# A participatory process supporting design of future work

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## ABSTRACT

This paper illustrates how a participatory design process has developed as a result of empirical studies with workers. The view on design as a process presented here necessitates an explicit analysis of work where both workers and designers participate. The analysis gives workers a possibility to reflect on present and future work practices and to evaluate effects in advance. Moreover, it provides designers insights that facilitate design of support systems that match work complexity. It has often been argued that the full potential of a new IT-support system is not reached, but that only old work procedures are preserved. It is one of the purposes of our work re-design process to support creative changes of different nature. To ascertain that the complexity of work is acknowledged and that work redesign is enabled in the design process, we recommend that workers participate to a much higher degree than present.

During a number of projects this process has successively developed. In this paper, the process is described, together with a selection of cases where it has been applied. Important experiences are the need for extensive user participation in the design process and the time and resources the process must be given.

## KEYWORDS

Participatory design, user involvement, the design process, work process design

## 1. INTRODUCTION

Our research is performed in working life. The people who use technology in their work are affected by and often become dependent on a computer support system to achieve their tasks in an efficient way. A usability professional's first priority must be to facilitate their work, so that they can avoid stress and maintain efficiency, satisfaction and health. Such concerns involve not only the tasks assigned to an individual worker but are indeed related to the surrounding organization as well.

The participatory work design process suggested and described in this paper should be carried out in the very beginning of the development of computer support systems. Design is often understood as the complete software development process [21], but the participatory design process described here finishes with descriptions of future work often accompanied by design sketches and interactive prototypes. Besides improved work, the process focuses on increased efficiency; a goal shared by the workers[1], who often suffer from inefficient support systems.

### 1.1 Work tasks and responsibilities are changing

In many respects, work has changed in the last decades. For instance, simple administrative jobs, traditionally considered undemanding, have become obsolete due to automation by computerization and more recently because tasks have been made available to the general public for self service, performing e.g. bank matters, travel arrangements and shopping on the Internet. Administrators are often required to think on their own feet without instructions from above, rapid and often complex decions are required. Due to the flat organizations, there is no manager to ask for advice. Responsibilities have increased but sometimes the authority and the means to carry things out have not developed at the same pace. Our research has frequently taken place in organizations that have been affected by such changes.

The work environments analyzed in the case studies reported here, have not been selected because of their particular qualities. All the same, they share characteristics such as a high degree of responsibility placed on the individual worker, who has to make decisions that affect other people, sometimes even their lives, and the life of hundreds of others as is the case with train drivers for instance. Work in particular is also characterized by its demands on flexibility; in such environments, people must handle several tasks in parallel, which raise demands on concurrent information and non-sequential systems. In our experience, interruptions by colleagues and customers are frequent, along with deviations from the expected as observed by Sachs [30], and various kinds of problems that are bound to occur.

Designing new systems adapted to organizations and work in change is a challenge. Through our experience from design work in a number of applied projects a participatory design process has developed. We agree with Bødker & Iversen [10] who argued that designers need time for reflection to develop their

[1] Through this paper we have decided to use Vicente's [34, p. 10] definition of workers as "the people who participate in and act in a sociotechnical system", rather than more general terms as e.g. "users" or "operators", since the application domains exemplified are associated with the service sector as well as the industrial sector.

participatory work practices. Initially, quality time must also be spent on aquiring knowledge of the work domain, and to establish a common ground in terms of shared knowledge and a better understanding of the work context between the parties involved. Thus, the design process described here includes time for reflection on current work practices, on organization as well as job redesign and development of future support systems, *for workers as well as designers*. Furthermore, the process requires a new perspective on workers and respect for their skills, in line with Bannon's [1] description of workers in terms of active and controlling people with underlying values and motivation in the work setting. The workers are the central actors in working life; consequently, we argue that they should have a key position in development of new support systems that are to become their tools and a part of their work practice.

## 2. SOURCES OF INSPIRATION

Our participatory design process has been refined through empirical work in research projects for a long time. Inevitably, our conception of the process has been inspired by previous work in this area; the most important will be outlined next.

### 2.1 Designing work

Greenbaum and Kyng [17] were optimistic about the progress made in the area of work design since the workers and the designers had started to learn more about each other's work and actions at work places. Both professions have developed since then and unfortunately, present demands on e.g. efficiency and keeping delivery dates seem to diminish this predicted increase in understanding and cooperation. Worker participation seems to be an activity that suffers from these conditions.

The initiative started as an attempt to empower labor, fighting against management's introduction of computer supports that were unfit in terms of considering and reinforcing their skills. The approach has been referred to as the Scandinavian challenge [4].

### 2.2 The Utopia project

Early work on cooperative design in the Utopia project [9] indicated that workers could specify systems requirement based on their interests and goals [3]. The project has had a decisive influence on how workers are regarded and involved in the design of computer systems for the workplace. Although, research projects practicing participatory design are more frequent than corresponding commercial projects.

### 2.3 Participatory Design Requirements

To practice participatory design (PD) a number of requirements have to be fulfilled. The degree of participation required is somewhat inspired by different political interest and the existence of strong unions in Scandinavia. Those conditions also influence the language used, e.g. "workers" and "empowerment". Workers must for instance be active participators, but it is not enough:

> *"The focus of PD is not only the improvement of the information system, but also the empowerment of workers so they can codetermine the development of the information system and of their workplace." [14]*

Kensing [25] formulated the following undoubtedly politically inspired basic requirements on PD:

- Employees must have access to relevant information (interpreted as organizational and decision making information by the authors).
- Employees must have the possibility to take an independent position on problems.
- Employees must participate in the process of decision making.

The political perspective on PD has decreased. Spinuzzi [32] means that PD has shifted from *democratic empowerment* to *functional empowerment*. These concepts were introduced by Clement [13] as a way to differentiate between a focus on the organization's goals and improved performance from the organizational horizon (functional empowerment), in contrast to the democratic empowerment where workers were encouraged to achieve greater control over their lives, their rights and abilities to participate as equals in decisions that affected themselves. Today PD is primarily considered an approach that can inspire and encourage a worker perspective where workers are regarded as central actors in development teams.

The success of PD initiatives has been reported [9, 16] but the long-term viability and continuation of local self-sustaining processes of participation has been harder to accomplish. Clement & Besselaar [14] found that the attention to active worker involvement ended when the initiators left upon project completion. Their follow up study on ten PD projects uncovered that the discontinued PD activities were explained by the short-term focus of the projects and that resources for PD were directly withdrawn when the projects finished.

### 2.4 Context awareness contribute to design

The importance of context awareness or domain knowledge for design has been emphasized in our earlier research [18, 29]. Contextual design including contextual inquiry [2] is an established method for rapid gathering of contextual information, mainly adapted to product development. In line with contextual design, our design process very much aims at enhancing the tools people use at work, but we advocate worker involvement in the design process and redesign of work processes as well to enable them to perform better. Contrary to the assumptions behind contextual inquiry and design [2] where systems are developed for a market, our research concern in-house development of systems where workers are relatively well defined. Moreover, although these workers perform their work on their own most of the time, they communicate and exchange information with their colleagues, and with their awareness of the overall picture, they offer important contributions to the design process.

## 3. INVOLVING WORKERS IN THE DESIGN PROCESS

### 3.1 Our core values

Research projects carried out in working life as those described below are often a joint initiative between an industrial assigner and usability researchers. The objective from the assigner's point of view has sometimes been understood as an initiative to "make over" a computer support system, roughly, to deliver a new user interface to an old system. However, when workplaces are studied in collaboration with workers, a remake of the user interface has never seemed to be a plausible solution to existing problems. On the contrary, the need for job redesign and organizational changes are often significant.

Our core values, or the goals we have elaborated on, are derived from a perspective on workers as skilled and motivated. Furthermore, they are often experienced and knowledgeable; therefore, their participation in change and development work is essential. Experience from the projects reported on below shows that if workers obtain respect and appreciation for their knowledge, the significance of their contributions increases.

### 3.2 Knowledge acquisition with workers

Structured methods have been criticized for not functioning, that they omit too much, and that they are too technically oriented [12]. The decision to adopt structured development processes within an organization is based on other reasons than a concern about users and usability [5]; perceived control over time and resources has become more important. It has also been suggested that the inherent steps and measures may become more important than the contents and the usability of the software when relying too heavily on structured methods [19]. They may thus become a means to certify that *something* will come out of the process rather than something *usable.*

The complex pattern of a workplace needs to be understood by all involved in the design process, but it is not easily described in block diagrams and schemata. In the early work analysis and design, we prefer to focus on a description of the work related contents revealed by the design process understandable by workers and designers alike, rather than relying on a structured method where workers encounter an unfamiliar view on their own work that they do not understand. It is easy to anticipate how the completely new terminology workers otherwise may meet, including process models, use cases and so on, may make them feel uncertain [28]. In addition, the groups work best when usability professionals act as facilitators [8] of the design process, rather than someone who controls the pace and progress at the expense of quality and commitment.

### 3.3 Possible ways to get lost in user involvement

User involvement may go wrong for a number of reasons, possibly related to misconceptions of practical methods for involvement and false expectations on the immediate results. Well-known problems in requirement elicitation and analysis are continuously repeated. Allegedly users:

- Do not know the requirements

- Cannot articulate the requirements even if they know them
- Change their minds
- Say different things to different people
- Disagree about joint requirements
- Do not represent real users

The statements above are occasionally regarded as universal facts, and are used as arguments against involving users in design. User participation in the design process has also been questioned on the grounds of the users' inexperience and consequently less creative solutions e.g. [35]. They are moreover accused of being unable to free themselves from present work practices; therefore, they are considered less liable to generate innovative ideas on work and new systems that could make them more effective.

Woolgar reminds us that we need to become aware of the nature of these problems and our reactions to them, and the prevailing assumption that "actual requirements pre-exists our efforts to capture them" [36, p.203]. Obviously, requirements do not exist "out there". If users are asked about future requirements without envisioning activities and time for reflection on their own, they probably will perpetuate prevalent practices into the future system. What's more, if user communication is initiated with questions like, "How do you want to work in the future? How would you like the new system to support that work?" and so on, the users will not be able to deliver constructive answers. Their replies will be of limited use to developers, and subsequently both parties will end up frustrated. Users need time for reflection and hands-on activities that include both actual and future work practices. Such activities are discussed further down in the paper.

We recommend active involvement of users in the design process, which also involves prototyping, and creation of mock-ups. However, we do not recommend that users spend time on development of prototypes contrary to what has been recommended by e.g. Ehn & Kyng [15] simply because such practices turn out to be ineffective. Even though users are professionals in terms of their computer support systems, in our experience they are seldom knowledgeable in design tools and programming languages. The threshold to acquire even basic knowledge in this area is high, and users who have to spend time and effort on learning design tools may lose focus on their profession and the possibilities for development and increased skill in that area. In our research, designers have therefore been responsible for visualization and implementation of the design, but it is carried out in close cooperation with users.

Furthermore, users should not be restricted in their innovative thinking by technical constraints. Kristensson et.al. [26] have shown that users that identify with developers and take on their perspective, run the risk of damaging their creativity. They think more about feasible solutions with a particular technical solution, than desirable solutions.

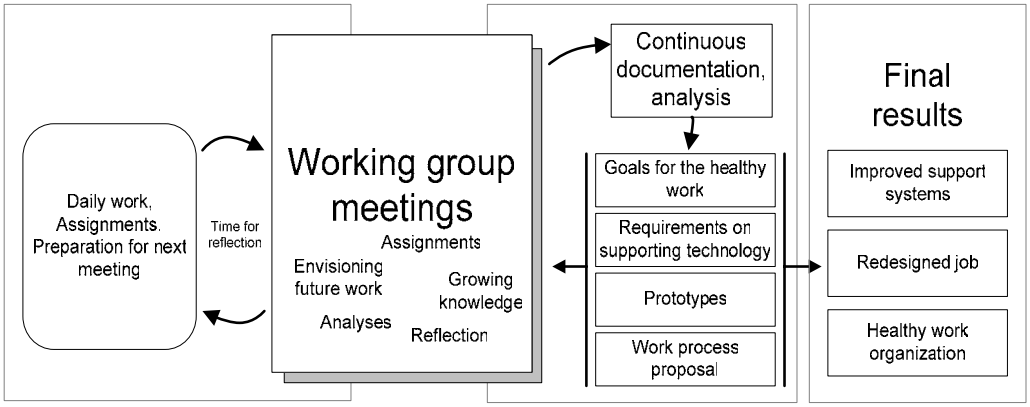
To conclude, the resulting assumption in an organization must not be to shut out users from the design process. We claim that the arguments against user participation above are misleading in important ways and a better understanding of users in this situation give directions to attitudes and methods needed instead.

## 4. THE DESIGN PROCESS

Next, the participatory design process will be outlined. The objective of the process is to provide the foundation for a sustainable organization of work, redesigned jobs, and a support system that enhance the workers' skills. The process does not finish with a developed support system, but the results may be used as prerequisites for the final design. The most important achievements are the thoroughly explored views on future work, from the individual worker's, to the organization's perspective.

The design process presented here has developed and matured during several years of research in a number of projects, and will most likely continue to do so. The process has developed from a focus on the visual results, to attitudes towards participation, perspectives on workers as skilled professionals, and an awareness of the need for work redesign in processes of change. Complicated schematic visualization of the workers' work processes within a workplace has thus been abandoned. Instead the present participatory design process pays attention to the essentials of work, what work is really about, how work can be improved to enhance possibilities for users to maintain and increase their skills, how future needs can be dealt with, and finally how needs on collaboration can be handled.

The design process including themes for working group meetings, goals, results, and documentation is visualized in figure 1. The purpose of the process is not to deliver a step-by-step instruction with a fixed implementation or static approach. Even though the process is not definite or prescriptive in terms of methods and steps, it requires continuous user involvement to a high degree under all conditions, in line with previous suggestions on PD [17].




**Figur 1** Iterative working group meetings. A shared knowledge base develops throughout the participatory design process where time for reflection is included.

Every workplace is special and consequently has special needs, the process must be adapted to the workplace, and the people involved. Sensitivity and flexibility is required in the application of the process. Finally, it has to be treated as a guide and source of inspiration while it still evolves.

### 4.1 Analyzing current work

All our research projects including participatory work have always been initiated through field studies, participatory observations, and open interviews. Field studies including observation of workers are an important prerequisite to design of support systems. Without field studies uninformed systems designers may draw attention to unimportant issues, draw false conclusions, and lead the work in an inappropriate direction. As a result, discussions with workers run the risk of becoming inefficient. Field studies have previously been suggested as a method for information gathering [2], but the subsequent involvement of active workers in the design process has not been seen as equally essential.

### 4.2 Setting up working groups

Implementation of usability methods requires commitment and support from all levels in the organizational hierarchy. A condition for success is that management is responsible for initiating change activities and acknowledges the results.

In our experience, workers representing different parts of an organization may have to participate in the design process to make sure that e.g. problems concerning shared information, communication, and misconceptions related to such areas are resolved. There is often a need for thorough work with participants from particular parts of the organization. Therefore, different working groups may have to be formed. Management may also have a different view of the work performed and the inherent goals involved in the work and such aspects need to be considered too in the design process. Although, management should not participate in working groups as it may restrain the desired frank and open climate. The participants in the working group must be carefully selected, a positive atmosphere where all are encouraged to participate and where all opinions matter is necessary.

### 4.3 Working group meetings

A number of meetings are held with a few weeks in between each meeting. To facilitate the discussions and to prepare the participants, an assignment is often given ahead of the next meeting. The assignments are often related to how things work and why. The participants are encouraged to seek information and viewpoints from colleagues when completing the assignments. The time between the meetings gives the participants opportunity for reflection and accomplishing assignments. Gained experiences may thus unconsciously mature and inspire new ideas.

Every meeting has a theme, e.g. “Organization”, “Technology” and “Information and communication”. The working group discusses their work from different perspectives, the organization at their workplace, communication, skills, collaboration and so on. Inspiration in the form of new knowledge on interesting topics e.g. organization, ethics, and new technology is provided by internal or external lecturers. This puts the participants in a better position to perform critical evaluations, creative thinking and to identify and propose solutions to problems at their own workplace.

Someone must conduct the meetings, but it does not have to be the same person at all meetings. Workers may equally well lead meetings as designers. Participants should also work in different settings from time to time, in groups and in pairs, to

avoid team building within the working group. It is often practical two have two designers present, to smooth the progress of work, and to document the activities properly. Finally, the atmosphere at the design sessions must be open and allowing, different opinions and critique must absolutely be welcome.

### 4.4 Thorough analysis of present work

The aim of the thorough analysis is to document present work, tasks, cooperation, and workers' skills; it extends through a number of working group meetings. Present conditions are investigated initially. Skilled people easily describe the work they are involved with at present, what works well, and what does not. Rather than making a list of a number of tasks that workers make up, descriptions such as "a day at work" capture the essentials of work. In order to get an overview of the present work situation the group might discuss questions like the following:

- What do you consider most important in your work?
- What do you like most in your work?
- What work do you do really well?
- What are your qualifications?
- What does good quality mean in your work?
- Is the quality of your work insufficient in any way?
- Which technical systems do you use? For what purpose?
- Which information do you use in your work? For what purpose? Where? When? How?
- With which people do you communicate? What matters do you discuss? How? Why?

When collaboration is considered, the complexity of the work routines at a workplace becomes evident. Such aspects easily remain concealed if work is regarded as a set of individual tasks that have to be managed.

From time to time, the working group has to elevate itself from the present level, and take on an outsider's perspective on their own work. People from different levels in the organizational hierarchy may also be engaged to develop their views on e.g. goals, their individual goals, colleagues', managements' and finally the organization's business goals. A constructive exercise is to let the workers put themselves in a position that differs from their daily work and start to think about changes from that perspective. Questions and topics discussed in such exercises are for example:

- How do you think your organization works?
- How do you think your manager thinks it works?
- How does the manager think it works?
- If this was my company and I was the manager, I would change the following things.

Exercises like these are bound to reveal how perspectives differ within an organization depending on the roles people have, and these differences may give rise to demands on e.g. a future support system.

## 4.5 Envisioning future work

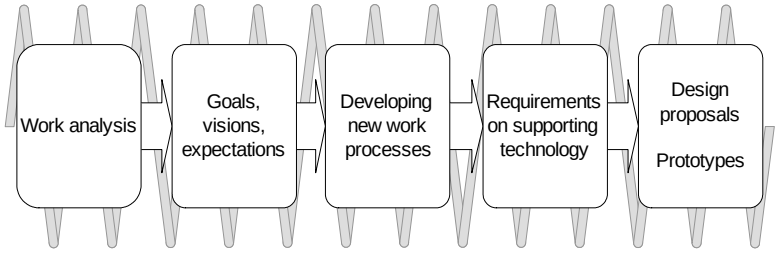
Future work is to a certain degree determined by for instance organizational goals, stipulated policies, technical constraints and possibilities, regulating laws and economic constraints. For example, from governmental authorities' decisions on nursing homes for the elderly, it can be assumed that patients depending on the home health care services will stay in their own homes much longer in the future. Taken together, such contextual factors determine the degrees of freedom for changes in work procedures etc.

Requirements on change develop from the group discussions about present practices, problems, goals, and possibilities. The vision seminars are performed in order to envision future possibilities of changes to work organization as well as practices. The inherent goal is a more efficient, stimulating and sustainable work. The aspects that must be addressed at the vision seminars are:

- Work practices
- Work processes
- Work organization
- Work environment
- Technology used for support systems

A few rhetorical activities may be utilized in the visionary work to encourage creativity and commitment of the workers. For instance, by reasoning about barriers that hinder workers from perform their best and enjoy their work the barriers can be identified. The working group needs to discuss what the differences are between the examples of an ideal day at work, that they have envisioned, and the present situation. What are the barriers in terms of e.g. work schedules, system support and economy, that stop them from accomplishing a more ideal situation? When these discussions take place, the involved parties often discover that fewer barriers than they think hinder them from achieving what they wish. The discussions can be stimulated by asking questions like: "How would you organize things if it was your own company?" or "How would you manage the team if you were the boss?" Barriers often exist only in their heads and sit in the company walls. An organization might become inflexible because many of its members believe that it is rigid and promote that to be the truth. From here on the discussions may continue and the members of the working group strive to find out how, in their eyes, the optimal future organization could be formed.

The examined alterations can concern anything from individual competencies and skills, to work routines, and organization. The results can indicate requirements on support systems, and other aspects of future work, and provide a future perspective on the workplace as a whole. The results achieved are summarized and the outcome of the process is a shared understanding of the actual work practices together with a proposal of future work processes (see figure 2).




**Figur 2** The participatory design process. The working group meetings including e.g. analysis, goal formulation, expectations analysis, and envisioning future work, results in proposals on new work processes, support systems and organizational change. The proposals are accompanied by design proposals and prototypes.

More precisely, we have most often tried to structure the work in the following steps:

- *Goals for the future work situation*, needed to achieve a more "ideal" situation, are specified.
- A summary of *factors in the present work situation that should be changed* in order to achieve the stated goals is produced.
- The *result of the "vision seminars"* is documented, i.e. possibilities and limitations for the future work situation. Here the time horizon for the future situation is specified, e.g. "in 2 years" or "in 5 years.
- *Important aspects of the future work situation*. I.e. what do we want to achieve, what should characterize our organization and our future work procedures?
- Specification of more elaborated *scenarios* describing the future work. These can be made very concrete, in form of stories of "one day at work". The scenarios should be as complete as possible, so that all relevant aspects of how work is performed are included.
- Important parts of the scenarios can now be described in terms of *activity specifications*. This is a more formally description of what tasks that are performed, which information is used and produced, how persons communicate etc.
- Based on these scenarios and the activity specifications, we can summaries the *information and communication needs* of the future work procedures.
- If needed, and this is often important in order to make things concrete and understandable for the involved workers, preliminary *sketches of new IT-support systems* can be produced. These roughly designed IT-support systems are now based on rather detailed descriptions of the proposed future work settings. Even if they are not designed in a more traditional sense, they have shown to be very useful if and when a systems development project is initiated as a result of this process.

## 4.6 Documentation and peripheral research work

Each meeting is carefully documented. The documentation is informally evaluated and revised by all participants after each meeting as a reminder of the previous

meeting. Misunderstandings are adjusted and emerging opinions are sometimes added. The researchers write and read the documentations in order to make conclusions, do reflections and to refine the knowledge about the organization.

The result accumulates through several iterations, all thoroughly treated in the working group meetings. After a number of meetings, opportunities are given to define goals, visions, and expectations of the desired good and sustainable work. Based on these results, new work practices can be defined and proposed.

### 4.7 Moving on to implementation

An advantage of the participatory design process, compared to traditional requirements engineering, is the collected domain knowledge that provide the participants a common ground [11] in the following work, awareness that is vital when people take part in joint activities. The designers who have participated in the design process must accordingly be involved in the design of the support system; otherwise, the result from the design process may be difficult to transpose to a system design. When the desired future way of work has stabilized in the working group, the user centered systems development project can start as suggested in [22].

## 5. CASES THAT ILLUSTRATE THE PROCESS DEVELOPMENT

To provide examples of the different workplaces where the participatory design process has been applied and developed, a few cases will be outlined next. The cases are all performed in working life, where complex support systems are needed, even though the workplaces are quite different to their nature.

### 5.1 The Daisy project

In the Daisy project, performed during three years from 1986 until 1988, the objective was to develop work organizations and prototypes for computer support systems for future work in different types of health care units, such as e.g. the doctor's office, outpatient clinics and primary care units. The reason for initiating the project was experiences from numerous earlier projects where large efforts and money had been invested in development projects without the expected outcome. The reasons for the failure of the earlier projects were many. One reason was the fact that technical support systems were developed separated from work organization, resulting in technology not coordinated with the present or the future work organization. Another reason was the difficulties to formulate technical requirements that were both relevant for the intended use and innovative enough to improve conditions for the health care professionals substantially. A third reason was the difficulties to design efficient user interfaces, since the specifications of the future work processes were not detailed enough.

In order to achieve better result, some important prerequisites were formulated. Among these were e.g. that work organization and design of computer support systems should be considered simultaneously, that a user centred development model should be used throughout the whole project and that future work organization, work processes and computer support systems should not only be

specified in terms of requirements but also visualized in a form that allowed practical evaluation.

A work group was established that consisted of four health care professionals, a physician, a nurse, an assistant nurse and a physician's secretary. They were employed by the project on a half time basis for one year. Together with these some work organization, computer support and usability experts were also engaged in the work. A massive resource was thus invested in the project, but it was motivated with respect to the enormous costs that the previous, failing projects had resulted in. The goal was first to develop important knowledge that could be used as a basis for several future development projects, aiming at improving health care organizations by introducing useful and efficient computer support systems, and secondly to develop some more specific prototype work situations and computer support systems.

The Daisy project started by analysing the present work situations, by inviting different experts with knowledge in the field and by visiting and analysing earlier development projects, both of a more and less successful nature. When the competencies to describe and analyse health care work settings and earlier development projects had been created in the project group, the process to develop future solutions was initiated. The proposed work organizations, work processes, specification of activities, information systems and technical support systems were step by step formulated, first in terms of verbal descriptions and simple sketches, later in terms of full scale prototypes. In the end we even built the actual local settings, developed complete scenarios for the proposed future solutions, produced professional videos of these scenarios and developed functional prototypes of the proposed computer support systems. These were tested and evaluated both by the project group and by independent health care professionals.

The result of the Daisy project have been extensively used by several later development projects as a reference model, both concerning work organization, specification of work processes and design of technical support systems.

## 5.2 The FTTS project

The FTTS project [31] concerns the specification of work organization, control principles and user interfaces for future train traffic control. The project was performed during 1998-2003 in cooperation between the Dept. of IT/HCI, Uppsala University, and the Swedish National Rail Administration. The objectives were both to develop basic knowledge for the Rail Administration in their future development activities and to develop prototype systems for future control systems and user interfaces. Some of the more important and unique features will be shortly discussed.

The initial phase of the project comprised a detailed analysis and description of the present work within the train traffic control organization. This was performed as a set of observation interviews. The goal for this was to give the external project members a chance to gain more insight into the actual work processes, but also to make a map of the basic cognitive models and control strategies of the traffic control operators (dispatchers).

The project was then carried out by an active work group consisting of six experiences dispatchers together with some usability and design experts. The group was intact and active for several years, with regular one-day meetings every month. During the time gap between group meetings, the design experts analysed and prepared information and prototypes and the dispatchers further developed and evaluated the ideas about future work processes and technical support systems.

The work in the project group has covered aspects such as problems in present work situation, visions and prerequisites for future organization and work processes, details in future organization and solutions such as work organization, room design, control strategies, information systems, decision support, user interfaces etc. We will only describe some specific results that probably would not have been reached without this work model.

In the beginning, the work focused on improving the fragmented user interfaces by information integration and enhanced visualisation. During this work, and based on the earlier mapping of cognitive strategies, we understood that the information the dispatchers really used in the control process was not included in the present system. They based their decisions on dynamic prognoses of the trains' behaviour, but the available information was old static data about occupation of track segments. They had to mentally create the information they needed from available information, something that was extremely cognitive demanding and required years of training. When we proposed new systems, where all decision relevant information was simultaneously presented, they could understand the present dynamic traffic situation much faster and save their cognitive capacity for advanced problem solving.

Today the control tasks are completely focused on the control of the technical infrastructure, and we started to develop more efficient systems to support such tasks. When we together analysed how they were using the proposed new systems, we slowly realised that they actually did not aim at controlling the technical infrastructure, even if this was what the control system allowed. The ultimate goal was to define traffic plans for the trains which were optimal for each train in the given context. This indicated that what they really needed was to identify upcoming conflicts, to find optimal solutions by real time re-planning of each trains traffic plan, and to execute these plans. When we now radically changed the information presentation and included support for re-planning in the user interface, we found that in most cases the plan could also easily be automatically executed. In this way we had created a completely new paradigm for train traffic control: control by re-planning in real time. The new train planners continuously are in control of the dynamic development of the traffic process, they are supported to detect upcoming conflicts and disturbances early, they can re-plan each train to obtain an optimal traffic plan and this plan is in time automatically executed. The technical control of the infrastructure has been transformed into a planning process for the traffic units.

The new control paradigm also made it necessary to develop the communication between the traffic control centre and the train drivers, since they must be made aware of the new traffic plans and the dynamic development of the surrounding traffic.

We have also developed an experimental environment, where the new solutions can be tested in a simulated environment. The Swedish National Rail Administration is now in the process to implement these new control strategies and support systems in an operative environment.

## 5.3 The TRAIN Project

The TRAIN-project [24] that went on for three years has provided a multi-disciplinary investigation of train drivers work environment by using task and ergonomic analyses, usability evaluation of the automatic train protection system and analyses of stress, mental workload and work hours. The knowledge gathered has been a resource when developing an understanding of the drivers' various actions and activities. A common ground among drivers and researchers has thus been established.

In the final phase of the project, participatory design work was carried out. Six drivers worked together with two researchers to design an executable prototype of a train drivers future cab interface. The framework for the group was that the infrastructure and related signaling system would change in the future, it would thus be possible to obtain more information inside the cabin, but the details were not specified. The group spent eight days on the work over two months, with assignments to perform in between. The group analyzed experiences from the present system, situations in which the system was hindering an optimal performance, future goals, and visions of how a future system would support their natural way of working.

None of the drivers had previous experience of activities connected to work task development, user interface design, or evaluation. In spite of this, they quickly adapted to the new situation and soon reflected on low-level issues concerning design, such as precedence of different kinds of information and information density on the display, as well as high-level issues, such as how to preserve driver skills with a new support system enabling automation and supervision of the driver's actions. Most of the discussions concerned having correct information to sustain high quality situation awareness, thus being able to predict what would happen on the track ahead of the train. Yet another concern was the matter of how to help the driver to stay alert in a future more automated driver environment and how to avoid automation that forces the driver "out of the loop".

Rapid prototyping is good for gathering and visualizing functional requirements. Intuitively you may think that abstract requirements, such as how to maintain the train driver's skill in the new system, are more difficult to visualize. However, the discussions in the driver group made obvious that such aspects have consequences for how work is performed, and how corresponding information may be presented in the interface. It is thus possible to evaluate those aspects too in a prototype.

The resulting interface design has recently been implemented in a simulator and is at present evaluated by other train drivers.

## 5.4 The RSV cooperation

We have been cooperating with the Swedish National Tax Board now for well over ten years with the purpose of enhancing the usability of the computer systems developed for internal use by the case administrators within the organization. Initially we were consulted for traditional expert usability evaluations, typically when it was too late to enforce any changes in the system. But, as the maturity within the organization grew, we were allowed in much earlier in the projects and also allowed to develop methods, processes and strategic support for usability and user centered systems design in all development work.

The tax board has an in-house development organization and as most big public authorities in Sweden, they have extensive experience of user involvement in development work. The user involvement typically takes place in analysis and evaluation. Design was almost a non-existent phase – the design of the systems merely occurred as the result of an engineering process. Involvement in the construction phase was totally out of the question. But, when analyzing previously performed projects the result of the construction bared few similarities with the specification for the construction. Hence, several crucial design decisions are made during the construction phase, decisions whose quality would benefit from increased user involvement.

In one particular case that took place in the year 2000, we performed collaborative prototyping sessions with users [20], usability designers, and one HCI researcher. In these sessions, the users were the active designers, making decisions that heavily influenced the layout, the interaction, and the organization of the work tasks. One essential part of this process was the role of the usability designer [6], who was in charge of keeping the development process user centered, and document decisions made and communicating the results back to the development project. The overall impression from the user organization and the user representatives participating in the collaborative prototyping was that they performed high quality work and arrived at a result that, if developed, could serve the user group much better than the other designs that had been suggested. However, the design was not implemented as it appeared in the report from the collaborative prototyping sessions. The reasons for this are many, e.g. a crucial decision was made more than halfway through the project to change the technical platform, against all advice, the designs were not adapted to and taking care of the use case models that were developed simultaneously, etc.

Despite the problematic end of that particular project, perhaps the major impact our research has had at the tax board is the definition of the role of the usability designer and the fact that the organization now has employed about 15 usability designers. In addition, even if the organization still has problems when it comes to getting any impact of the usability activities, it is obvious that the organization is aware and cares about these issues.

## 5.5 The VIHO project

The organization for care of the elderly in Kortedala, a local community of Gothenburg in Sweden, has been phasing strained economic budgets, as the population is getting older. Because of this, they have started to look for efficiency

gains made possible by proposed new technology. Test activities have been initiated to compare different available computer support systems.

The community decrees a forthcoming change of organization and work that aims at supporting the following objectives:

- to let elderly people stay in their own home longer, rather than being referred to institutional care
- to increase safety for elderly people who stay in their homes
- to maintain present levels of service, despite decreasing budgets

The main research objective for the VIHO project (Efficient Computer Support in Care for the Elderly) was to investigate how the organization of a home-help service can develop in order to be prepared for the increased demands on service. This means that the VIHO project is a prerequisite for formulation of requirements for other more technically oriented IT-development projects.

We looked into the home help personnel's need for support and investigated how the new organization should be shaped to meet the new requirements. A supporting computer system was early suggested by the assigners, but according to the proposed process we kept focusing on the essentials of the work and how the work could be improved in the future, before doing any design proposals.

Personnel in the home-help service naturally need to be highly mobile. On the way to their patients, they are in contact with nurses, doctors, relatives, colleagues, pharmacies, etc. and they always need up-to-date information. A plan for a day's round does rarely stay intact. A patient might need special care one day or there might for example be an immediate shortage of drugs. Several documents are in use. The most important and sensitive documents must be carried along, stored in the patient's home, or kept at the home-help service center. This forces the personnel to memorize information until the center is reached next time. Early it became clear that it is essential to have access to correct information, on the right time, at the right place, in the right way. It is also essential to support better planning, better overview, and better evaluation of care compared to present possibilities.

The project's first phase was conducted as a series of ten seminars in a work group with six experienced professionals from the care organization and four researchers. Between the seminars, a few one-day field studies also were carried out at some of the participant's workplaces. The seminar series was performed during a six-month period. The first phase of the project focused on the design of the future work organization and work processes. Focus was first on how today's work is performed. Further on, work led to the formulation of desirable, good and sustainable work.

The results were formulated as "aspects on future work", containing many new solutions. A common theme was the development of local responsibilities and competencies, which resulted in radically improved local planning and evaluation in the care teams. A new work organization was also suggested, where much of the planning and responsibilities were decentralized to the local work teams. In the future, the resources can be used more optimally and the care professionals know

that they perform the appropriate activities in relation to existing demands and available resources.

Personnel in the elderly care sector have very little experiences of technical support systems, but with relevant well-designed technical support, their work could extensively develop. Based on the results from the first phase, a second phase of the project will be conducted, in order to design details of new supporting computer systems.

## 6. DISCUSSION

The participatory design process described in this report aims at considering the present and future work in a comprehensive way and establishing demands on future support systems. In our practical work with the design process, we have in the different working groups focused on the participants work practice today, in the future and how the future work can be organized to run smoother and be facilitated by improved support systems. The design work and the working groups meetings involve people with different professions and with different experiences. The designer that act as facilitator in working groups must also have skills and capability to achieve a positive, open, and allowing climate where participants feel that good results can be accomplished.

The suggested process gives less guidance to inexperienced designers who may benefit from a rigorous method with a step-by-step instruction. Fears might also be expressed that the result is dependent on the individual analyst. However, even more structured and formal methods can easily be misused, and thus produce a more or less unintelligible result. Moreover, what we want to achieve is not one optimal design solution, there is none. We want to find a number of good solutions, visualize, and evaluate them before a system is designed.

We assume a perspective on workers' participation in design that does not fully agree with the perspective assumed by e.g. [15]. We argue that workers should not be forced to learn design tools and waste time on making design solutions of their own. We propose that workers work together with designers on job design and redesign, not user interface design. The primary responsibility for the practical design should be with the designers who are knowledgeable in this area. Negative consequences of such an approach have been discussed since the designer must interpret the workers' intensions and transpose them to the interface design. However, we have considered it more important that workers are given the possibility to focus on their own profession and develop their skills in that area. Any erroneous interpretations on behalf of the designer should be solved in the comprehensive iterative work with the workers.

Kensing & Madsen [25] suggested Future Workshops and metaphorical design as examples of new approaches to stimulate creative visions of future use in organizations. Future Workshops was a technique developed by Jungk & Müllert [23]. The general idea was that the three phases Critique, Fantasy, and Implementation should evoke criticism of current work, visions of future work and finally identify the resources needed to realize the visions. The metaphors would be used to stimulate new perspectives, in particular when people got stuck. Our

approach is similar to the Future Workshops, although the implementation is less formal. The working group meetings where workers discuss present work, identify barriers to good work, debate expectations and visualize future work, are performed in order to bring out the essence of work, while preserving good practices and envisioning future possibilities of changes to work practices as well as organization.

Consequences of the introduction of new computer systems are often neglected, even though their effects on the organization, work activities, and human beings and their skills have been recognized for a long time [27]. In reality, new systems may affect scheduling of work patterns, relocation of work, and reorganization of the structure of the workforce and so on [34]. Beyer & Holtzblatt [2] suggest that it is equally important to reorganize work as to create new systems. Although workers always change their practices in accordance with a new support system, their creativity and preparedness for change is often ignored. Vicente [34] demands flexible systems to support such changes of work that comes about after the introduction of a new system.

The limited perspective on what workers can contribute has been blamed on organizational politics that complicate contacts between workers and designers and thus impede on active worker participation [1]. However, perhaps the primary sources of concern for involved managers on both sides (business/government authority – software engineering) are partly the seemingly unpredictable results and partly the less definite time plan. What will the results be when the design process is finished and how long will it take? Even if these questions often have an ostensibly definite answer when structured methods are applied, the final date is still unpredictable, and the developed systems may very well be unusable.

## 7. CONCLUSIONS

The following rules of thumb have evolved and served as guidelines in the development of the design process illustrated in this paper:

### 7.1 User involvement is required

*Developers cannot develop the system users need without involving users [20].*

There are no success stories describing how experts have developed systems without user involvement. This is simply because it is almost impossible to succeed with such a commission. When experts alone develop systems for users, the systems will not fulfill the actual needs that users have, and they will certainly not facilitate development of work processes. The parties involved in system development, e.g. managers, users, architects, designers, developers etc., all need to develop a common ground and understanding to be successful in their work and to reach their common goal.

### 7.2 Quality time is needed initially

*Design with user involvement is a process that needs time to develop.*

Processes where education and learning are involved require time to prosper and time is exactly what is needed in this work. Time for managers, workers, and

developers alike to learn from each other, listen to narrations of present work, think things through, leave false assumptions behind and develop new visions. Creativity has to be inspired, and that inspiration may come from discussions about present work (what works, and what does not, what is superfluous and so on), and visions of future work (what would we like to do instead).

Designers on their own are in general eager to decide and go to work [7]. It has been proved that time spent early in a project gives more in return than having to fix things in the nearly finished product. Efforts spent on a proper pre-study might prevent dramatic changes in the final product, when cost of changes has grown exponentially, which has often been the case when products turn out to be unusable.

### 7.3 Reflecting on practices and getting out of the box

*It is impossible to elevate oneself from the daily practices and immediately start to produce creative ideas concerning new ways of working. Workers need support to free themselves from their current situation and get an outside view on their work practices, that is, being inspired to out-of-the-box thinking.*

Sachs [30] found that to inspire users to integrate tacit elements of their work into analysis and design, they needed to participate in extensive discussions, collect data, and reflect upon this knowledge. Furthermore, people often work together at a workplace; they are not doing their tasks in a vacuum [33]. For that reason, a good start is to let different workers describe what they do, how they do things and why. Soon they can start to educate each other, misconceptions can be clarified, and a common ground develops. This often results in suggestions on new ways of working together and simplified work practice. The process matters as much as the outcome, in fact it is a pre-requisite for a successful outcome.

For those buried in everyday concerns it takes an effort to open up to new ideas. Therefore, we must support workers with knowledge and sources of inspiration such as alternative ways of working, and if possible good, and positive examples of organizations that function. Workers may need to be informed about applications of new technology, to be inspired and to understand possibilities in light of the technology. However, a degree of sensitivity is recommended here to avoid too much focus on new technology compared to the essentials of work. This has sometimes been the case with PD-initiatives previously [3].

We argue that a few conditions must be fulfilled in order to allow workers to be innovative. They must be heard and respected; they must feel confident that their work matters and those changes are possible to bring about, no matter if they are focused on organization, tasks, or support systems. New computerized support systems always change work. To be successful in changes of work, the present organization’s fundamental structures must be questioned to a large degree. Eyes must be opened, management must be prepared to allow people to be responsible and have more control over their work. Finally, people need information and competencies to take on the increased responsibility.

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## 9. REFERENCES

[1] Bannon, L. (1991). *From Human Factors to Human Actors: The Role of Psychology and Human-Computer Interaction Studies in System Design*. In Greenbaum, J. & Kyng, M. (Eds.) Design at Work: Cooperative Design of Computer Systems. Lawrence Erlbaum Associates, Hillsdale, New Jersey, pp. 25-44.

[2] Beyer, H., & Holtzblatt, K. (1998). *Contextual design*. San Francisco: Morgan Kaufmann Publishers, Inc.

[3] van den Besselaar, P. (1998). *Democracy & Technological Change: Limits to Steering*. In Proceedings of the Participatory Design Conference, Chatfield, R., Kuhn, S. & Muller, M. (Eds.), Seattle USA.

[4] Bjerknes, G., Ehn, P. & Kyng, M. (1987).*Computers and Democracy: A Scandinavian Challenge*. Gower Press, Brookfield, VT.

[5] Boivie, I., Åborg, C., Persson, J. and Löfberg, M. (2004). *Why Usability Gets Lost or Usability in In-house Software Development*. Interacting with Computers, 15 (4), pp. 473-639.

[6] Boivie, I., Gulliksen, J., Göransson, B. The lonesome cowboy – A study of the Usability Designer role in systems development. Submitted to Interacting with Computers.

[7] Borchers, J.O. (2000) *A Pattern Approach to Interaction Design*, In Proceedings of DIS 2000 International Conference on Designing Interactive Systems, August 16-19, New York, USA, pp. 369-378.

[8] Buur, J. & Bødker, S. (2000). *From Usability Lab to "Design Collaboratorium": Reframing Usability Practise*. Boyarski, D. & Kellogg, W.A. (Eds.), In Proceedings of the Conference on Designing Interactive Systems, pp. 297-307, ACM Press, New York.

[9] Bødker, S., Ehn, P., Kammersgaard, J., Kyng, M. & Sundblad, Y. (1987). *A utopian experience – On design of powerful computer-based tools for skilled graphic workers*. In Bjerknes, G., Ehn, P. & Kyng, M. (Eds.), Computers and Democracy – a Scandinavian Challenge. Aldershot, Avebury, UK.

[10] Bødker, S. & Iversen, O.S. (2002). *Staging a Professional Participatory Desing Practice – Moving PD beyond the Initial Fascination of User Involvement*. In Proceedings of NordiCHI, October 19-23, Aarhus, pp. 11- 18.

[11] Clark, H.H. (1996). *Using language*. Cambridge University Press, Cambridge, UK.

[12] Clegg, C., Axtell, C., Damodaran, L., Farbey, B., Hull, R., Lloyd-Jones, R., Nicholls, J., Sell, R., Tomlinson, C. (1997). *Information Technology: a Study of Performance and the Role of Human and Organizational Factors*, Ergonomics, 40 (9), pp. 851-871.

[13] Clement, A. (1994). *Computing at Work: Empowering Action by 'Low- level Users'*. Communications of the ACM, Special Issue on 'Social Computing', Volume 37, #1, pp. 52-63.,

[14] Clement, A. & van den Besselaar, P. (1993). A *Retrospective Look at PD Projects*. Communications of the ACM. Vol 36, 6, 29 – 37.

[15] Ehn, P. & Kyng, M. (1991). *Cardboard Computers*. In Greenbaum, J. & Kyng, M. (Eds.) Design at Work: Cooperative Design of Computer Systems. Lawrence Erlbaum Hillsdale, N.J., pp. 169-195.

[16] Ehn, P. & Sjögren, D. (1991). *From System Description to Scripts for Action*. In Greenbaum, J. & Kyng, M. (Eds.) *Design at Work: Cooperative Design of Computer Systems*. Lawrence Erlbaum Associates, Hillsdale, New Jersey, pp. 241-268.

[17] Greenbaum, J. & Kyng, M. (1991). *Introduction: Situated Design*. In Greenbaum, J. & Kyng, M. (Eds.) *Design at Work: Cooperative Design of Computer Systems*. Lawrence Erlbaum Hillsdale, N.J., pp. 1-24.

[18] Gulliksen, J. & Sandblad, B. (1995). *Domain-Specific Design of User Interfaces*. International Journal of Human-Computer Interaction, 7(2), pp. 135–151. Ablex Publishing Corporation, Norwood, New Jersey.

[19] Gulliksen, J., Göransson, B. & Lif, M. (2001). *A User-Centred Approach to Object-Oriented User Interface Design*. In Van Harmelen, M. (ed). *Object Modeling and User Interface Design: Designing Interactive Systems*, pp. 283-312. Addison-Wesley, US.

[20] Gulliksen, J., Göransson, B., Boivie, I., Blomkvist, S. Persson, J. & Cajander, Å. (2003). *Key principles for user-centred systems design*. Behaviour and Information Technology, 22 (6), pp.397-410.

[21] Gulliksen, J. & Lantz, A. (2003). *Design versus design – From the shaping of products to the creation of user experiences*. International Journal of Human-Computer Interaction, 15(1), pp. 5-20.

[22] Göransson, B. (2004). *User-Centred Systems Design: Designing Usable Interactive Systems in Practice*. Comprehensive Summaries of Uppsala Dissertations from the Faculty of Science and Technology, ISSN 1104-232X ; 981, http://urn.kb.se/resolve?urn=urn:nbn:se:uu:diva-4273

[23] Jungk & Müllert (1987). *Future Workshops: How to Create Desirable Futures*. Institute for Social Inventions, London.

[24] Kecklund, L. Ingre, M., Kecklund, G., Söderström, M., Åkerstedt, T., Lindberg, E., Jansson, A., Olsson, E., Sandblad, B. & Almqvist, P. (2000). *Railway safety and the train driver information environment*. In Computers in

Railways VII, J. Allen, R.J. Hill, C.A. Brebbia, G. Sciutto & S. Sone (Eds.). Southampton: WIT Press.

[25] Kensing, F. & Halskov-Madsen, K. (1991). *Generating visions: Future Workshops and Metaphorical Design*. In Greenbaum, J. & Kyng, M. (Eds.) *Design at Work: Cooperative Design of Computer Systems*. Lawrence Erlbaum Hillsdale, N.J.

[26] Kristensson, P., Magnusson, P. & Matthing, J. (2002). *Users as a hidden resource for creativity. Findings from an experimental study on user involvement*. Creativity and Innovation Management, Vol. 11 (1), 55-61.

[27] Leavitt, H.J. (1958). *Managerial Psychology*. University of Chicago Press, London.

[28] Olsson, E. (2004). *What Active Users and Designers Contribute in the Design Process*. Interacting with Computers, 16(2), 377-401.

[29] Olsson, E. & Gulliksen, J. (1999). *A Corporate Style Guide That Includes Domain Knowledge*. International Journal of Human-Computer Interaction, 11(4), pp. 317–338.

[30] Sachs, P. (1995). *Transforming Work: Collaboration, Learning and Design*, Communications of the ACM, 38 (9), 36-44.

[31] Sandblad,B., Andersson, A.W., Byström, J. & Kauppi, A. (2002). *New control strategies and user interfaces for train traffic control*. In Computers in Railways VIII, Wessex Institute of Technology.

[32] Spinuzzi, C. (2002). *A Scandinavian Challenge, a US Response: Methodological Assumptions in Scandinavian and US Prototyping Approaches*. SIGDOC'02, October 20-23, 2002, pp 208-215. Toronto, Ontario, Canada.

[33] Tollmar, K., Sandor, O. & Schömer, A. (1996). *Supporting Social Awareness @ Work – Design and Experience*. In Proceedings of CSCW'96, Cambridge, MA, USA.

[34] Vicente, Kim J. (1999). *Cognitive Work Analysis*. Lawrence Erlbaum Associates, Inc, UK.

[35] Webb, B.R. (1996). *The role of users in interactive systems design: when computers are theatre, do we want the audience to write the script?* Behaviour & Information Technology, Vol. 15, no. 2, pp. 76-83.

[36] Woolgar, S. (1994). *Rethinking requirements analysis: Some implications of recent research into producer-consumer relationships in IT development*. In Jirotka, M. & Goguen, J. (Eds.) Requirements Engineering - Social and Technical Issues, Academic Press, UK, pp. 201-216.