An emerging approach to systems design - experience from the MUST-program

Finn Kensing, Keld Bødker and Jesper Simonsen
Computer Science Department
Roskilde University
P.O. Box 260
DK 4000 Roskilde Denmark

kensing/keldb/simonsen@dat.ruc.dk

ABSTRACT
The paper present our first attempt to formulate a design approach based upon our experiences from nine design projects in various organizations. In the projects we have experimented with techniques for analyzing the needs of the organization in question and for supporting the design process. The term "approach" is used as something in between commodified methods and isolated techniques supporting one or a few activities.

KEYWORDS: design approach, participation, contextual design, techniques and tools

1. INTRODUCTION

What is reported on here is part of the research program MUST, the purpose of which is to develop *theories of and approaches to* systems design. The research program comprises design projects carried out by us, as well as by others using our approach, and studies of designers working under industrial conditions. This paper is a reflection upon our own practice as designers, trying to render it in a communicable way. In this way the paper presents the status of our experiences in relation to formulating a design approach. We hope, by the example given here, to facilitate learning among interested practitioners, students and researchers along with reflections upon (descriptions of) concrete design projects. Over the years many methods have been presented as the solution to "the software crisis" and marketed as commodified methods. On the other hand, the literature is ripe with descriptions of techniques used for supporting one or few activities in succesful design projects. We do not intend to come up with such promises, never the less we feel a need to go beyond the description of "stand alone techniques". Hence the term "approach" is used as something in between commodified methods and isolated techniques supporting one or a few activities.

Our main interest lies in designing for a specific organization's needs rather than generic products for a larger market. We use the term design in the same way as architects do - focusing on the analysis of needs and opportunities, and the preliminary design of functionality and form.

1

Therefor we see results of a design project to include a conceptual design in terms of a written document, sketches, mock ups and/or prototypes. We consider an evaluation of consequences of implementing the design as well as a plan for the implementation to be part of the result too. Based upon a design proposal it should be possible for the organization to say "go", "no go", or "more design is needed". Eventually the project may proceed to construction and implementation, but we consider this latter part of systems development to be outside the scope of our emerging approach which focus on the initial part of systems development.

The motivation for studying early design processes is a hypothesis that these activities are important to consider in relation to individuals' and organizations' experience that often they don't get the computer support they (thought they) asked for [30] and in relation to Boehm's findings that many large projects fail because of inadequate requirements [5]. In earlier work we have worked with designers responsible for the entire systems development process in industrial settings [1, 9], and one of us has worked as a designer in such settings.

Section 2 is the main body of the paper describing the design approach, while section 3 concludes the paper with a short discussion.

2. A DESIGN APPROACH

In order to make our own design approach explicit we have reflected upon nine projects we have been engaged in during the last six years [8, 10, 27, 41]. Starting from our own experience as designers, we present a first attempt to generalize in terms of an approach, specifying the *what*, the *how* and the *why*, as well as the *who* and the *where* when in projects we strive to get from an understanding of complex work settings to designing computer support. The point is not to promote what we have done as *the* design approach, nor to start an inquiry to find such an approach. Rather the point is to facilitate one type of learning among practitioners, researchers, and students: learning from guidelines.

We will describe our emerging design approach by the following headings[1]:

- **Application area** (type of settings and of the new systems in terms of e.g. size, type of work and equipment, and type of intended organizational change) - section 2.1

- **Perspective** (basic assumptions and principles, concepts and ways of understanding users, their work, and an organization) - section 2.2

- **Overall approach** (basic strategies for the approach) - section 2.3

---

[1] Andersen, Kensing, et al. [1] articulate dimensions for characterizing a method, which will be (partly) used in the articulation of our approach to design.

- **Techniques** (how a specific activity can be performed; links knowledge of desired product to an understanding of how the activity should be performed) - section 2.4

- **Representations** (how to represent the knowledge being developed in design activities) - section 2.5

We are aware that in the design community central concepts in relation to the nature of work, and dimensions of common artifacts has been proposed, which also serve as guidelines for design, e.g. [35, 38].

2.1 Application Area

We developed our approach, and hence our experience, in projects with the aim to investigate opportunities for computer support for a specific organization. In all but one we were brought in because somebody, employees or managers, thought that computers might be part of solutions to problems they had encountered[2]. The initial problem definitions have been quite open. We have carried out detailed studies of the organization's needs and opportunities and designed tailored applications in combination with (modified) standard products found feasible.

Most of the people we have worked with saw the main part of their jobs as problem solving and problem definition rather than routine work, and cooperation was considered a substantial part of the jobs. The list of jobs comprises: radio journalists; university secretaries; operations people in an airport; managers, consultants, and secretaries in a multinational medical company; managers, editors, secretaries, and store-clerks in a film board; scientists in a R/D lab; and senior managers within the administration at a university.

A common objective of the projects has been to support the existing work force which was considered overworked. Another has been that the existing work force or management wanted to automate some of the routine tasks. In some projects there was a request for computer support of activities which had really never been done before in the organization. Sometimes the purpose was stated explicitly to improve quality of working life and the product and service delivered by the organization. None had the (explicitly stated) purpose of head count reduction, down-sizing or "right-sizing"(sic!).

The nine projects we have been engaged in are characterized below.

1) University secretaries: Action-research project in which one researcher worked with a group of five secretaries at a university to identify appropriate computer support for local study administration (clarify if appropriate, if yes then outline overall design). The research goal was to develop and test the use of a study of workplace cultures as part of a design project. The university had 3500 students, 250 professors, 200 secretaries of which approximately half was employed in the local administration and half

---

[2] In the last project we were part of a larger analytical oriented research project.

in the central administration. The secretaries in the project group were all responsible for local study administration, and the project was set up by their local union with which participation was agreed and to which the results was reported. The project was set up in order for the union to be prepared for negotiating with management who had initiated a project to develop a computer system for study administration in the central administration. The project lasted six months and comprised three months of work [8].

2) Radio station: Action-research project where two researchers and a postgraduate student together with a group of three journalists and a secretary from an editorial unit of a radio-station worked to identify appropriate computer support for editorial work and administrative follow-up in the particular editorial unit. The editorial unit had fifteen journalists, a small number of free-lance reporters, and two secretaries. The project was set up by the editorial unit to clarify their own needs in terms of computer support in order to prepare for management plans for implementing a standard product developed and "run" by the central IT-department. The research goal was to develop end test the use of ethnographic techniques. The project lasted five months and comprised in total five months of work by the two researchers and the student [10].

3) Education: Action research project in the (internal) educational department of a large multinational medical company employing in total 9000 people. The department had sixteen full-time employees, of which six were "consultants" (academics), five teachers, three secretaries and two trainees, and a large number of part-time teachers for specific courses. The project was carried out by three researchers working closely with two consultants and a secretary. The project was set up to clarify if and how the employees could benefit from more cooperation and from using computers more extensively. Also they wanted to evaluate our approach for its applicability for them working as consultants in the company. The research goal was to develop and test our approach in a setting characterized by mutual change in relation to computer systems, work organization, and development of qualifications.

4)-6) The Film Board: Action-research project comprising three design projects over a total period of 1 1/2 years.

- 4) Two postgraduate students (supervised by one researcher) worked with two managers and seventeen employees in the Order Receiving and Shipping Departments to clarify how problems in managing a film stock and the cooperation between the Shipping and the Order Receiving functions could be supported by an inventory control system. The research goal was to test a variety of design techniques. The project lasted three months with both students working full time.

- 5) Two researchers were engaged in the Editorial Board consisting of one production manager, four editors, and three secretaries. We clarified needs for computer support for managing the overall production of films. The research goal was to develop and test ethnographic techniques. The

project lasted one year and comprised in total five months of work from the researchers [41].

- 6) One researcher conducted a project with the Marketing and the Order Receiving Departments with three managers and fourteen employees. We clarified needs for computer support of the Order Receiving and the Marketing functions, the integration with the overall production of films, and organizational consequences of a parallel restructuring and merging of the two departments. The research goal was experimenting with the Work Analysis [39]. The project lasted five months comprising two months of work by the researcher.

7) Operations room/Airport: Pilot study in an operations room at a metropolitan airport. The study was part of a larger research project that focused on "just what the work of operations comprises as situated activity within this particular site" [43]. Two researchers analyzed the work and generated design ideas with a low degree of participation and we had no contract with the airline. In the operations room two people co-ordinate the servicing of arriving and departing planes. This is primarily done by communicating through a variety of media with a diverse group of people in and outside the airport. The research goal of our part of the project was to develop and test forms of representations that would support a Language/Action Approach to design. The project lasted four month with part time involvement [27].

8) R/D-Lab: Action-research in a research and development laboratory. One researcher worked with a group of twelve engineers and physicists who wanted to investigate new types of computer support and reorganization of their work. The lab has sixty employees who develop high tech artefacts. The research goal was to learn and test ethnographic techniques, especially video based analysis. The project lasted two month full time.

9) University administration senior managers: Case-study where one researcher observed one of five design teams in a large design project. The overall purpose of the project was to change the current design approach from mainly managed by the University's own staff of programmers to initially being analysed and managed by professionals involved in the work which should be supported. The design team studied in the case was analysing the current central systems supporting the chart of accounts and general ledger. The team had eight members, and the project lasted for eight months.

2.2 Perspective

We agree with Suchman [44] that categories do have politics. Guidelines may be used in rather different ways according to how you perceive what you are doing, and who is doing it to/for whom. Therefor we need to specify explicitly our basic assumptions and principles and how we as designers, working in participatory projects, perceive organizations; their members and their role in design, as well as our own role; and how we perceive design processes and their products.

5

Organizations do of course have structural properties, however organizations are not *there* to be studied, rather we perceive them as constantly being enacted through members' interaction and activities. Stable structures - understood as enacted social order - as well as procedural aspects need to be understood as part of a design project. Since organizations are constantly changing, a design might need a review if say it has "simmered" for eighteen months, as one of our designs did in the Film Board.

We see organizations as frameworks for cooperation as well as for conflicts. Therefore groups and individuals participating in design should be expected to have common, as well as conflicting goals. The role of designers is neither to cover up nor to solve political conflicts in design. Rather they should help the parties to formulate their visions, and leave it to them to solve conflicts in relevant fora.

We expect users, given the right opportunities, to be able to make their own decisions concerning what kind of computer support and work re-organization they might need and what kind they might want to get rid of, cf. [28]. As addressed above "they" however, is seldom experienced to be a homogenous entity. In the Film Board we ran into a conflict between the production manager and the editors [41]. When we realized the conflict we arranged a meeting and explained the consequences as to each of the parties of various design decisions. The production manager then gave in, but subsequently tried - unsuccessfully - to persuade the president to make an end to the project in the department.

Direct confrontation might not work in all situations. Blomberg, Suchman and Trigg [5] report on a project where they came to know of management's confidential plan of closing down a department in which they were doing their design project. At a meeting with management they chose to mediate between management and employees by speaking at least partly on behalf of the supervisor of the department they had studied. Whether and how designers might approach conflicts that evolve in a project depends on how the conflict is related to the design project [41].

Working with users and from ethnographic studies of organizational life we have learned that often there is quite a difference between what people say they do and what they observably do. This is not necessarily because people play games (though they do), sometimes they are truly surprised when confronted with the difference. With the journalists in the Radio project our observations told us that there was a contradiction between their initial request for technology to support cooperation and their enacted values showing a desire for working solo. Our detailed study of their work practice aimed at making it discussible in which parts of their work they wanted to cooperate and in which they preferred to work alone with. The final design reflected a joint decision of this aspect [10].

We are in favour of participatory design as a democratic ideal. Also we are in favour of having users at all levels from the organisation participating in managing the project: it as a human right to be able to influence one's own

working situation. Also we have pragmatic reasons: as designers we need direct interaction with users' knowledge in order to propose feasible designs, and there is a need for anchoring a design vision with those who are going to create the change.

Though we advocate a participatory approach we have not always succeeded in establishing a *real* working group consisting of users and designers[3] taking joint responsibility for the process as well as the product of the design project. Sometimes we have had to accept that users would just show up at meetings arranged by us, being willing to be observed, test a prototype, decide upon what to do next, or what ever kind of activities we ask them to participate in. This is however not the ideal form of cooperation, neither in terms of democratic principles, nor in terms of anchoring design visions in the organization.

A good product of a design process most often is a mix of tradition and transcendence [16]. One reason for bringing in designers is to transcend the tradition. At least someone in the organization has considered some of the old ways of doing things to have lost their rationale, or found that new technological opportunities are worthwhile investigating. We have experienced managers as well as employees in that role. However, designers need to respect traditions in an organization, both as a way of maintaining (or establishing!) credibility but also because there often is a rationale behind phenomena perceived odd by a newcomer. Designers thus have to be careful in reading the meaning attached to mundane activities, modes of cooperation, or artefacts used in the work processes.

2.3 Overall approach

We apply a combination of intervention and ethnographic techniques in our overall iterative approach to design. In earlier work [26] we advocate that it is the responsibility of designers[4] to set up activities applying tools and techniques that will allow themselves and users to develop knowledge at two levels - abstract and concrete, within three areas - users' present work, new systems[5], and technological options[6]. A combination of intervention

---

[3] Yes, users can be - and often are - designers too. The naming used here has been chosen for its simplicity.

[4] Mogensen and Trigg [33] have a similar concern saying that the use of concrete artefacts in user-developer workshops helps meeting the challenge to trigger simultaneous changes in analysis, design and practice.

[5] By new systems we mean new (or changed) computer systems and changes in the content and the organization of the users' work.

[6] Here technology incorporates not only hardware and software, but also work organization. This may seem strange but in this context we find it useful and acceptable to group these matters. Various organizational options, as well as several hardware and

	Users' present work	New system	Technological options
Abstract knowledge	Relevant (2) structures on users' present work	Visions (5) and design proposals	Overview of (4) technological options
Concrete experience	Concrete (1) experience with users' present work	Concrete (6) experience with the new system	Concrete (3) experience with technological options

Figure 1. Six areas of knowledge in user-designer communication. [26].

and ethnographic techniques in an iterative approach has turned out to be a good learning strategy for this purpose.

During a project we use the model in figure 1 as a point of reference. We are responsible for using tools and techniques that support communication with and among users within the areas indicated in the model. In the below presentation of proposed techniques and representations these are related to the areas within which we have found them useful.

It is crucial for designers to develop a thorough understanding of users' present work (work practice, organization of work, products/services, relations to customers, clients, suppliers, history of recent major changes, management strategies and style, etc.) This in order for the design to reflect - in a realistic way - the traditions of the organization. Realistic in the sense that the design reflects an appreciation of the rationale given by members of the organization, and in the sense that the organization is geared to meet the challenge of the envisioned design. Thus, by detailed studies of the present situation we try to "measure" the organizations needs and readiness for change. What we are trying to avoid is a too futuristic design or a design, the greater proportion of which will never be used. We have found that ethnographic techniques are helpful in accomplishing this.

Ethnographic techniques vs. intervention
Ethnographic techniques come out of a tradition where the basic idea was to develop and present to other scholars an understanding of a foreign culture. In its original form this implied that ethnographers tried not to change what they were studying. Current ethnographers however, reconceptualize this practice and try to establish an encounter between different cultures, for the purpose of informing those involved [4, 21]. Also Blomberg, Suchman and Trigg report from a project "linking ethnography with design" in an organizational setting: "We orient to the details of people's practices, recognizing the importance of members' own articulation of what they do [....] we are accountable to the people who are or may become users of our technology" [4].

---

software options, should be considered and coordinated in order to fit together as well as possible.

Interventionists deliberately set up activities designed to change the organization or the work settings of some of its members. The presumption is that it is through change that key factors of organizations and their members perception become observable. Our interventions address each of the three areas of discourse in figure 1. The intentions are to facilitate reflections upon current practice, to generate ideas, and to further develop the "technological fantasy" of users and designers.

We strive to select carefully the area and the mode of intervention based upon what we have learned by the ethnographic techniques. This is in contrast to some consultants bringing with them from site to site a design concept, claiming that what people in the organization know is irrelevant for their re-engineering project[7]. Using ethnographic techniques - as they were originally developed - one spends years to develop and present an understanding of the culture studied. The interventionist is more impatient. Taking into account the time constraints put on most designers in the context we are talking about, we have found that interventions help make short cuts feasible. Also we find that ethnographic techniques provide a significantly deeper understanding than traditional computer science/software engineering techniques. This holds even when the former are used in "a quick and dirty way" compared to what they were originally developed for.

When we first tried to become quasi-ethnographers, colleagues and students claimed that such an approach would take far too much time, so why not start prototyping right away? We found that spending time on analysis, without going to the extreme of systems analysis of the 70-ties and 80-ties, paid back in relation to single out areas of the work relevant for prototyping and in relation to generating realistic design proposals. Also we found that detailed knowledge of users' current work allowed us to discard by "mental testing" design ideas that turned out not to be worth prototyping [10, 41].

Ethnography and intervention are contradictory in terms of basic approach and intended results. However to us at a practical level, the two approaches in combination have been an effective way to learn about the organization and also a main resource for generating realistic visions of future use of technology.

We have one main concern though, which is part of the reason why we think it is necessary to reveal and discuss approaches in the design community, part of which develops technologies with a wide range of impacts on organizations, groups, and individuals. Getting to know people in an organization as closely as you do when carrying out in-depth analysis for the purpose of design, you easily get into political/ethical dilemmas [4, 41]. Since organizations are (also) political battle fields - people are fighting for their jobs, for preserving/getting an interesting job, for preserving/increasing their power base etc. And since the introduction of new

---

[7] This statement is based upon oral descriptions given by someone encountering this type of consultant.

9

technologies often affect such issues, designers cannot avoid playing a role and sometimes taking a stand in these battles. This is true whatever approach designers use, but some approaches allow you to keep a greater distance from those affected by your designs than others. Choosing an approach that might get him into close relations with users, the designer had better be prepared to defend his observations and design ideas - not all designers may be ready for that, nor may their employers give them the opportunity.

Iteration
The overall approach is iterative in two ways.

First, we iterate between analysis of the present and generating and eventually prototyping design ideas. This is not at all a new idea. What might be new is our hesitation to start prototyping before developing a thorough understanding of the organization in question.

Second, we iterate between the two levels of knowledge indicated in figure 1. This is in contrast with most methods currently used in industrial systems design, where an understanding is achieved only by acquiring abstract knowledge documented by formal tools and techniques. Kensing and Munk-Madsen [26] argue from a theoretical standpoint that designers have to put themselves in situations where they experience users while they are performing their every day activities. The examples in [10, 41, 42] show the consequences of this kind of experience as to the proposed design. Parts of this will be shown below.

2.4 Techniques
In our design projects we have applied a number of techniques to support the investigation of users' present work, technological options and the new system, as well as iterations back and forth between the various areas. Some of the techniques are well-known, such as observation, interviewing, and prototyping, while others are more specifically developed within various design traditions, e.g. design workshops from the Participatory Design-tradition [18, 34, 40]. Each technique provides information which might identify a need for further investigation, either in terms of opening up the search space - when it turns out that the problems are not properly understood, or not agreed upon - or narrowing down the search space - when it turns out that it is necessary to understand the problem in greater detail by e.g. using another technique.

Some techniques rely on users as informants through interviews in situations detached from their ongoing work, others rely on the designers' ability to observe users while performing their daily work, yet others establish a situation in between (e.g. interview in-situ). What ever the situation, we have found it important - even if we do focus on specific issues - to constantly remind ourselves to be open to what ever might come up. Field notes or audio/video recording are helpful tools for documenting and for shifting focus [10, 41, 45].

Ethnographers have developed elaborate techniques for analyzing recordings [23, 46]. We have no experience in this type of analysis, though for some tapes we have done content logging. Running through the tapes several times may generate hypotheses and design ideas, or identify issues to look for in greater detail. An example of this was found in an observed and taped meeting where the production manager and an editor from the Film Board were negotiating a contract with a producer and a director. Running through the tapes several times made us aware that in addition to the negotiation with the producer and the director, negotiations were taking place between the two people from the Film Board. This observation, which we did not note at the meeting or during the first couple of runs of the tape, turned out to have direct consequences for our design proposal later on [41].

Below is a condensed list of techniques which we have applied in our design projects. Each technique is described very briefly by key words; some of the techniques and how they were used are elaborated one step further in what follows.

Project establishment: technique used in order to clarify what the project will be all about and how it should be approached [1].

Observation: fly-on-the-wall; used to get an initial understanding of the workplace or to get a detailed understanding of a more focused area; provides opportunities for occasioned dialogues; documented by notes, audio- or video recordings.

Thinking aloud: users thinks aloud while "doing the work" (either a real work task or one created by the outsider); documented by notes, audio- or video recording.

Document analysis: much basic information about the organizational context of a department may be found in official written material like annual reports, organization diagrams, also work manuals may provide valuable information; from observation and interviews forms and reports may be obtained which then provide valuable reference to details of work.

Prompted reflection: two or more workplace members are asked to describe - to each other and the outsider - how they perceive their work, problems, and improvements; documented by a shared drawing, notes, audio- or video recording.

Interview: structured or unstructured interview in a situation "set up" for an interview detached from the work setting of the person interviewed (e.g. in a meeting room, with no phone calls to interrupt, etc.)

Interview (in-situ): open-ended interviews in-situ provide an opportunity to "check"/complement the answers given by looking at - and eventually collecting - forms, reports or artefacts used or created in the work processes, and with the opportunity to obtain background information of the contextual aspects of the work process (number of interruptions, office/workplace layout, etc.)

11

Analysis of existing systems: a new system may have to be integrated with or partly replace existing systems, both functionally and with respect to data, so such systems have to be studied; study documentation, conduct workshops or observation to identify problems with the use of existing systems.

Workshop: participatory technique for analysis, design or evaluation purposes;

- analysis: designers and users work on developing and articulating a common understanding of the workplace, e.g. by using a wall-graph [41], or by mapping [29]. A shared drawing might depict flow of work, information needs, use of tools, results of work, etc.

- design: designers and users work on generating ideas or visions of computer support (by brainstorming, metaphorical design [31], and future workshop [24]) - or with detailing a promising design idea.

- evaluation: designers and users work on evaluating a design idea by relating the vision to the shared understanding of users present work in the specific organizational setting; the intention is to judge if the design idea is realistic, and not merely a "good" idea which is unrealistic in the actual work setting due to economy or preferred ways of working [10].

Prototyping: prototyping a new system is a way of experimenting with a new system before it is actually build; we distinguish between different levels of prototyping depending on the intention with the experiment, the completeness of the prototype, and the extension of the experimentation with the prototype [17];

- horizontal: a very simple model of the new system - maybe just a mock up - may be demonstrated at a design workshop and evaluated on the background of the shared understanding of work processes to be supported.

- vertical: a more stable model of the system which is used in the daily work; conduct an experiment where the prototype is used for a fixed period of time for specific work tasks, and then evaluated.

- experimental: a certain level of expertise and experience with a specific type of system, e.g. electronic communication, is often needed in order to decide whether more advanced technology is appropriate; this experience may be obtained by conducting an experiment where e.g. a whole department use a standard product or an elaborated prototype for a fixed period of time.

Expose to technical options: the idea is to give users an idea of the options in relation to technology or work organization; by demonstrating typical products or by visiting other companies or "show rooms"; a third option is to conduct a market survey to identify relevant technological options.

To illustrate our approach, four techniques are described one step further: (a) project establishment, (b) interview, (c) prototyping, and (d) evaluation workshop.

(A) Project Establishment

To start a design project you have to get access to the organization. Apparently someone has asked you to show up in the first place, but when entering an organization you need to establish/negotiate access to management and employees at various levels. This might be an ongoing process since the daily work most often will be given first priority compared to a design project.

We use a technique, Systematic Project Establishment in order to clarify what the project will be all about and how it should be approached [1]. We interview people at various levels in the organization, including (if they exists) representatives of technology committees, a computer coordinating person and the local IT-department. We might sit in at meetings or observe work processes, but we always ask to be presented to the whole organization, if small, or the department(s) considered appropriate, in order for everybody to know who we are and why we are there.

We write a project charter clarifying the assignment and objective, level of ambition, resources, interest groups, critical conditions, organization and management of the project, etc. Sometimes, when goals of the design project are rather blurred, the project charter might comprise a first overview of problems and opportunities of the entire organization - or the part of the organization in question. During the interviews and meetings organized to do some initial sorting out of these matters, we also address formation of the design group as well as its work practices and social relations in the design group.

The project charter is negotiated and eventually signed. We consider this to be an important ritual. The purpose is to seek a common ground and commitment as to the participation, objectives, and intended results of the project.

Usually, we end up spending one or two calendar months - part time involvement - getting so acquainted with the organization that we are able to write a worthwhile and agreeable project charter. Techniques and representation forms described below are already used in an iterative process during this period of the project.

(B) Interview

Structured and unstructured interviews are fast ways in terms of getting to the "facts". However, it is well established that often there is a difference between what people tell they are doing and what an outsider may observe them doing. The reason for this is a mix of people not being able to express what they are doing because knowledge of work practice' is often tacit, deliberately information hiding, and people wanting to believe what they are saying is - or should become - true. This corresponds to the analytical distinction between area 1 and 2 in figure 1.

13

In the Film Board, an interview developed knowledge in area 1, 2, and 5. This was a situation with one of the secretaries supporting the production manager in charge of keeping a financial overview of all the productions "in the air". The interview was "in situ" i.e. the researcher and the secretary were sitting at her workplace. She explained how she made her different postings, tables, and accounts showing and referring to the files, documents, and paper available for this task. This quickly turned into a dialogue and a discussion which clarified the understanding of the task and the problems of gathering information from the Bookkeeping Department, the editors, and secretaries from the Editorial Board. Soon design ideas of how she could arrange different amounts and sums for productions in a spreadsheet emerged, and how some of these data could be transferred directly from a project management system which was under consideration and the central account system in the Bookkeeping Department. Thus the interview established a mutual learning situation where relevant structures of the secretary's current work were developed on the basis on her concrete experiences. The outcome was a drawing which captured a design vision to support the tasks in question.

(C) Prototyping
In the Radio project we developed a mock-up supporting the cooperation between the editor of the day, the producer, and the secretaries; and we developed a vertical prototype of an "electronic archive", one of the envisioned tools to support individual journalist's work.

The mock up illustrated the sharing of data in creating the various documents or work sheets from the very beginning of outlining the programme (at the editorial meeting and subsequently the sequence of the editor of the day) to the final producer manuscript used during programme production. The mock up also illustrated the subsequent adding of precise time figures of the various features during the broadcasting of the programme, noted by the producer, and it finally included the programme report, prepared the following day by the secretary. Rather than designing a specific work flow, the point was to facilitate the oral and written communication around the emerging programme in terms of an electronic version of the sequence.

The mock up was but a Microsoft Word document, which we had prepared to simulate the key functionality and a possible user interface of the proposed system. It was presented to illustrate the vision and to facilitate a discussion of how the vision (area 5 in figure 1) related to the elicited needs coming out of the understanding of "users' present work" (area 1 and 2).

As the mock-up had no functionality at all, it could not be used in real work situations, i.e. it was not possible to develop knowledge in area 6. But the mock up facilitated very detailed discussions of the relations between the vision and the work practice: the mock-up was evaluated and modified and in doing this especially the relationship between the roles of the producer and the editor, and of how that relationship differed with different pairs of journalists playing these roles were discussed (i.e. how different actors enacted the roles differently).

14

In the vertical prototyping one of the designers and a journalist developed a database and an interface to allow the journalists enter, search and retrieve information on issues or persons in relation to features, books, articles, etc. The prototype was presented to the group, and later three journalists used it in their daily work for about a week, before it was evaluated, i.e. allowing for area 6 knowledge to develop.

The evaluation indicated among other things that the key information should be related to a person, and not an issue as in the prototype. It turned out from the actual use situations that a specific person was always the starting point for information retrieval in the "electronic archive", i.e. the evaluation related knowledge from area 1 and 6. This is an example of how the design - in spite of rather detailed observations of journalists doing research and discussions in design workshops - turned out to be out of line with the actual work practice. [10]

(D) Evaluation workshop
In evaluation workshops in the Radio project we extensively used information from detailed studies of "users' present work" to question design proposals. At some point we had a rather stable design, but for parts of the design we felt a bit uneasy. During our observations and subsequent analysis we had noted aspects of work situations which for some parts of the design challenged the assumptions behind the vision.

To explore these uncertainties further we returned to studies of work practice in order to contrast visions and design proposals with concrete experience with users work. Here we used two techniques. One was to go back to observing and recording the communication involved in the production of the daily program, this time from the perspective of the editor. The other technique used was a study of workplace culture focusing on values and assumptions in relation to central aspects of the journalists' individual work. In this study we particularly focused on assumptions in relation to the use of artefacts in the journalists' individual work practice, i.e. work tools such as note pads and archives and work routines such as their use of sources.

During the observations and the subsequent analysis we focused on any mismatch between the actual actions taken by the journalists and the inherent assumptions in the design proposal. We performed so to speak "a mental test" of the design proposal against their actual actions, asking ourselves questions like "What would have happened if our proposal had been implemented?" For instance we had incorporated in the design that it would be possible for all the journalists to look into the plans and options of the editor, e.g. to see which features are currently planned to be in the program and for how long time (the sequence). The observations clearly revealed that the editor needed to keep this kind of information to himself as it played a part in the ongoing negotiations with his colleagues. It would have been easy to modify the design, but instead we included it as an example of a conflict/dilemma that had to be addressed, since some journalists had asked for this kind of information and because it was part of the general aim of improving the coherence of the programme as a whole.

15

After recapitulating the design proposal at a workshop the results of these detailed studies of work practice were presented orally to the project group in the form of eleven assertions. These were presented to stimulate and provoke a discussion of the premises and consequences of the design by articulating assumptions behind the ideas for computer support as well as behind articulated and observed work practice. The assertions expressed how we, as designers and outsiders, perceived their work practice *to be*, as opposed to how the journalists and the secretary, as insiders, *said or thought* it was. I.e. the objective was to test if - and where - the design was founded upon espoused or idealistic assumptions about the work, which were not reflected in the actual work practice. During the discussion we constantly focused upon contradictions or tensions between how the journalists and the secretary said or believed they worked, and our interpretation of how they worked and the implications for design. We were able then to discuss changes of the design and become aware of critical premises and fundamental values and beliefs regarding changes of the work practices. In turn, these findings had to be regarded as essential organisational decision points if the new system was to be used as intended.

2.5 Representations

In our design projects we have applied a number of representations to document knowledge of users present work, technological options or the new system. Designers might apply more formal representations for their internal communication; e.g. in order to develop a prototype a consistent data model (an E/R model) has been used. However, we tend to postpone formal tools and techniques introducing concepts and symbols not familiar to the users until detailed analysis and implementation of the visions. At that time designers cannot do without them, but still when users are involved in this part of design, some kind of translation might be appropriate. In general, representations are used to develop and represent knowledge with a particular emphasis, so it is a medium for developing knowledge as well as a medium for later referencing. We judge the relevance of a description on how well it facilitates discussions among us as designers and among us and users and their managers. Below is a condensed list of representations which we have applied in our projects, followed by a more elaborate description of three of them.

Communication model: a map of the communicative structure within the workplace and/or between the workplace and the surrounding organization and suppliers, customers, federal agencies, etc.; the map may focus on who is involved, media or tools, direction of the communication [27, 47, 48].

Cultural model: depicts the relations between expressed values-in-use and central elements of the workplace culture; the model may relate key values to one or more of the dimensions of the basic assumptions (in terms of Schein's model of culture) [8, 11].

Functional model: a model of the (overall) functions of the workplace/department and their relations in terms of functional interdependencies [37, 39].

16

Role model: a model of the various roles enacted by the users. The list of roles can be the outset for modelling the use of existing tools and envisioned new tools in relation to various work situations [10].

Map: a map is an interpretative description of a problematic situation or envisioned new ones. A diagnostic map is oriented towards problems in the present situation, while a virtual map includes identification of possible actions to change the situation and an evaluation of the consequences [29].

Collage/drawing: a description of users present work as perceived by the designers; basically a collage/drawing is a free hand drawing e.g. augmented with clips of pictures from magazines illustrating the use of tools, including forms and reports used in the workplace; a collage/drawing is usually made up by the designers (though it could be made with the users) and then later discussed with the users [10].

Wall-graph: a description of users' present work as perceived by them; it is basically a free-hand drawing on large sheets of paper worked out at a workshop illustrating flow of work, activities, functions, information and data required/produced [41].

Mock up/prototype: a model of an envisioned computer system; a mock up is a simple model - maybe running on a computer, maybe not; a prototype is more stable and complete and can be tested in actual work processes [10, 28].

Design sketch: a (rough) outline of the functional structure of the design. It may be related to identified roles or functions of the workplace and thus show the functional relations or the sharing of data among the various parts of the design [10].

Data flow diagram: illustrates the flow of data within a specific work task. We have used a free interpretation of the well-known "DeMarco-dataflow diagram" for this purpose.

Design report: the final report of a design project; contains a description of the present situation, the proposed design, a proposal for how the design might be developed/implemented, and an evaluation of consequences/cost-benefit.

To illustrate our approach, three representation are described one step further: (a) communication model, (b) collage/drawing, and (c) wall-graphs.

(A) Communication model
The model depicts communicative structures within (part of) the organization and with individuals or organizations from the outside. The maps have for instance focused on who is involved, media or other tools involved, directions (one/two/multiple ways), and what they are trying to accomplish (the latter being text, is left out in the example below). In the

17

operations room at the airport the model looked like figure 2 [27]. The questions we addressed were where do breakdowns in the communication happen, and would computer technology help avoiding/fixing such breakdowns by supporting, triggering or automating the activities which caused the breakdown [47, 48]. In the Film Board we made a communication model that had an editor and her secretary in the centre and all the partners the co-operated with in- and outside of the Board. We focused especially on the media involved and had a design workshop where other media were discussed including electronic mail, which eventually praised for internal use but discard for communicating with the outside due to technology available to outside partners.
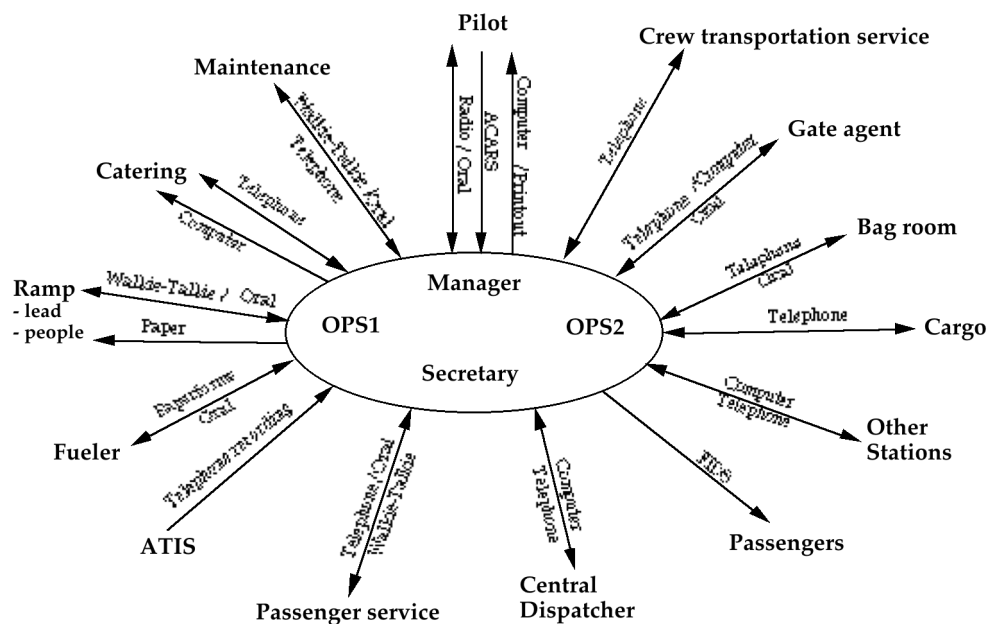
Figure 2. Communication path diagram (OPS1 and OPS2 are humans)

(B) Collage/drawing
In the Radio project collages were used to document and represent the designers emerging picture of what editorial and administrative follow-up on programmes actually meant. The information obtained from initial observations of the journalists and the secretaries formed the basis for descriptions of users' present work. At this point the descriptions took the form of a list of roles and several large formatted collages consisting of freehand drawings combined with clips of pictures from magazines. These clips illustrated tools and situations that related to their work, see figure 3. The collages were made up by the designers, but could also have been made in cooperation with the users.

18

The descriptions were presented at a workshop in the project group. The discussion focused on to which degree we - as designers and outsiders - had understood the essence of their work. The list of roles and the collages were subsequently corrected and added to. The focus of the workshop was directed towards what they (dis-)liked in their jobs and the way in which they enacted the various roles and situations depicted in the collages, as well as towards inexpediencies and breakdowns. Whenever design ideas came up as to computer support or new ways of organising the work, these were briefly discussed.

The identified ideas for computer support then became the subject of a design workshop where a coherent design idea was outlined. The various parts of this design were later detailed into various degrees by paper based descriptions, mock ups or prototypes. When we later discussed the general idea of the design or more specific details at evaluation workshops, we could always relate the intended change to the shared understanding of users' present work represented by the collages and the role lists hanging on the wall during the workshop.

Figure 3. Excerpt from a collage (text is in Danish)

(C) Wall-graphs
Wall-graphs are large pieces of paper where work involving various people and competencies is described in a coherent way. At the Film Board we gathered different participants in the life cycle of the production of a film (the secretaries, the editors, and the production manager). We asked them to write down all activities and functions (on the upper part of the wall-graph),

19

and data and information needed and/or recorded (on the lower part of the wall-graph), through the life cycle of a production. Everything was written on one piece of paper (1x10 m) with the start of the production in one end (an application is received), and the end of the production in the other (the film is discharged and taken out of distribution). Each participant used his or her own colour writing on the wall-graph. The wall-graph sessions were important for all to realise the complex cooperative work involved in the life span of a production and formed a coherent picture of the cooperative aspects of their work. The wall-graph formed the basic for a later presentation of how the design of a production management system could support the work with productions, and for a workshop where all users involved discussed "who is responsible for what" in a envisioned future work organization. The wall-graph hence served as a reference in the succeeding discussions concerning possible computer support and thus played an important role in anchoring the vision of the design. Figure 4 shows two pieces of the wall graph developed in the Film Board, each approximately one meter wide. The figure only roughly outlines their real form, which was much more "free-style", hand-written and with the text in different colours.

Figure 4. Example of a wall-graph

Summary

In this section we have presented an elaborate description of an emerging design approach specifying the *what* (section 2.3 - Overall approach), the *how* (section 2.4 and 2.5 - Techniques and representations) and the *why* (section 2.2 - Perspective), as well as the *who* and *where* (section 2.1 Application area). Table 1 summarizes the techniques and representations in our emerging design approach and indicates in which projects they have been used. The University administration project was a case study of a design project. The techniques used by the design team in this project are much more structured and less qualitative in the sense of paying attention to

20

Techniques used	Projects								
	1	2	3	4	5	6	7	8	9
Project establishment	x	x	x	x	x	x			
Observation	x	x	x	x	x	x	x	x	
Thinking aloud		x	x		x				
Document analysis	x	x	x	x	x	x		x	x
Prompted reflection							x		
Interview				x		x	x	x	x
Interview (in situ)	x	x	x	x	x	x	x	x	
Analysis of ex. syst.		x	x	x		x		x	x
Workshop	x	x			x				x
Prototyping		x	x						
Expose to techn. opt.	x	x	x	x	x				x
Representations used									
Comm. model	x	x			x		x		
Cultural model	x	x							
Function model				x	x				
Role model		x							
Maps	x	x		x			x		
Collage/drawing		x		x				x	
Wall-graph				x					
Design sketch		x		x	x	x			
Mock-up/prototype		x	x		x				
Dataflow Diagram				x					
Design report	x	x	x	x	x	x	x	x	

Table 1. Techniques and representations used in projects

1) University secretaries
2) Radio station,
3) Education,
4) Film Board Shipping dep.,
5) Film Board Editorial Board,
6) Film Board Marketing dept,
7) Operations room/airport,
8) R/D-Lab,
9) University administration

individual work practices in the university administration. It is, however outside the scope of this paper to discuss differences and similarities between the approach of this project and our emerging approach.

It is also outside the scope of this paper to discuss the reasons behind choosing the techniques and representations in the various projects. This is however a very important issue for further research which is part of our ongoing work.

3. DISCUSSION

In the paper we have presented an emerging approach for designing computer-based systems. We apply a combination of ethnographic techniques and intervention in an overall iterative approach. We find that ethnographic techniques provide a significantly deeper understanding than traditional computer science/software engineering techniques. This holds even when the former are used in "a quick and dirty way" compared to what they were originally developed for. Some may argue that such an approach would take far too much time, so why not start prototyping right away? We have presented three arguments towards this. First, taking into account the time constraints put on most designers in the context we are talking about, we have found that interventions help make short cuts in the ethnographic study feasible. Secondly, we found that spending time on analysis, without going to the extreme of systems analysis of the 70-ties and 80-ties, paid back in relation to single out areas of the work relevant for prototyping and in relation to generating realistic design proposals. Third, we found that detailed knowledge of users' current work allowed us to discard by "mental testing" design ideas that turned out not to be worth prototyping.

This design approach is in line with what has been labelled "ethnographically informed design"[8], as represented in e.g. [4, 21]. The approach of the Lancaster CSCW Centre [3, 21] - a cooperative effort involving sociologists and computer scientists - implies that the ethnographic study, performed by social scientists, inform the systems design, performed by designers, and further that the system design is evaluated and tested jointly. We take a slightly modified approach. Being computer scientists we have used ethnographic techniques in design processes. Our research goal is to develop theories and approaches for design oriented towards practitioners working under industrial conditions. Here we have not found sociologists available. The crucial question as to whether it is possible for designers in general - as lay persons - to apply concepts and methods from social science and the humanities is a very relevant question which we are investigating by further empirical studies.

Our emerging design approach is closely related to the work of Goguen and Linde [17a]. They propose ethnomethodology for obtaining detailed insight into the work practices of a user organization, and they propose a "zooming" method where structural methods are used to identify areas where the detailed ethnomethodological methods can be used in cost-effective ways. This comes quite close to our idea of iterating between techniques focusing on respectively abstract and concrete levels of knowledge of users' present work and the new system. Each step in this iteration might identify a need for further investigation, either in terms of opening up the search space - when it turns out that the problems are not properly understood, or not agreed upon - or narrowing down the search space - when it turns out that it is necessary to understand the problem in greater detail by e.g. using another technique.

ACKNOWLEDGEMENTS

---

[8] A term used f.ex. in the title of a session at CSCW '92.

22

REFERENCES

[1] Andersen, N.E. et al. *Professional Systems Development*. Prentice-Hall, Englewood Cliffs, N.J., 1990.

[2] Bannon, Liam. CSCW: An Initial Exploration. In *Scandinavian Journal of Information Systems*, vol. 5, 1993, pp. 3-24.

[3] Bentley, R., T. Rodden et al. Ethnographically-Informed Design for Air Traffic Control, in Turner, J. & R. Kraut (Eds): *CSCW '92 Sharing Perspectives. Proceedings of the Conference on Computer Supported Cooperative Work,* ACM, pp. 123-129

[4] Blomberg, Jeanette, Lucy Suchman and Randall Trigg. Reflections on Work-Oriented Design in Three Voices. To appear in S.L. Star "*Paris workshop*", 1994

[5] Boehm, B. *Software Engineering Economics*, Prentice-Hall, 1981

[7] Bødker, Keld. *Analyse og design i et kulturperspektiv - udfordring til systemperspektivet*, Ph.D thesis (in Danish) [Analysis and Design in a Cultural Perspective - Challenging the Systems Perspective], Datalogiske skrifter No. 26, Roskilde University, Denmark 1989.

[8] Bødker, Keld. A Cultural Perspective on Organizations Applied to Analysis and Design of Information Systems. In *Organizational Competence in Systems Development. A Scandinavian Contribution*, Gro Bjerknes et al. (Eds), Studentlitteratur, Lund 1990.

[9] Bødker, Keld and Jørgen Bansler: A Reappraisal of Structured Analysis: Design in an Organizational Context, in *ACM Transactions on Information Systems*, spring 1993

[10] Bødker, Keld, and Finn Kensing. Designing Computer Support for Editorial and Administrative Work in an Editorial Section in a Danish Radio Station, in *Scandinavian Journal of Information Systems,* Vol 6, no. 1, (April 1994), pp.47-68

[11] Bødker, Keld, and Jesper Strandgaard Pedersen. Workplace Cultures: Looking at Artifacts, Symbols, and Practices. In [18].

[12] Bødker, S. and K. Grønbæk. Design in Action - From Prototyping by Demonstration to Cooperative Prototyping. In [18].

[13] Checkland, Peter, and Ji Scholes. *Soft Systems Methodology in Action*. Chichester, West Sussex, UK, 1990.

[14] Dahlbom, Bo, and Lars Mathiassen. *Computers in Context. The Philosophy and Practice of Systems Design*. Blackwell, Oxford, UK, 1993.

[15] Dreyfus, Hubert L., and Stuart E. Dreyfus. *Mind Over Machine. The Power of Human Intuition and Expertice in the Era of the Computer*. The Free Press, Macmillan Inc., New York, 1986.

[16] Ehn, Pelle. *Work-Oriented Design of ComputerArtifacts*. Arbetslivcentrum, Stockholm, 1988.

[17] Floyd, C. A Systematic Look at Prototyping. In *Approaches to Prototyping*, R. Budde et al. (Eds), Springer Verlag, 1984, pp. 1-18.

[17a] Goguen, J. & C. Linde.Techniques for requirements elicitation. In *Proceedings of the IEEE International Symposium on Requirements Engineering,* January 4-6, 1993. IEEE Computer Society Press, Los Alamitos, California, pp. 152-164.

[18] Greenbaum, Joan, and Morten Kyng (eds). *Design at Work: Cooperative Design of Computer Systems*. Lawrence Erlbaum Associates, Chichester, UK, 1991.

[19] Heath, C. and P. Luff: Collaboration and Control. Crisis Management and Multimedia Technology in London Underground Line Control Rooms, in *Computer Supported Cooperative Work*, Vol 1, Nos 1-2, 1992, pp 69-94

[20] Heath, C, M. Jirotka, P. Luff, and J.Hindmarsh: Unpacking Collaboration: the Interactional Organisation of Trading in a City Dealing Room, in G. De Michelis, C. Simone, K. Schmidt (Eds): *Proceedings of the Third Eurpean Conference on Computer Supported Cooperative Work*, Kluwer, Dordrecht, Holland, 1993

[21] Hughes, J., D. Randall & Dan Shapiro (1992): Faltering from Ethnography to Design, in Turner, J. & R. Kraut (Eds): CSCW '92 Sharing Perspectives. Proceedings of the Conference on Computer Supported Cooperative Work, ACM, pp. 115-122

[22] Jordan, Brigitte. Ethnographic Workplace Studies and Computer Supported Cooperative Work, in *Proceedings of the Interdisciplinary Workshop on Informatics and Psykology, Schärding, Austria, June 1-3, 1993*, North Holland, Amsterdam (forthcoming).

[23] Jordan, Brigitte and Austin Henderson. Interaction Analysis: Foundations and Practice. To appear in *Journal of the Learning Sciences*.

[24] Kensing, F.: Generation of Visions in Systems Development. In *Systems Design for Human Development and Productivity*. P. Docherty et al. (Eds), *Proceedings of the IFIP TC 9/WG 9.1 Working Conference*. North-Holland, 1987.

[25] Kensing, F. and K.H. Madsen. Generating Visions - Future Workshops and Metaphorical Design. In [18].

[26] Kensing Finn and Andreas Munk-Madsen. Participatory Design; Structure in the Toolbox. In *Communications of the ACM*, no. 36, Vol. 4, 1993, pp. 78-85.

[27] Kensing, Finn and Terry Winograd. Operationalizing the Language/Action Approach to Design of Computer-Support for Cooperative Work. In *Collaborative Work, Social Communications and Information Systems*, R. K. Stamper et al. Eds. North-Holland, 1991, pp. 311-331.

[28] Kyng. Designing for a dollar a day, Office: Technology and People, 4 (1989), pp. 157-170.

[29] Lanzara, G.F. and L. Mathiassen. Mapping Situations within a System Development Project. *Information Management*, vol. 8 no. 1

[30] Lyytinen, K. & R. Hirschheim (1987): Information systems failures - a survey and classification of the empirical literature. In *Oxford Surveys in Information Technology*, vol. 4, pp 257-309

[31] Madsen, Kim Halskov. Breakthrough by Breakdown: Metaphors and Structured Domains. In *Systems Development for Human Progress*, H. K. Klein and K Kumar (Eds), Elsevier Science Publishers B. V. (North-Holland), 1989, pp. 41-53.

[32] Mathiassen, Lars. *Systemudvikling og systemudviklingsmetode*. (in Danish) [Systems Development and Systems Development Method], Ph.D. thesis, DAIMI PB-136, Computer Science Department, Århus University, Denmark, 1981.

[33] Mogensen, Preben, and Randall Trigg. Artifacts as Triggers for Participatory Analysis. In [34]

[34] Muller, M.J., S. Kuhn and J.A. Meskill (Eds): PDC'92 Proceedings of the Participatory Design Conference, Cambridge MA US, 6-7 November 1992. Computer Professional for Social Responsability

[35] Robinson, Mike: "Design for unanticipated use.... ", in G. De Michelis, C. Simone, K. Schmidt (Eds): *Proceedings of the Third Eurpean Conference on Computer Supported Cooperative Work*, Kluwer, Dordrecht, Holland, 1993

[36] Schein, Edgar. *Organizational Cultures and Leadership*. A Dynamic View. Joessey Bass, San Francisco, 1985.

[37] Schmidt, Kjeld. Function Analysis Instrument. In *Functional Analysis of Office Requirements: A Multiperspective Approach*, G. Schäfer et al. Ed, Wiley, Chichester etc., UK, 1988, pp. 261-289.

[38] Schmidt, Kjeld, and Liam Bannon: "Taking CSCW Seriously. Supporting Articulation Work" in *Computer Supported Cooperative Work (CSCW)*. Vol. 1, Nos. 1-2, Kluwer Academic Publishers, Dordrecht, The Netherlands, 1992. pp. 7-40.

[39] Schmidt, Kjeld, and Peter Carstensen. *Arbejdsanalyse, Teori og praksis*, (in Danish) [Work Analysis, Theory and practice], Risø National Laboratory, (Risø-M-2889), Roskilde, Denmark, 1990.

[40] Schuler and Namioka (Eds.). *Participatory Design: Perspectives on System Design*, Lawrence Erlbaum, Hillsdale, NJ1993.

[41] Simonsen, Jesper, and Finn Kensing. *Take Users Seriously, but Take a Deeper Look: - Organizational and Technical Effects from Designing with an Intervention and Ethnographically Inspired Approach*. Stanford University/CSLI (Center for the Study of Language and Information), Report No. CSLI-94-185, 1994.

[42] Simonsen, Jesper. *Designing Systems in an Organizational Context*, Ph.D. thesis, Roskilde University, Computer Science Department, 1994 .

[43] Suchman, Lucy. The Structuring of Everyday Activity. In *Advances in Japanese Cognitive Science,* viol 7, 1992.

[44] Suchman, Lucy A. Do Categories Have Politics? The Language/Action Perspective Reconsidered. In *Proceedings of the Third European Conference on Computer-Supported Cooperative Work, 13-17 September 1993, Milan, Italy*, pp.1-14.

[45] Suchman, Lucy A., and Randall H. Trigg. Understanding Practice: Video as a Medium for Reflection and Design". In [18].

[46] Trigg, Randal, Susanne Bødker, and Kaj Grønbæk. Open-Ended Interaction in Cooperative Prototyping. In *Scandinavian Journal of Information Systems,* vol. 3, pp. 63-86, 1991.

[47] Winograd, Terry. A language/action perspective on the design of cooperative work. In *Human-Computer Interaction* 3:1 (1987-88), pp. 3-30.

[48] Winograd, Terry, and Fernando Flores. *Understanding Computers and Cognition, A New Foundation for Design*, Addison-Wesley, New York, 1986.