asked upfront about such practices of work, they will probably be unable to reveal anything about them.

It is important that tacit knowledge is uncovered in systems design. Essential aspects of work may easily be ignored if work only is considered at an over-
all level. If such knowledge is left out, the result may be a deficient system that does not support the work practices. Ballman (Allen et al., 1993, p.253) exposed the sometimes-absent understanding of this process in his critique of people that were difficult to work with in interface development:

…experts who find it difficult to express what it is they do when they work. We could call them “Witch Doctors”. They are in part engaged in a legitimate attempt to preserve their professional integrity (the mystery of their craft), and, in part, unable to express cognitive activity which is both complex and intuitive.

However, to uncover tacit knowledge and translate this information into a system, collaboration and efficient communication between users and developers is required. There are ways for systems designers to begin to approach such knowledge. It is for instance, without question, important to observe users at work for successful systems development. A perceptive observer may see such unarticulated practices or at least spot traces of them, and begin to explore them. To discuss work with users where it takes place, i.e. at workplaces rather than at distant conference facilities, is often rewarding, and increases systems designers’ understanding of work. Talking about work in the workplace makes it less abstract - pointing at actual tools and objects may also facilitate the articulation of tacit knowledge.

In the work with the train drivers described in paper no. 4 yet another technique was used. Some train drivers were recorded on video in action; later other drivers watched video clips, reflected, and commented on their own probable behavior in corresponding situations. Such comments must of course be critically assessed since people in such a situation may want to describe themselves in a different light, and appear to be more competent. The drivers’ comments were nevertheless valuable, in particular when several of them agreed on their own probable behavior.

What we initially see as awkward, irrational and without purpose when workplaces are studied, may appear as rational and purposive after some time, due to our own socialization and understanding of the practices (Bødker & Strandgaard Pedersen, 1991). When workplaces are studied, it is important to be observant on the different perspectives a newcomer and an experienced may have. With fresh eyes, we might misunderstand many things in work and focus on less important aspects due to our ignorance or prioritization from previous experiences. Nevertheless, there is also a chance that we make important findings. Not even seemingly commonsense or general findings should be devaluated, as Plowman et al. (1995) put forth, they must be validated in the context of use.
When you are deeply involved in work there are customs and practices that are difficult to oppose since they have been established for a long time. An outsider may be more apt to focus on, e.g. impracticable customs. Pictures and video recordings may also be useful in these situations. They provide the opportunity to return to previous recordings and observe new actions and events, and you may understand them differently with the knowledge you have gained in the meantime. In the next chapter on the work studies performed, I will discuss these issues further.

3.4 Inaccurate work descriptions may lead to poor design

As humans, we can handle complex situations, we are ready to solve problems, and we try to bring order into an otherwise chaotic world. In a similar effort, designers may approach a new work domain and try to develop a system that makes the work less complex. Such intentions may go wrong. Misdirected concerns of simplifying things may emanate from desires to facilitate work. The designer’s difficulties in grasping the work as such may, in fact, result in fragmented interfaces and subdivided tasks that have no correspondence in working life. Such efforts may destroy skilled users’ natural ways of working. This has for instance been acknowledged by Anderson (1994) who says:

…but when more closely inspected apparent inefficiencies usually turn out to be not problems but precisely shaped (and therefore effective) solutions to the exigencies to which individuals in a working order are subject (p. 170)

It is also important to identify and remember features of normal work and work practices that work well. Previous research has for instance acknowledged that people use the size of the document piles on their desk to assess the present amount of work (Boivie et al., 2003a), and that physicians use the thickness of the medical record to judge the medical history of a patient (Nygren et al., 1992). It is easy to conclude that people will work less efficiently if we deprive them of such qualities, which often happens at computerization of work. Control over one’s own work (Karasek, 1979) has displayed a significant importance in staying healthy, and avoiding stress. This does not necessarily mean that information must be depicted in exactly the same way as in previous practices, only that it must be present.

When work is analyzed and described in a formal way, the result may actually not depict how work is really performed. Nyce & Bader (2002) discuss the effects of taking a “problem - solution” approach to users’ work. In such an approach, practices are structured according to an engineering perspec-
Behavior, practice, skills, and judgments are aspects of work that may be ignored or excluded in such formal descriptions.

The mere construction of computers and programs invites a procedural thinking; the engineering perspective is firmly rooted in systematic procedures. Most requirements analysis techniques produce a representation of the organization that is tidy, clear-cut, and logical (Westrup, 1999). Moreover, the design and development process is delimited by an obsession with problem and solution (Anderson, 1994), a step-by-step process with a technological agenda that defines the technological constraints and leads to a particular solution.

Seeking to evaluate all practices against a single or narrow range of formal criteria may cause designers to miss much of what is vital to the lived-work of the technology in use. (Anderson, 1994, p. 170)

Unfortunately, natural work is often not clear-cut and logical. A number of qualities that characterize human beings make our lives easier, but at the same time, they make us jump to conclusions and actions that may be unfit in a particular situation. That is, for instance, why we need checklists in situations where we are absolutely required to go through a number of steps, in a particular order, and without skipping one or two of them (see Figure 6).

Users are flexible and creative; a combination that poorly fits strictly sequential application flows. Consequently, rigid systems are not useful for flexible people. Because of the complexity and flexibility of work, we need to study work in detail to be able to grasp the essentials and initiate a discussion with users. Current state analysis must pay consideration to strengths and weaknesses before proposing improvements.

To sum it up, the users’ interests must become the prime issue in systems development. Our goal should not be to develop “user friendly” systems, in the sense that users can understand and handle the systems reasonably well. Systems must become usable, and according to ISO-9241, the usability is judged by their effectiveness, efficiency, and satisfaction in a specified context with specified users. Accordingly, users’ demands on usable systems should rule.
Figure 6. Recall notes with step-by step procedures are always found in control environments, here on the control panel on the bridge of a high-speed ferry.
4 Qualitative studies of work

4.1 Research problems and goals

The aim of this research has been to study work in order to find the essentials that need to be translated into the design of artifacts. Furthermore, a subsequent goal has been to find means that facilitate the systems design process. My research questions were by no means fixed when I started out on the thesis; they have developed through my thesis work and are at present best concluded as follows.

Overall issues related to interpretation of work:
- What are the essentials of work?
- How can we design systems that support competence growth and enhance skill?
- Which theoretical knowledge can inform design and increase usability?

Issues related to the systems designers' practices:
- How can systems designers be provided with easily accessible domain and design knowledge?
- How should systems that support work best be designed?

Issues related to practices involving users:
- What contributions do users make to the design process?
- How can users be involved in the design process most efficiently?

Table 2 presents an overview of the research questions and their relation to research papers and methods put into practice. Workplace studies include participatory observations, observation interviews (Åborg et al., 2003b), open interviews and semi-structured interviews. Workplaces have also been documented in the form of video recordings and digital still images. In studies of administrative workplaces, different kinds of documents and forms used in the work setting have also been collected to enable information utilization analysis (Gulliksen et al., 1997). Literature reviews were a part of all studies.
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<td>2 Participatory design with train drivers - a process analysis</td>
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The following more specific research issues have developed from the research questions above, literature reviews, and empirical studies of work and implementation of methods, some involving systems designers, and some involving users:

- In what ways can general theories from psychology, etc. be effectively utilized in UI design?
- How can we utilize the understandings of work developed in empirical studies in systems design?
- Would for instance domain-specific style guides provide better support in user interface design than the general style guides and platform specific guidelines?
- Would domain specific interface elements support systems designers and increase the usability of the systems?
- Would high-level interface elements support natural work more efficiently than present fragmented interfaces do?
- How can we acknowledge the users domain, their vocabulary, and their ways of discussing work in the systems design process?
- How can users be involved in systems design most efficiently, without becoming entangled in software development processes and thus becoming IT workers, and instead develop their skills at work?

These issues have been explored with qualitative methods.

4.2 Interpretations of qualitative studies

In the following sections, I will go through the methods underpinning the qualitative interpretations of work performed in my research.

4.2.1 Ethnographic approaches to work analysis

The problem of creating useful contributions to systems design from an extensive work analysis has been under debate for a long time. At this stage, ethnographic methods have attracted attention, since they may help us make work visible and allow us to understand not only what goes on but also the meaning of what goes on. Ethnographic records offer a potential for uncovering tacit knowledge and understandings embedded in work activities (Hughes, Randall & Shapiro, 1993). Moreover, according to Frances et al. (1997) ethnographic studies can inform on the situated nature of work, focus on evaluation of real work and context, and bridge the gap between the communities involved.
Forsythe (1999) defends real ethnography performed by ethnographers contrasted with the quasi-ethnography currently performed by engineers who attempt to borrow the technique, which may give superficial and unreliable results. The reason for such malpractices is, according to Forsythe (ibid.), that engineers fail to see/realize the invisible part of ethnography. On the surface, ethnography appears to be straightforward, but this is not really the case. A few of the misconceptions that Forsythe (ibid.) introduces as basis for the malpractice are relevant to mention, e.g. that anyone can do ethnography, that it does not involve a systematic method, that it is just chatting with people, and asking them what they do.

To conclude Forsythe’s arguments, only ethnographers have the expertise to apply systematic and theory-based unobtrusive methods, and not take people’s self-reports at face value, but evaluate them against the reports and observable behavior of other members in the work setting.

I would not suggest that the methods I have used at field studies could be called genuine ethnography. Nevertheless, the approach is similar, with plenty of participatory observations, initially taking notes, video recording users at work, and following-up by tape-recorded interviews.

Interviews have been transcribed, analyzed and interpreted together with observations. Generalizations have deliberately been postponed, although I argue that this is not completely true; human nature strives continuously to interpret and make sense of the surrounding world. Equally important is that we never enter a workplace without preconceptions from previous experiences. Nevertheless, in our work, we have not taken either observations or user statements at face value. Of course, untrained people may overlook important aspects of ethnographic work, but in my experience, the advantages of being in the field at all are larger than the disadvantages of not being an ethnographer in the field.

Workplace studies are without question required and valuable. Ehn (1989) suggested that design of complex systems required a deep understanding of both application domain and user practices, and that designers need to work to attain this knowledge. Anderson (1994) points to other advantages such as bringing novel and deep design possibilities to light. Furthermore, Anderson (ibid.) suggests that ethnography can question the conventional problem-solution frames that otherwise impose a constraint on design.

Plowman et al. (ibid.) carried out a survey of 75 workplace studies published (in the CSCW area) to find out how effective field studies were in informing design. They concluded that the lack of papers including detailed specific design guidelines was attributed to the lack of work that had resulted in sys-
tem prototypes and maybe to constraints imposed by industrial partners and their presumed confidentiality about design solutions. Plowman et al. (ibid.) offer harsh critique on researchers that anyway feel obliged to force design guidelines from their findings, many little more than “semi-platitudinous” implications for design:

> It is as iniquitous to expect researchers to produce highly specified design guidelines for systems designers as it is to expect systems designers to 'assume responsibility for the redesign of work' (Shapiro, 1994) but these expectations still appear to be widespread. (p. 313)

However, since the findings lack the formality of software engineering methods, they may be difficult to use for software engineers (Hughes, Randall & Shapiro, 1992). Plowman et al. (ibid.) related the problems to the clash between the sociality generated by field studies and the expectations systems designers had on requirements. Further work is needed to transform the results from workplace studies to practical implications and prescriptions useful for systems designers.

### 4.2.2 Action research in studies of work

Action research can be considered an iterative process involving researchers and practitioners acting together on a particular cycle of activities (Avison et al., 1999). These activities include problem diagnosis, action intervention, and reflective learning (Schön, 1991). The aim of action research is to increase the understanding of, for instance, a workplace and to bring about change (Dick, 1993). The increased understanding does not relate only to the researcher. According to Rapoport (1970), action research also aims to contribute both to the immediate practical concerns of people in a problematic situation, and to the goals of social science, by joint collaboration within a mutually acceptable ethical framework.

The researchers do more than just listen to what people say they do. They also observe what people do and draw conclusions from differences that arise. Much of the knowledge at a work place is tacit to the people working there and can only be revealed by methods such as participatory observation of users performing their tasks. The role of the researcher in these settings is to mediate knowledge and methods that can be applied in practice, analyze and reflect on the results and, finally, to revise the methods applied.

An action research approach has been used, for instance, at RSV as reported in papers no. 8 and 9. The results of the studies were returned to the workplace and were implemented in the work environment. The consequences of these interventions were once more studied and reflected upon.
4.2.3 A framework for cognitive work analysis

Models are often used to describe a system (see Terms and definitions) in a simplified way. Usually, a model contains fewer components and relations than the depicted system. Only the most essential characteristics for the present purpose are chosen. Different approaches are possible, e.g. normative models that prescribe how a system should behave, and descriptive models that describe how a system actually behaves.

According to Vicente (1999), descriptive approaches inherit the deficiencies of current practice. They are good for collecting information that inform a work analysis, but they need to be complemented by formative work models to design systems that enable new and effective ways of performing work. Rather than focussing on the way things should be or the way things are, formative approaches focus on the way things could be by identifying novel possibilities for productive work.

Vicente therefore introduces the framework cognitive work analysis, an approach that has developed over the last 30 years (Rasmussen, Pejtersen & Goodstein, 1994). The underlying principle is that when a computer system or any other cognitive artifact is designed, a complete work system is developed which includes people and artifacts. The work system is thus more than the sum of its parts, a whole, with emergent properties.

A notion included in the framework is that worker behaviour over time emerges from “a confluence of behaviour shaping constraints that specify the dimensions that must be incorporated in a framework for work analysis” (ibid., p. 34). A subsequent goal is consequently to identify the factors that shape human behaviour (see Figure 7) since these constraints can be used to identify requirements on the systems design.

The cognitive work analysis presented by Vicente (1999) is only one approach to work analysis among many, but it provides a constructive perspective on work. In addition, it can be adapted and modified according to the particular needs and horizon of a research or design team. In our research, we have also adopted the initial part of the framework, mostly concerned with how users and workplaces need to be studied and modeled. We used the framework to increase our understanding of decision processes on the bridge and in the train, and further to find out which control situations, control strategies, and risks the users are exposed to.
4.2.4 Control theory as a framework for work analysis

The engineering principle Control theory (Brehmer, 1992; Jansson, 1997) has previously been used for the study of human decisions in dynamic decision tasks. The studies have mostly been performed in the laboratory, using so-called micro worlds. The control theory framework merely serves as a structured explanatory/descriptive model; it does not support predictions.

The control theory framework is a closed-loop control system (Figure 8), which constantly monitors the effects of its output on the environment and uses observations and feedback to modify future behavior.

The framework was the starting point for the field studies of work performed by train drivers and sea-captains described in papers no. 4 and 5. This means that we applied the control theory principles out of the laboratory, to study real-life work settings.
According to control theory, four general preconditions are required for the control of any dynamic system (e.g. MacKinnon & Wearing, 1985) regardless of whether humans or machines survey the operations:

- **The goal condition** – there must be a goal or a set of goals. Typical goals on the bridges we have studied are a safe journey, a comfortable journey for the passengers, arriving on time and so forth.

- **The model condition** – there must be a model of the system, that tells the operator what actions will lead to. E.g., a captain on a high-speed craft with two water jets and an integrated joystick has a model of how the ship will behave in different joystick modes. This does not necessarily mean that two captains have exactly the same model; both experience and personality seem to affect the model.

- **The observability condition** – it must be possible to determine the current state of the system. The observability criteria can be exemplified with the maneuvering mode of an integrated joystick. A joystick often has three or four different maneuvering modes. But, it might be impossible to determine the present mode at first glance; you may have to verify the mode by checking buttons as well, or by simply moving the throttle and simultaneously check the instruments.

- **The controllability condition** – it must be possible to change the state of the system. A joystick is a typical example of a means for changing the state of the system on the bridge.

It is commonly assumed that operators in complex technical systems create a mental representation or a mental model of their task environment that allows them to diagnose the system’s current state. The goal and model conditions thus belong to the user. Goals must be familiar, and the model understood, even if the user may be unaware of the mental model and unable to explain it to others.

Observability and controllability are system properties. A driver must be able to recognize states and change states. In order to maintain feed-forward control, i.e., planning and acting upon plans (contrary to a feedback control where the driver reacts to occurring events), a good internal representation of
the situation is required. Figure 9 illustrates how the control conditions may apply on the bridge.

![Diagram](image)

Figure 9. The four preconditions required for the control of any system. An operator has a mental model of the controlled system and certain goals; these are accomplished by observing the process and exercising proper control actions.

### 4.3 Research approach and chosen methods

The studies performed and reported in this thesis involve qualitative research methods, such as action research and ethnographic approaches, participatory observations and direct observation. Qualitative interviews (Kvale, 1996) have been used to a large extent, both open as well as structured interviews. Two or more researchers in collaboration performed all of the interviews and observations discussed here. Still, this does not guarantee objectivity, especially since it is difficult, nearly impossible, to free oneself from preconceptions that may influence the results. In those terms, the studies are subjective to a large degree. However, the purpose of the studies has not been to reveal an objective “truth”, rather to become aware of and understand the users’ subjective experiences of their work.

Video recordings and still images have also been used to capture work settings and activities.
I will exemplify the way the studies have been conducted by briefly describing the efforts in the TRAIN-project (Kecklund et al., 2003). Our work in this project is partly summarized in paper no. 4. The study of the train driver task included a number of methods; see Figure 10 for an early proposal of the study. To begin with, 79 train accidents were reviewed. On a subset of 30 accidents a cognitive reliability and error analysis (Hollnagel, 1998) was performed (Hollnagel et al., 1999). The purpose was to look for events and conditions that led to the outcome, and to find a set of probable causes (Woods et al., 1994). Then ten drivers on different kinds of trains and in different kinds of traffic were studied through their work shifts to gather knowledge on the train-driving task. Observations were conducted and field notes were taken. On four occasions, a train was studied from the start to its final destination and the drivers were video-taped in action. The communication between train drivers and train traffic control centers was analyzed and
suggestions on future solutions were reported (Olsson, Sandblad & Kecklund, 2000). The drivers’ views on the information environment in the train and the automatic train protection system (ATC) were investigated by means of a questionnaire (Olsson et al., 2001). Besides the informal observation interviews performed on trains, a structured interview was later performed with seven drivers when a representation of the train driver’s work had matured. While watching video-clips of other drivers, these drivers performed a recognition task and accomplished think-aloud protocols. In the final phase of the project, that lasted three years, a participatory design process was conducted to engage drivers in the design of a future user interface.

For natural reasons, studies of work are best performed at actual workplaces. Extensive field research has thus been performed in actual work settings, at corporations, and in larger development projects, in trains and on ship bridges. Only in this context is it possible to observe the full spectrum of events that take place, and the characteristics that influence on, e.g. a driver at work. The validity of the findings from the workplace studies is thus improved. However, these conditions also affect the ease and control with which the studies are performed. Field research generates large amounts of findings, documented through notes, images, tape recordings and video.

The only exception to the field research approach is the limited laboratory study reported on in Paper no. 6. Sea-captains were exposed to a prototype implementing a novel user interface and were studied when managing a high-speed ferry in a simulator. Still, the collected results were qualitative. Even though simulators may be elaborated in many aspects and provide a possibility to control a situation and to gather different kinds of quantitative data, they cannot induce the same complexity that you find, e.g. on a ship bridge in a real work setting.

As a consequence of the qualitative methods chosen the field studies are interpretive. As researchers, we interpret what is going on; behavioral patterns do not just exist out there. Our studies are inspired by ethnography, but they are not as extensive in time as traditional ethnography demands, since we have no intention of becoming submerged in the workplace or becoming equally skilled in the work as the users. Moreover, such skills often take many years to develop. The studies have thus been extended in time as long as has been needed to build an understanding of the actual work performed. The representations of work that have emerged have also been revised and expanded through participatory work on prototypes with users on some occasions.

When a basic knowledge of the work has been acquired, a framework for interviews and further work analysis has been prepared. We have often used
informed confederates (e.g. a train driver instructor, a sea-captain, or a ship designer) to confirm that we are on the right track, that the terminology is used correctly, and that the knowledge we have acquired is correct, e.g. about how different control systems work. But even at this stage you have to be open for how an interview develops, there are always interesting topics brought up that have not been specified in the framework prepared in advance. Such topics or issues may provide essential knowledge.

When you know more about the salient features, you can start to drill down in the work activities to identify problematic areas and breakdowns. Knowledge gained from incidents and accidents is particularly useful for discovering breakdowns in different situations. Incident reports often reveal courses of events that otherwise would have been impossible to imagine. People who work on ship bridges and trains, frequently use this kind of knowledge to educate each other in an informal way, e.g. at the coffee table or on the bridge. Nonetheless, it is equally important to identify and consider features of normal work and work practices that work well.

In workplace studies (see Figure 11), you never enter a work setting without some preconceptions about work. Independently of the research methods, previous experience and the researcher’s core values affect the research from observations, through analysis and results. Previous experience guides your eyes in where to look and what to look for. A number of previous field studies and experiences clearly affect what I have looked for even if my aim has been to keep an open mind for different findings and new ideas. An exciting part of the field studies, that has helped me to keep an open mind, is all the different kinds of work settings I have had the opportunity to study. Moreover, the studies have involved meeting users from different cultures and with different perspectives on aspects of their work.

In my experience, you need to know a lot about a work setting before you can start to ask sensible questions about it. Otherwise, you may disrupt the interviews and discussions with your obvious ignorance. People in general are eager to please an interviewer when they are asked about their work. As an example, when I have transcribed open interviews, they occasionally reveal how the interviewer interrupts a user in order to get an explanation for something unfamiliar or ambiguous. Such interruptions often mean that the user never gets back to the previous line of thought, but instead continues with another issue, possibly one that is related to the interrupting question. Further, occasionally I have noticed how users adapt their work descriptions to the interviewer’s knowledge level, as they perceive it, to make sure they are understood correctly. The explanations thus run the risk of being too simplified to fill a function, and the complexity of work may get lost. Our
field studies have therefore often started with observations in the work setting, studying people at work without disturbing them too much.

Figure 11. Interviewing a captain on the bridge. The interviews were recorded and transcribed later on.
5 Summary of studies

The structure of this thesis is not chronological, primarily to draw attention to the recent work that concludes my growing experiences of user involvement and how my perspectives have changed over time. I appreciated user involvement early in my research, but my awareness of its utility and the need for appropriate precautions for efficient user involvement has grown immensely during the work.

The paper no. 1 “A participatory design process supporting future work” describes a design process involving users that we have developed through frequent participatory work. The design process includes activities such as analysis of current work and practices, finding the essential goals in work, finding barriers that obstruct work, finding organizational complications, and envisioning future work. The results of these activities are propositions of work redesign, and changes to the organization and support systems, including but not limited to IT. They are documented and often visualized in the form of design sketches and interactive prototypes. The paper also discusses how work groups should be formed and conditions for successful user involvement. I wrote the major part of the paper and it summarizes work that has been carried out by several researchers at our department over the last decade.

Paper no. 2 “Participatory design with train drivers - a process analysis” describes how the above-mentioned participatory design process was put into practice. A group of train drivers were involved in the development of a new driver’s interface. The work took place in the final phase of an extensive research project (TRAIN) where the complete picture of a train driver’s work was studied (described in paper no. 4). The focus of the paper was the communication between the train drivers; in what manners they discussed their work and how the resulting design was shaped by their actual practices. I performed the analysis and wrote the paper.

Paper no. 3 “What Active Users and Designers Contribute in the Design Process” describes a case study where user representatives and user interface designers separately worked on a design task in order to reveal differences in their respective contributions to design. The design task was based on design sketches that had been developed in the work with captains on high-speed trains.
ferries (described in paper no. 5). The paper analyses how the participants communicate in the different groups, and the disparity between their vocabularies related to their professions. The significance of a common vocabulary for the outcome of collaborative work is discussed. I planned and conducted the study, and wrote the paper.

Paper no. 4 “Acting or reacting? A cognitive work analysis approach to the train driver task” describes the work in the TRAIN project. A thorough analysis of the train driver’s work including extensive field studies, interviews and a questionnaire was complemented with cognitive work analysis. The paper summarizes the work within the project and describes briefly the participatory design work on a new interface with a group of train drivers. The paper suggests that information, which supports situation awareness and feed-forward planning, can be provided in the interface. The authors contributed equally to the work, Anders Jansson wrote the paper.

Paper no. 5 “Work on the bridge – studies of officers on high-speed ferries” contains a work analysis of captains on high-speed craft. The authors contributed equally to the work, I wrote the paper.

Paper no. 6 “Safer Navigation at Sea using Augmented Reality” is a case study where some of the key findings from the maritime work analysis described in paper no. 5 were transformed into practical design. The paper suggests that problems with divided attention related to simultaneous overview of surroundings, radar screen, and other displays, can decrease with an overlay on the windscreen including a path, shorelines, and other vessels. The suggested solution would allow the captain to survey radar information while simultaneously watching the surroundings. Three captains evaluated this so-called augmented reality in a simulator. The authors collaborated on visualization, planning, and evaluation. I wrote the paper.

Paper no. 7 “On design of a high-speed ferry bridge” reports on an interview with a bridge designer. Important issues that are not given proper attention in design of new bridges are highlighted. I conducted the interview and wrote the paper.

Paper no. 8 “Workspaces enhance efficiency – Theories, concepts and a case study” makes a case for workspaces. Moreover, it describes how they can provide a more efficient work environment, and at the same time simplify the systems development process. The workspace concept is particularly useful in the case-handling domain where the user frequently switches between a few tasks. The workspace concept was introduced in the work with the domain specific style guide (described in paper no. 9), and was later added as a fundamental high-level interface element in the style guide. The
authors collaborated on the introduction of workspaces as high-level interface elements and I also contributed with the description of how workspaces had been introduced at RSV as a part of their domain specific style guide.

Paper no. 9 “A Corporate Style Guide that Includes Domain Knowledge” describes how the case-handling domain at the Swedish National Tax Board (RSV), a governmental service, was examined and furthermore how a domain-specific style guide was developed for this domain. The development work involved a group of usability professionals at RSV and extended over a year. The authors performed the research in collaboration, and I wrote the paper.

Paper no. 10 “Usability and efficiency. The HELIOS approach to development of user interfaces” reports on the first case study where the ideas of implementing a style guide adapted to a particular domain were initially investigated. Such style guides were intended to serve as a means of increasing HCI knowledge in software engineers. The target domain was health care. The paper outlines how a domain-specific style guide was compiled in order to produce effective interfaces in a software project (Helios-2) involving different development teams producing applications for administrative, clinical, biological data, and radiological systems. I developed the style guide, which is also described in the paper and contributed to the introduction of the paper in collaboration with the co-authors.

5.1 Conclusions

The main conclusions from the research are related to the need of methods and processes that explore what support users really need in their work and the need for increased quality of communication between those who use support systems and those who design the systems. To a certain degree, deficiencies in computer systems can probably be ascribed to inadequacies in the designers’ understanding of the users’ work. Systems designers should be more knowledgeable on the users’ domain, but they cannot act or think in the users’ place, and consequently users need to be involved in the development process.

From the studies reported here, it can be concluded that measures increasing quality in support systems in terms of usability are related to:

- usability activities in the development process
- systems designers’ enhanced knowledge of the target domain
- in-depth analysis of the present work
- space and time allotted for users to discuss their work among themselves
- visionary activities where users and systems designers explore future work
- increased communication between users and systems designers
- increased quality of such communication
- active participation of users in decision-making
- increased respect and humility for different professions from all parties involved

From the more practical findings it can be concluded that style guides, proved to be far less effective in transferring knowledge to systems designers than we had expected, among other things due to the difficulties in making them usable and updated (as confirmed by RSV). Furthermore, in my experience, you need to be educated in HCI to use them and when you have gained that knowledge; you do not need the style guide anymore.

In contrast, the implementation of workspaces that support complete work tasks seems more promising and applicable in many work settings.

The suggested augmented reality used on ship bridges is still an interesting issue, and ongoing research on similar ideas has recently been reported (e.g. Bjorneset, 2003). The train driver simulator, where the interface from the participatory work with train drivers will be assessed, is currently being developed.

My conclusion is that user involvement in systems design is imperative for increasing the usability of computer systems. However, the application of user involvement in working life has been more or less restricted to research projects and preliminary studies that seldom result in developed systems. Active user involvement in systems design should be standard operating procedures.
6 Discussion

ISO 13407 suggests that the human-centered design process should be integrated in an appropriate form and used as a complement to any of the industrial or proprietary methods. Active involvement of users and a clear understanding of user and task requirements are typical characteristics of user-centered design. Nevertheless, in practice, users are less involved in systems development than I would wish as researcher. Expert-based methods such as heuristic evaluation (Nielsen, 1994), that exclude users, have become one of the most widely used usability activities in practice (Vredenburg et al., 2002). The following comment from a questionnaire with designers (Boivie, Göransson & Gulliksen, forthcoming) confirms actual conditions:

To me, user involvement is very important. But unfortunately, the company and the IT manager do not see things in the same light. Instead, they want to develop the system first, and then involve the users. Completely wrong approach, if you ask me!

It seems that methods are chosen from a cost-benefit perspective rather than from their ability to increase usability, as the study by Vredenburg et al. verifies. Consequently, in my experience, users are sometimes asked about their opinion on the appearance of screens, rather than being given the opportunity to decide the contents of the support system.

Development work involving users is often seen as time-consuming and thereby expensive. Given deadlines and multiple constraints that systems designers have to deal with, they are in general not inclined to increase user involvement. However, systems designers need to realize that they are there for the users, not the other way around. Allocation of time for communication between users and systems designers should be mandatory in project planning. Questions concerning communication difficulties when the participants have different backgrounds and different vocabularies also need to be addressed. Moreover, users as well as systems designers need to be familiar with user-centered design processes, and what such usability activities encompass.

Our research is based on work in workplaces. What measures can we recommend to meet the requirements on efficient design methods that may arise
in the organizations we study? My experiences with user involvement in analysis and design, and previous research (e.g. Blackburn, Scudder & Wassenhove, 2000) suggest that the time invested in the early phases of system development gives the best return on investment. ISO 13407 is explicit on this matter:

Extra communication and discussion to identify and resolve problems early on in the project can result in significant savings at later stages when changes are generally more costly. (p.5)

From our horizon, we can only recommend methods that have worked under the preconditions that the research projects have had. The results have often been delivered as prototypes, often including new ways of performing work that users trust in. At present, we cannot be sure that active user involvement really does take more time and resources in the end, since the approach has mostly been deployed in research projects. It is possible that time is gained at the end of the project, due to lower numbers of errors, and increased acceptance of the system. What we do know is that systems with poor usability are bad for user health and well-being (Åborg & Billing, 2003a).

Finally, the software business needs to consider usability to a much larger degree than at present. In my experience, there are patches of committed companies here and there, but largely they are uninformed of usability activities actively involving users. From her knowledge in the consulting business (I assume), Mayhew (1999) concludes that an average software engineer does not know how to deliver usability; moreover, an average software development method does not address it.

Usability professionals often complain about the lack of UCD in the design process, and that if their services are requested in design teams, it is often too late to achieve any real difference in the system. Siegel & Dray (2003) suggested that UCD professionals should start generating designs and products, as opposed to doing studies and criticizing other’s designs. UCD will not be involved earlier and given more influence until it is perceived as pointing towards solutions rather than identifying problems in existing solutions (ibid.). I agree with Siegel & Dray, but the challenge for the software industry, as I see it, is to stop paying lip service and lead usability activities beyond discount usability. I look forward to a growing and disseminating HCI knowledge, and that the awareness of usability within business grows.
6.1 Future research

The knowledge base we have built up through years of field studies is by no means fully explored. The knowledge may inspire further creative and innovative ideas. Work is ongoing on a full-scale train simulator where the interface that was developed in collaboration with train drivers will be subject to usability assessment with real drivers.

Moreover, immature technology influenced the performance and the practicability of the augmented reality prototype reported in paper no. 6. The path and shoreline information were displayed on a simulated windscreen in front of a screen, showing the surroundings, the “real world”. Since a person cannot sit exactly in the same position for more than seconds a head tracker was required to check the captain’s position and coordinate the displayed information so that it overlapped the “real world” in the background in an acceptable way. There was a slight lag in this updating, thus the displayed information became a bit jerky. The prototype in its present design would moreover only work on a bridge with one officer, since the information in the line of sight could only be adapted for one person at a time. When new technology becomes cheaper and more easily deployed in work settings technologies such as augmented reality can be assessed in real life.

IT sometimes “blinds” people. New technology is routinely assumed to make work more efficient. Nyce & Bader (2002) suggest that questions and answers that designers and developers come up with are framed by technology and not the social world of which technology is a product:

Further, the idea that the development process is an eminently rational procedure is confirmed, reaffirmed, and validated through all the work designers and developers do. This natural order of things is so constituted that for designers and developers “analysis”, “problem”, and “solution”, as well as the social, are read, equated, and satisfied through technology. In other words, software designers and developers define design and development as a scientific, engineering problem, and this is taken to be the natural order of things. As a result, designers and developers are very concerned with problem identification and problem solving. (ibid., pp. 31-32)

To exemplify, one of the studies described in paper no. 1 was initiated when the local community realized that the budget for elderly care would decrease, while the population was getting older. Consequently, they started to look for technical devices that could make work more efficient. Once again, it turned out that technology is usually in focus when changes of activities are initiated, which has previously been reported by, e.g. Clegg et al. (1997). There is nothing wrong with technology, as long as it is applied for the right reasons. Still, in my perspective people at work must be given priority. We
must focus on how their work can develop, and explore how they can benefit from new technology. Furthermore, in the elderly care case, related to above, there is a third party, the elderly, who have an interest in the solution finally chosen. Will it make life more enjoyable for them?

I argue that the focus on technology as a starting point needs to be replaced with a focus on work, what the users really need, and how they can be supported best. Instead of asking what we can do with this technology, we should ask if and how technology could facilitate the work.

In our research, we have seen that participatory design processes work in smaller projects with committed participants. However, even if participatory design processes are applied as has been suggested in this thesis, there is still the question of how the designs can be implemented and deployed. Moreover, when there are many parties involved in the development process, how can they communicate efficiently? How can results from studies of work be transformed into useful knowledge, from both user and systems designer perspective in larger projects? As I see it, this is the research area where there is most left to be accomplished. Unfortunately, technology does not solve these problems.
Acknowledgements

First, I want to thank the head of our department, Professor Bengt Sandblad who kindly introduced me to the intricacies of work analysis and design.

I have been fortunate to work with and meet a number of great people during my years as a PhD student. Else Nygren was a great source of inspiration in the initial work on guidelines and design. The collaboration with Erik Borälv and Bengt Göransson in the Helios project was very stimulating and a lot of fun. Many of the following workplace studies were performed in collaborating with colleagues at CMD, for instance Mats Lind, Magnus Lif, and Anders Jansson. Your support in the work was much appreciated as well as your pleasant company. Thanks to Niklas Johansson who worked late with me on the completion of the paper concluding the participatory design process that have evolved through the years, initially at CMD and later at the HCI department.

My warmest thanks go to the people in the MMSÄK and SÄSAM projects for stimulating work through the years, Claes Källström and his group at SSPA, Christer Bergquist at Kalmar Maritime Academy, and Eric Wagner, MSI Design. Further, I want to express my gratitude to Clas Norrstrand at Light Craft Design Group, who provided access to many ferry companies. I am also in debt to Stefan Seipel at our department who made the set-up of the initial augmented reality-prototype in collaboration with Claudio Mihel.

In particular, I want to express my appreciation to all those that willingly and patiently exposed themselves to field studies, interviews, and evaluations in our lab, and made my work so easy and delightful. Some of the workplaces I studied were the specialists in dentistry in Uppsala, the Medical Products Agency, the Swedish National Tax Board (RSV), train drivers at The Swedish Rail Company (SJ AB), and a number of crews working for different ferry operators in Sweden, Norway, the Irish Sea, and in Hong Kong.

A number of people provided us with information in their much appreciated participation in design sessions of work, for instance drivers from A-train AB, SJ AB, and Citypendeln, teachers and captains at Kalmar Maritime Academy, Stefan Blomquist from our department and Torsten Sandbäck from Enea-Redina AB.
I also want to thank my discussion partners at the department; sad to say we never worked together, but your warm support has been essential to my well-being, thank you, Inger Boivie and Jenny Persson.

This work was financially supported by Banverket, the Swedish National Board for Industrial and Technical Development (NUTEK), the Swedish Council for Work Life Research (RALF), the Swedish Tax Authority (RSV), the Foundation of Technology Transfer (Teknikbrostiftelsen) and, finally, Swedish Agency for Innovation Systems (VINNOVA).

To conclude, I want to express my gratitude to my supervisor Jan Gulliksen who entered late in the process but kindly spent more time and effort than anyone could ask for, and likewise my ever so encouraging assistant supervisor Carl Åborg.

Writing a thesis is just the last, chaotic, step of a long journey. As I look back, I see all the warm memories of the many persons that shared this journey with me. To all of them I am indebted.
Design av arbetsstödjande system – för och med användare

Datoranvändare drabbas ofta av dåligt designade datorstöd som hindrar dem från att arbeta effektivt och på ett tillfredsställande sätt. Sådana förhållanden har framkommit vid observationer av användare som arbetar, i intervjuer med användare, vid utvärdering av datorsystem och i ett stort antal publicerade forskningsrapporter där system med låg användbarhet döms ut redan vid driftsättning.

De som verkligen vet vad ett arbete innebär och vad dess egentliga beståndsdelar är kallar vi i dagligt tal för användare. De användare som vi har studerat är skickliga i sitt arbete, specialister på detta, och de som utvecklar system är duktiga på systemutveckling. Av naturliga skäl har dessa två grupper har ofta liten kunskap och förståelse för varandras respektive världar, och deras språkbruk är också ganska olika.

När ett nytt system ska utvecklas konfronteras ofta användare med beskrivningar (representationer) av sitt arbete som de inte känner igen. Dessa beskrivningar har ofta konstruerats av systemdesigners som vill beskriva arbetet på ett förenklat sätt som passar som underlag för systemutveckling. Följaktligen är det svårt för användare att med ett sådant underlag förutse vilka konsekvenser ett färdigt system kommer att ha för den framtida arbets situationen, eftersom dessa beskrivningar är tagna ur sitt sammanhang och ofta beskriver arbete på ett fragmenterat och onaturligt sätt. Användare som förutsätts i en sådan situation kan av naturliga skäl bli mindre benägna att delta i ett förestående designarbete.

Vår forskning är helt och hållet förankrad i ett arbetslivssammanhang där nyttoeffekten för enskilda individer och organisationer har en hög prioritet. Den här avhandlingen presenterar därför forskning som genomförs med syftet att öka användbarheten av datorsystem i arbetslivet och att utforska de omständigheter som förenklar design av system som verklig stöder användares arbete. Forskningen omfattar fältstudier i olika arbetsområden, t.ex. inom sjukvård, tandvård, en statlig myndighet och inom transportväsendet.
Information om det som är viktigt i arbetet har samlats in och analyserats för att undersöka hur den sortens information kan användas i design av nya system. Vid en analys av en arbets situat i bör man alltid ha ett helhetsperspektiv, dvs. att man inte bara identifierar enskilda arbetsuppgifter som utförs i ett befintligt system, utan att man betraktar förutsättningar i omvärlden som också påverkar arbetsuppgiften. Här inkluderas även krav från omgivande organisation, kolleger man samarbetar med liksom förutsättningar i form av skiftande kompetensnivåer.

Ytterligare en viktig aspekt att ta hänsyn till är möjligheter till förändring. Det är viktigt att dåliga arbetsförhållanden och en olämplig organisationsstruktur inte konserveras i ett nytt system. Här är det också viktigt att användare medverkar och får möjlighet att både diskutera nuvarande arbetsrutiner och hur dessa kan förbättras i harmoni med ett framtidigt datorstöd. I detta sammanhang bör man naturligtvis också försäkra sig om att de kvaliteter i ett arbete som gör det intressant och omväxlande också tas tillvara i ett nyutvecklat system. I annat fall kan det framtidiga arbetet lätt bli rutinartat och utarmat, och att sådana arbeten kan öka stress och leda till ohälsa av olika slag har tidigare konstaterats i arbetslivsforskning.

För att utveckla bra arbetstödande system krävs en djup kunskap om vad det specifika arbetet innebär, men det är inte tillräckligt. Införandet av ett nytt system innebär alltid en förändring av det nuvarande arbetssättet. För att både fanga det väsentliga i dagens arbete och utforska hur ett framtidigt arbete kan komma att utformas krävs det att användare deltar aktiv under hela systemutvecklingsprocessen. Ytterligare ett mål med forskningen har varit att utforska hur användares erfarenheter och skicklighet i sitt arbete kan komma till nytta i utvecklingen av system som är bättre anpassade till deras verksamhet. De viktigaste resultaten i avhandlingen berörs därför användarmedverkan i systemutvecklingsprocessen, och viktiga hänsyn som måste tas för att användare ska kunna delta på ett bra sätt och framför allt kunna påverka sin framtidiga arbetssituation.

Under arbetets gång, och parallellt med min växande medvetenhet om hur viktigt det är med aktiv användarmedverkan, har en process som omfattar användarmedverkan i tidig analys och design utvecklats.
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A doctoral dissertation from the Faculty of Science and Technology, Uppsala University, is usually a summary of a number of papers. A few copies of the complete dissertation are kept at major Swedish research libraries, while the summary alone is distributed internationally through the series *Comprehensive Summaries of Uppsala Dissertations from the Faculty of Science and Technology*. (Prior to October, 1993, the series was published under the title “Comprehensive Summaries of Uppsala Dissertations from the Faculty of Science”.)