

Cooperative Prototyping

- Users and designers in mutual activity

by

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Summary

In most development projects, descriptions and prototypes are developed by system designers on their own utilizing users as suppliers of information on the use domain. In contrast, we are proposing a *cooperative prototyping* approach where users are involved actively and creatively in design and evaluation of early developed prototypes. This paper will present a detailed analysis of an example of application of the approach - design of computer support for casework in a technical department of a local government, where urban planning and environmental control of companies are central work tasks. The analysis starts out from the mutual object of design: the work processes of the prospective users. We look at design as a learning process and analyze various situations where openings for learning occur in the prototyping activity. These situations seem to fall into three categories: the first is situations where the future work situation is simulated and the conditions of the future work activity investigated, in particular the role of the computer application. The second is where the prototype is used as a basis for discussion and articulation of problems with the current work practice, and goals of the future one. The third kind of situations are situations where the design situation as such becomes the focus. Based on the example and earlier results we discuss benefits, problems and prospects of the approach. In particular we discuss the tension between needs for careful preparation of prototyping sessions and establishing good conditions for user and designer creativity. The message with this respect is that users and designers should learn from breakdowns and focus shifts in the prototyping sessions rather than trying to avoid them.

1. Introduction: Motivation and Background

In our previous work, we have discussed how, in current systems design, descriptions and prototypes are developed by system designers on their own utilizing users as sources to ask for information concerning the use domain (Bødker & Grønbæk, in press). We see prototyping with active user involvement as a way of overcoming some of the problems that current approaches have with developing computer applications that fit the actual needs of the users. This type of prototyping was used, with success, in the Utopia project (Bødker et al. 1987, Bødker, in press), as well as several smaller projects following this (Bødker&Grønbæk 1989). Experiences from these projects lead to proposals for a so-called *cooperative prototyping* technique (Bødker&Grønbæk 1989, Grønbæk 1989b). The nuts and bolts of this technique is

to use flexible computer-based design tools that support direct manipulation design and simulation of functionality. The tools are used early in development projects to establish a close coupling between prototype development/modification and work like evaluation of prototypes. This way users are involved actively and creatively in design and evaluation of early developed prototypes. The techniques, however, stand in contrast to most industrial projects. Even when such techniques as prototyping are employed, the typical user involvement has been limited to passive evaluation based on demonstrations or testing of whether programs meet their specifications (Grønbæk 1989a).

This paper is mainly based on experiences from a project that was set up to further investigate cooperative prototyping in realistic settings, here so-called casework in a Danish municipal office. Primarily, the project aimed to develop ways for users and designers to experience future use situations. The outcome of the project was quite different from that anticipated since it turned out that setting up ways for the users to experience future use was, in this case, much more difficult than in our previous cases. However, the prototyping sessions in a number of other ways stimulated creative cooperation between users and designers. The process that we went through is well documented by means of notes, audio and video tapes. In this paper we will primarily focus on some prototyping sessions where the users and designers work with a fairly advanced prototype.

These sessions have all been video-taped, and this material has been used in our analysis¹. Since our primary interest is in developing tools and techniques for cooperative prototyping, we have set up a framework to analyze the various situations and roles that users, designers, tools, prototypes, and test data play in and between prototyping sessions. This yields possibilities of a much more detailed analysis than what we have achieved in previous work in the field.

2. The Project: Designing Computer Support for Casework

In this section we will briefly describe the cooperative approach to prototyping used in the project. We were working on a design project with architects, engineers and draftspople in a technical department of local government. A technical department takes care of tasks such as long-term urban planning, environmental control and advice, and so on. Beside these tasks a number of smaller requests from inhabitants are treated on a day-to-day basis. The architects, engineers and draftspersons call their tasks *cases* and for short we use the term casework for their work. Thus, we call the architects, engineers and draftspersons, caseworkers. There is one caseworker in charge of a case. He or she takes care of external contacts and of involving a number of people with specific skills. The department currently possess three different kinds of computer equipment. They use terminal connections to a common mainframe running shared databases for a number of municipalities. PC's are used for small budget and environmental control calculations and finally they use Xerox Viewpoint workstations for advanced text and picture processing. The computer equipment is badly integrated and the caseworkers feel that they could improve their work by better computer support.

Overview of the design process

Inspired by the ideas discussed in Greenbaum & Kyng eds. (in press) (references to detailed descriptions of techniques can be found in this book) we went through a design process together with caseworkers from the technical department. The purpose of this was to take their

¹Refer to (Trigg, Bødker and Grønbæk, forthcoming) on the use of video and interaction analysis in this context.

practice seriously and involve them in a cooperative system design process that helped them influence technology development in their work environment.

We had previously had contacts to this technical department. We went on to present a project proposal aimed at trying out our cooperative approach to system design in their department. The aim was to design integrated computer support for their casework. The caseworkers agreed to participate, because they wanted to gain insight in possibilities for improving their work. They did not at the time have the economical conditions for starting an actual development project, but they wanted to experience participation in system design and requirements for a future system.

The process started by us improving our understanding of the work tasks in the department. In this round we interviewed most employees from the planning and environment offices, we recorded all interviews on tape and sent notes to all interviewed participants, concerning our impressions.

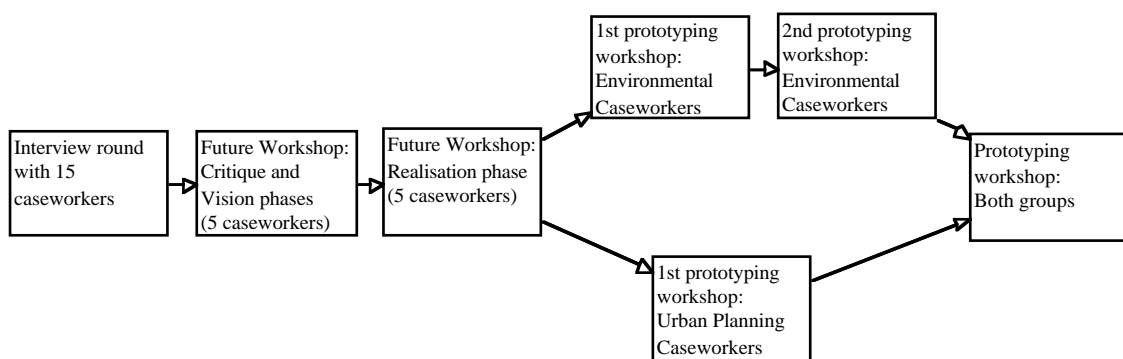


Figure 1: Overview of design process

Based on the interviews we arranged two workshops with five of the caseworkers, selected by the whole group of caseworkers, as participants. We used the future workshop idea as a frame, and started out, in the first session with the critique and vision phases. The participants were each asked to focus specifically on a central work tasks from their daily work in the presentations. Before the following workshop we tried to focus the discussions by suggesting some specific problem areas to work with. The caseworkers chose one of these, and in the second workshop, the visions were made more specific with respect to the selected problem.

Following this, two initial prototypes were set up, one for each of the offices. The idea of making two prototypes was to focus on the specific needs of the two offices, as well as to develop an idea of experiments with two alternative prototypes. The initial prototype for the environment office was made by a group of students, who had also attended the workshops.

The environment office prototype was first tried out by the two participants from the office in two consecutive half-day sessions set up by the students. These sessions took place in a meeting room in the office. The planning office prototypes were similarly tried out in one half-day session, set up by the researchers. The prototypes were augmented cooperatively in the workshops and revised by the designers between sessions. Following this, the prototypes were revised yet one more time and build together into one. This prototype was given to each of the five case workers to try out for one hour each. The idea was that they should start out from the work tasks that they had originally chosen, and work on these by means of the prototype. These tasks, thus sat the frames for the evaluation. The researchers/designers were present in the sessions. Some caseworkers succeeded better than others, partly because the prototype was more focused on some tasks than others. The five sessions from these workshops were all videotaped.

During the analyses in this paper we will discuss the prototyping workshops in more detail, but we will not discuss the initial interviews and future workshop sessions any further.

3. Breakdowns and Focus Shifts

In Bødker and Grønbæk, 1989, we talked about cooperative prototyping situations as something where users primarily experienced their future use situation. We made distinctions between two levels of focus shifts or breakdowns, present in the situation: breakdowns related to the use process, and breakdowns related to the, in-session, change of the prototype.

The participating caseworkers each had their framing work tasks to focus on and work from in the sessions. These work tasks were representative for the variety of tasks that was worked on in the offices and we had aimed to create prototypes which would simulate support for these selected work tasks. We aimed to have the prototypes tried out in a *worklike situation* lasting for an hour, following an introduction to and a demonstration of the prototype. We did not set up evaluation in the real work setting, because we knew that our example material was far too limited for that. However, we also experienced that even though the structure of the prototype was sufficient to support parts of the work tasks, the example data was too limited to keep the illusion of a worklike situation going for a longer period.

In retrospect, comparing what went on in the prototyping sessions to a real work process is of little value: We managed to start only one or two of the caseworkers on "their" work process. Rather the evaluation can be characterized as a step-wise hands-on evaluation of the prototype with the work task as a frame for the evaluation. The sessions become a mixture of caseworkers expressing expectations and trying out single features and designers guiding the caseworkers through the structure of the prototype. There is an ongoing vivid discussion between the designers and the caseworker participating in the session. The evaluation spans across a guided tour of the prototype, where the caseworker asks a lot of questions and come up with a number of proposals, but touches the keyboard and mouse very little, and only when asked; to situations where the focus is design of materials used in the work processes - forms, field sizes, headers, etc. of computer-based as well as paper-based materials.

The caseworkers in general never get into a fluent simulated use situation. This can be seen in that our analysis shows only few of the types of breakdowns in simulated use suggested by Bødker (In press): One of the examples is that we used an asterisk '*' as hypertext link icons attached to words, but to follow the link, the word marked with the '*' needed to be selected. Often the caseworkers selected the *, and got an error message, causing them some confusion. These are breakdowns in how the future work task was carried out, more than in what happened or why it happened. Another kind of breakdowns, we have discussed in earlier works (Bødker and Grønbæk 1989), happened when the users lost their patience with the designers' attempts to fix something in the prototype. This kind of breakdown was also observed in this project and the issue will be discussed later.

We claim that our material shows a lot of openings for learning that can be analyzed in terms of focus shifts and contradictions according to the theoretical framework of Engeström that will be introduced in Section 4. But the two kinds of breakdowns mentioned previously are far too simple to help us explain the rich variety of learning openings. Rather we look for more different kinds of potentials for focus shifts and breakdowns in prototyping situations than described in earlier works. Focus shifts and breakdowns indicate the unpredictability of prototyping sessions that cannot be avoided. In most cases they are not just "failure" indicators, but rather they lead to new insight and trigger new ideas to be explored. We will give a number of examples of situations that occurred during our prototyping sessions due to focus shifts and breakdowns that lead to new understanding.

4. The Theoretical Framework

The analysis of what is going on in the prototyping situation, is inspired by Engeström and Engeström's (19XX) usage of activity theory to analyze situations from empirical studies within a slightly different field, and by Bisgaard et al. (1989). The key ideas are that the design activity is a learning activity. It has the future work activity of the caseworkers as its main object. Prototyping is a part of this, where, in our case, the detailed conduction of the work tasks-to-be are in focus. Furthermore, design aim specifically at breaking down certain aspects of the current understanding of work, for both caseworkers and designers, ultimately by introducing a new instrument in the work process. Designers and users act together with the mutual purpose of changing the work practice of the users by means of introducing a computer application. The instruments of this change include prototypes and prototyping, programming and programming facilities, and so on, as well as the participants mutual language and the pre-understanding that the participants have of the use activity as well as the design activity (see fig. 2)

Some of the fundamental concepts from activity theory are necessary to qualify our understanding: *Human work activity* is the basic component of the theory. A human being takes part in a number of activities when conducting her work: getting food and clothes, making an urban plan, etc. Activity is bound to a purpose and it gives meaning to each concrete *action*, through which any activity is conducted. These actions are conducted consciously by individual human beings. Each action that a human being conducts is implemented through a series of *operations*. Each operation corresponds to the concrete material (physical or social) conditions for conduction of the actions, and it is triggered by the meeting with the specific concrete material conditions. Operations are performed by a human being in a specific situation, without consciously thinking of it, to perform the actions which she is consciously aware of. This framework is elaborated on in Bødker (in press). At the same time we can look at activity, action and operation aspects of any human undertaking, by asking *why* it takes place, *what* goes on, and *how* it is carried out (Bærentsen, 1987).

In Engeström and Engeström (19XX) the idea is that patients' sessions with doctors are confrontations of two practices in quest for a mutual goal, to diagnose a certain illness based on the symptoms of the patient. The doctor in his/her diagnosis uses both instruments such as X-rays, lab tests, etc, models of different diseases, and maybe even medical literature. The patient has access to the symptoms, the pain, and so on, but he or she also interprets these in terms of folklore medicine, etc. We find many similarities between this situation and the prototyping sessions that we have worked with. The common goal of the prototyping situation is to develop a computer application to function in work. The designers use instruments such as the prototyping environment, interview techniques, etc. They have a model or understanding of numerous technical issues relevant for the process and product, and they have some understanding of the work practice. The caseworkers, on the other hand have access to the instruments and materials that they employ in their current work situation. They also have an understanding of this, including also ideas for how they want things differently. We see this framework as one way of detailing the general understanding discussed in fig. 2.

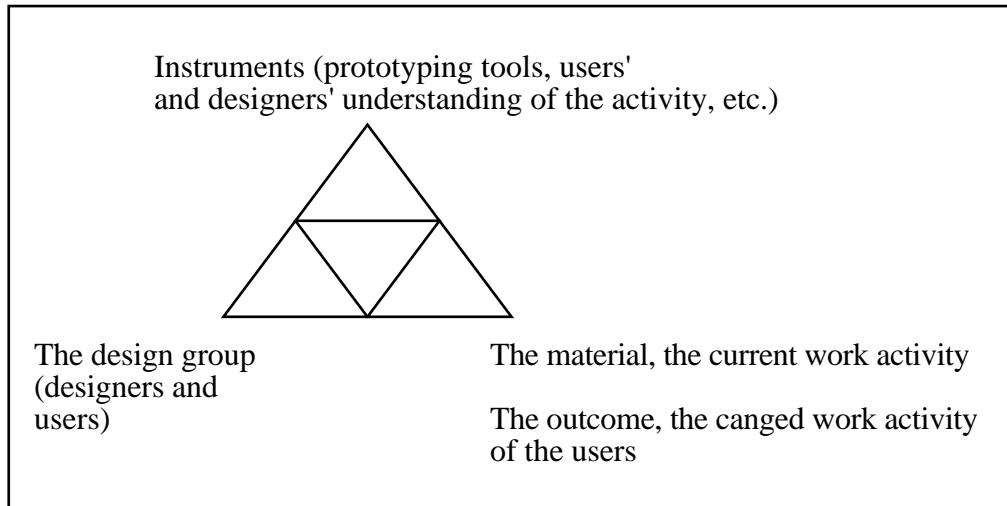


Figure 2: The design activity

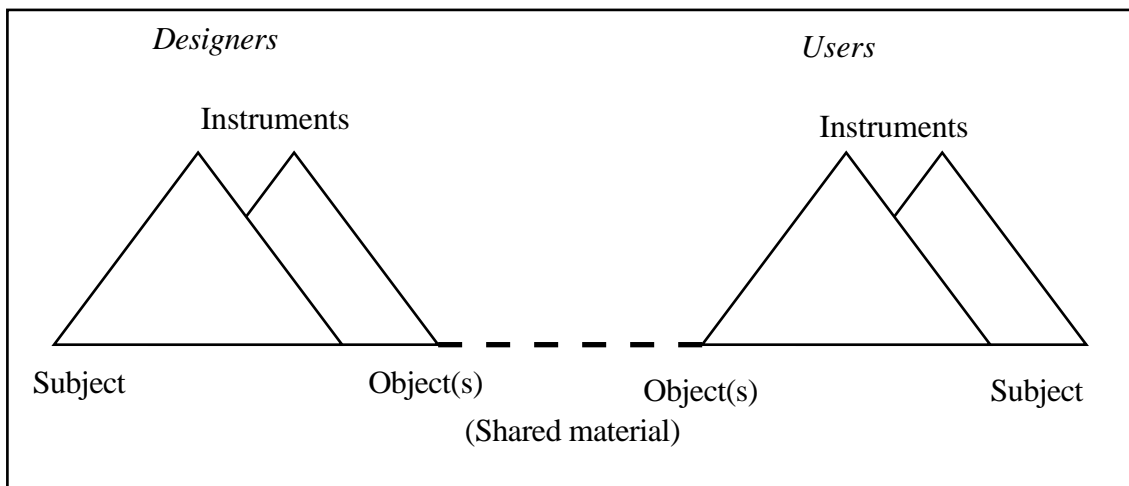


Figure 3: Activity model to use for description of design situations

In our situations we have found it more fruitful to look at the different actions that the different involved actors take as part of their mutual activity (in some cases there is a very subtle difference between a cluster of such actions and a separation into several activities such as Engeström and Engeström describes it). In our case, several caseworkers, as well as several designers can appear on the scene. In some situations, the designers, for example, take action together, in some they do not. Actions have intentions and contribute to the goal of the activity, and operations always take place under certain material conditions, and both, as well as the activity as such, are mediated by instruments. In general we find issues of sharing or not sharing instruments as well as understanding of the intentions of actions to be important for our analysis. For example, we can understand a situation where a caseworker is deeply involved in some details of his/her work tasks, and the designer looking impatiently at the clock, as a situation where the caseworker focuses on the work situation, and the designer on the prototyping session as such. We will identify situations based on the intentions and foci by which they are characterized. We see roles as a cluster of actions that share an actor as well as focus/intention. Sometimes, such a cluster could rightfully be seen as a separate activity, similar to what is done in the doctors' case.

Engeström (1987), when looking at change processes in organizational settings, base his analysis on *contradictions* within the activity and between this activity and surrounding activities, since they constitute the basis for change: he looks at contradictions in how tools, objects, subjects are seen. He suggests studying contradictions between for example, the tools currently used and the object created, or the norms that are part of praxis and the division of work. We use the idea of contradictions to understand changes in the design situation. The types of contradictions that are relevant for our triangle above, are - besides from the ones mentioned already, where e.g. the designer both feels part of a collective subject, and a need to act as individual - contradictions for one of the groups, between the instrument applied, and the object on which one is focusing. In the doctor's case, this could be situations where the symptoms of a patient do not fit the the models of deceases that the doctor has in mind.

In our analysis we will look both for such contradictions, and for situations where a shift of focus is actually caused in the situation: In a breakdown situation, the object or focus of a certain actor changes (Winograd & Flores, 1986, Bødker, in press). In our case, a breakdown will often happen for one of the parties, by which this actor changes focus. For example, the designer is changing the prototype. Something happens by which the designer needs to focus on the syntax of the programming language. This shift is causing a later contradiction when focus has become different for the two parties (e. g. the caseworker still believes that they are still designing screen images, while the designer is fighting to get the syntax right).

Breakdowns are openings for learning, and in our unhampered daily activity, we can see some breakdowns causing a focus shift by which a daily activity becomes the object of our learning activity (Engeström, 1987, Bisgaard et al. 1989). Learning can take place in deliberate learning actions as well, where e.g. one of the actors teaches some other actor about his or her work practice. In the same way, the design activity can as such become the object of our activity. We will use Vygotsky's notion of a zone of proximal development (see Engeström 1987) to understand along which lines such a learning can take place. Vygotsky's idea is that besides from a persons present skills and understanding there is a zone, within which the person is capable of/ motivated to learn. Vygotsky talks about children's development, and takes as a measurement of the zone of proximal development, the difference between what a certain child is able to learn on its own, and with proper adult guidance. We see prototyping as one way of uncovering the zone of proximal development.

5. Prototyping Sessions: Situations and Focus shifts

In this section we apply the framework on a variety of situation types and focus shifts experienced in the project. We illuminate some examples of openings for learning that occur in cooperative prototyping sessions. Types of openings that it is worth paying deliberate attention to in cooperative design in general. The examples are listed under headlines that may point to more general types of situations, but we are of course not claiming to be able to span all possible situation types in cooperative design based on our limited project material.

Evaluating Future Work Situations

This section focuses on situations from prototyping sessions with primary focus on the prototypes as a medium for establishing worklike evaluation sessions. The conditions for and problems in setting up prototyping sessions where users play they are in a future work situation using the prototype, are discussed.

Fluent play of worklike situations

We have already described that most of the sessions in the project described in this paper differ from the sessions described in (Bødker&Grønæk, 1989) with respect to the success in

establishing fluent worklike evaluation of prototypes simulated work situations. The examples in (Bødker&Grønbæk, 1989) were from a series of prototyping sessions with dental assistants evaluating a prototype patient record system featuring direct representation of teeth on the screen. One explanation on the difference could be that the prototypes used for these sessions were simpler than the ones we developed together with the caseworkers in the project described in this paper. Furthermore, it seems that the complexity of the change is also a matter of the extent to which the whole work activity is going to be changed, or only certain isolated actions and operations. But we see a more important difference in the characteristics of the work task and the need for example data to get a worklike evaluation going. In the dental patient record system only a few initial example data was needed to get started on a work task, moreover, registering data on patients was a considerable part of dental assistants work. This implied that an important work task with the prototype was entering of data, which meant that the dental assistants bootstrapped the prototype with example data when evaluating it. In the dental assistant project, the material conditions to make a worklike evaluation take place were easier brought about than in the case of the municipal caseworkers: Most casework in the technical department was concerned with the use of pieces of information that had to be gathered from numerous places in paper files and computer databases. Entering of new data into these files played a minor role in daily work. To let a caseworker get started on for instance modification of a local area plan he needed to have access to nearly all of the long-term plans in the hypertext structure that we had built. These long-term plans consisted of several hundred pages of text.

From the sessions of this project we only have quite short passages that could resemble a longer fluent simulation of a future work situation. One such situation was from the first prototyping workshop. Some of the caseworkers from the urban planning office was trying out the facilities to navigate in the hypermedia structure combining maps and physical data on a certain area under consideration for buildings renovation. One of the caseworkers clicked with the mouse on compass arrows and buttons invisibly attached to scanned maps, see Figures 4-6. The quality of the scanned maps was of course far too bad for the caseworkers to use the maps, but he had no problem in abstracting from that and pretend that he was navigating in real digitalized maps. At some point the caseworker had left the maps and tried to find the most detailed map again directly which was possible; he had to follow the links from the overview map and several levels down. This breakdown lead to a later development of a query facility to jump across the map hierarchy and find maps on all levels of detail. This facility was useful in all the situations where the caseworkers were resuming work on a case where they could remember the label of the sub map. The button navigation was useful in situations where they for instance had to find a detail map for the first time.

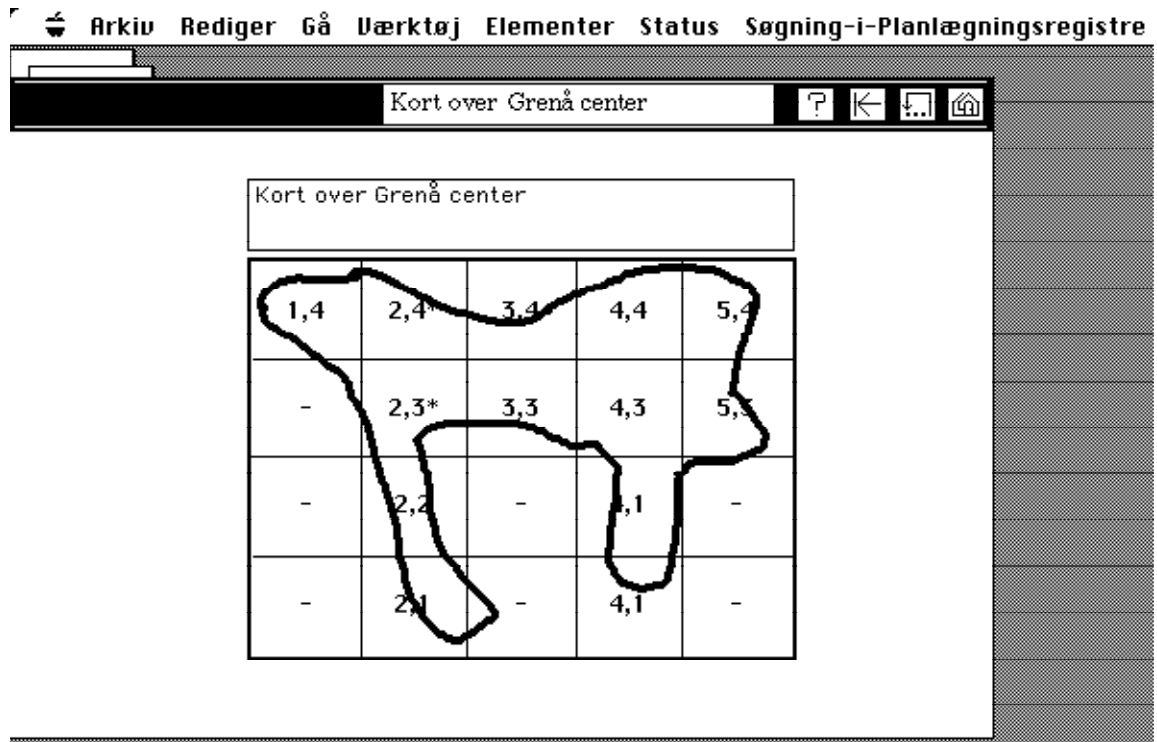


Figure 4: Sketch of top level map for simulation of map navigation

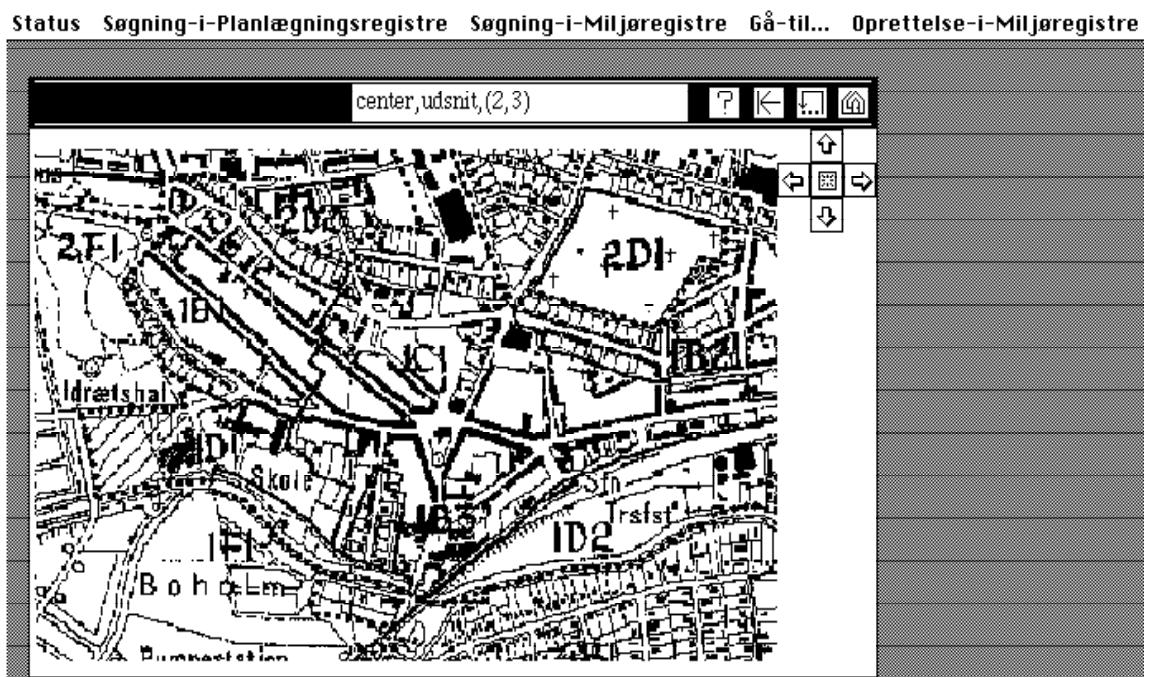


Figure 5: Scanned map for simulation of map navigation

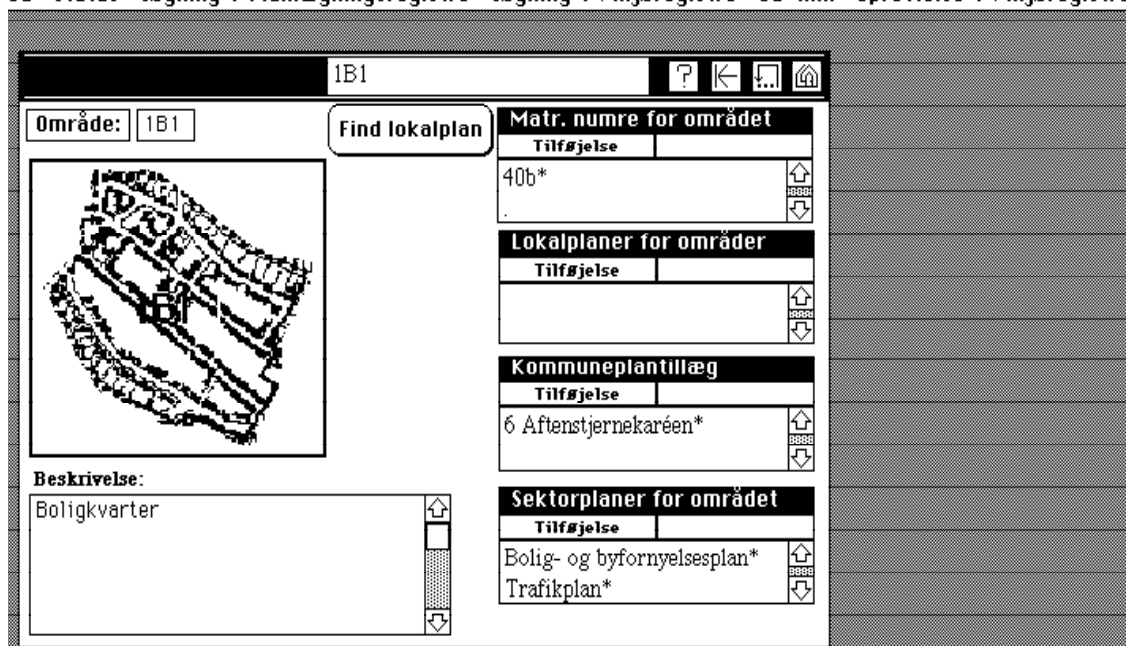


Figure 6: Scanned detail map and data fields for simulation of map navigation

The illusion of a fluent worklike situation did only last for very short periods of time, therefore the openings of learning caused by breakdowns in such situations were few. The worklike evaluation of such a prototype should ideally take place in surroundings where the user could focus entirely on the work task. However, we experienced others ways of bringing current or future work task to be in focus in the sessions.

Pointwise fluent performance of work actions

For one of the caseworkers, A, who in particular sat out to go through his work task with the prototype, it is clear that he was not in a fluent simulated work situation. Rather, we saw a performance of a sequence of actions, and thus operations, that the caseworker associated with the works task that was set up as a frame for the session. The caseworker used an important instrument in the prototyping situations, the model of how the information that was worked on, was organized in the real work situation. This model encompassed both structure and contents of a large body of text. While looking for information in the prototype a fluent work situation broke down because example data was missing. But the caseworker performed an advanced play, where he used only terms from his work domain when referring to the prototype. For instance he said "I need to look at the 'preconditions section' of the municipality plan" when he pushed a link icon and jumped to the place in the structure, where he expected to find that section. He was also able to abstract from some kinds of breakdowns that happened in performance of such actions. This can be seen from A's reactions in a situation where the designers had entered example data in wrong places of the structure. He said "let's just pretend that it was swapped....").

A maintained a focus on the framing work task throughout the whole session. When he tried to perform an action that he found not to be supported in the prototype, he continued a discussion of what he wanted to do with the prototype using concepts belonging to the work task domain. For instance he said at some point: "At this place I would like to be able to bring up list of tasks that I have to do when treating case on a local area plan, and I would like to be able to mark the task I have already done." Only in a few places breakdowns in actions were turning the focus to the prototype as a "thing" detached from the framing work task. These are cases where he needed instructions for how to continue. For instance he at some point wanted to follow a

hypertext link backwards, and asked "which button should I push? And when he got the answer he replied: "Oh, it is this arrow I have to push".

The sessions with A shows to us that even though a fluent work like performance of the work task is difficult to set up mainly due to lack of example data, evaluation activities with pointwise performance of actions from a framing work task help in maintaining a focus on the work task in a prototyping session. That the overall activity is design and not use did not seem to disturb the caseworker in his actions and operations. To some extent he used his paper-based materials when the materials were not available on the computer. There is no doubt that A knew that he was in a learning situation, and that not all the material conditions were as they should be, but the setting allowed A to try out certain future actions anyway. Thus we can consider the future work situations with computer support much closer than we could in an evaluation focusing on the prototype as a "thing" to be tested for errors, which is a quite common way of viewing prototype evaluation.

Our general conclusion from the two examples is that it is important to simulate the future use situation to some extent. The main purpose of this is to examine *how* in the future work activity - to try out the future material conditions set up by the computer application. It is less important though to make this simulation worklike in all respects. Actually, we have seen demonstrated that a playlike situation may be more useful. We need to further examine how such situations are set up. But first, we shall look at other situations from the case.

Generating and Exploring Ideas through Articulation

Some situations from the prototyping sessions resemble a combination of brainstorming and exploratory programming (Sheil 19xx) that is carried out in cooperation between caseworkers and designers². These are situations where caseworkers and designers used prototypes as an instrument for exploring technological possibilities and as instrument for experiments with design possibilities. In all of these situations the caseworkers were talking about their work tasks rather than doing them.

Talking through work tasks

In the sessions with C, B and D, the caseworkers were not working with the prototype very much. Rather the framing work task was talked through in front of the prototype. The prototype got the role as a "thing" that was brought in to illustrate how certain parts of the work task could be supported with a computer. The prototype never became an instrument that was used for work actions.

An example of such situations was seen in sessions with the caseworker, D, who did environmental control of companies in the municipality. D's frame task for the session was "collecting information before an inspection visit at a company". The sessions started out with the designer giving a brief guided tour in the relevant part of the prototype. Then the initiative was given to, D, by the designer asking: "Try and show what you would start out with when you collect information for an inspection visit?". D then took over and said "Firstly I'm checking whether the company has a 'Chapter 5 approval' and then I check whether I have made an earlier inspection visit at the company..... - I guess I'll enter this 'Chapter 5 approval' file". D clicked the mouse on the corresponding item on the table of contents of the prototype. When the screen image came up D sat thinking for a while and said: "This is only an overview of approvals given - how do I find the detailed information? There should be information on

²Some authors even introduced a term for a similar approach: Prototyping as Software storming (paper IEEE Computer)

heating technology, chimney size and the like!" The designer thought for a short while and said: "But these informations are kept in the file of inspection visit reports - have a look!" The designer grabbed the mouse and jumped to the file of 'inspection visit reports'. D said: "Oh here they are.....but this information is really needed in both places, because we have approvals on companies we haven't formally inspected yet!". This way we recognized a need for making links between 'Chapter 5 approval' documents and 'inspection visit reports'. And it was discussed how this could be done after the session.

The session progressed slowly through the frame task as D viewed it in this situation detached from his performance of the work. During this talk through of the frame task we experienced some more focus shifts that moved us into other kinds of situations. On the one hand we moved into situations where we modified and augmented the prototype. On the other hand we also experienced the need for getting more information on D's current work task. This led to an interview like situation with very little focus on future work, a kind of situations that is discussed in a following section.

In these talkthrough situations the caseworker on the one hand primarily took his own current role using his current instruments when going through a typical work task by thinking aloud, i.e. expressing what he was doing as he was progressing through the task. This use of "thinking aloud" is slightly different from the way it has been practiced in earlier human interface studies by e.g. Mack, Lewis and Carroll (1987). In those studies the designers define a new task that the users are going to learn and the designers want to study how they learn to do the task with e.g. a word processor. In our prototyping sessions the caseworkers were, however, going through a task they were already familiar with, even though they were detached from their normal performance of the task. The designers on the other hand were listening and using their more "analytic" instruments to understand the work task, to ask questions, and to bring in relevant parts of the prototype. Focus shifts or breakdowns typically occurred when contradictions in the caseworkers and the designers understanding of the work task were realized. Some of these contradictions could relate to the prototype as described above, but they could as well occur when the caseworker progressed in the detailed talkthrough of the work task.

Through the framing work task it is possible to go through the work actions and articulate and investigate not only questions of what is done, or should be done, also questions of how and why.

Going beyond the current prototype

In a session from the first prototyping workshop with the urban planning caseworkers we were designing computer support for urban and area planning. At some point we were looking at a task on local area planning for an area where a small airport was under investigation and construction. We used the initial prototype for trying out the organizing of the information in database fields on a series of screen layouts.

A more general issue was raised by one of the caseworkers, A: When working with a local area plan it was often necessary to look up certain issues in the long-term plans. These were kept as textual/graphical descriptions in manual folders. But in general the caseworkers found it hard to trace particular issues throughout these folders. Moreover, it was necessary to keep track of changes that were made between major revisions of the long-term plans. Such changes often had implications for a number of paragraphs, tables and figures throughout the plans and it would be useful for the caseworkers to be reminded of such add-ons when retrieving information.

This issue raised by the caseworker coined a discussion on how to represent large text and graphics documents in combination with the databaselike design. For the designers it seemed obvious that some kind of hypertext system was needed. One of the designers went to the blackboard and made a figure showing how sections and regions within sections of the long-term plan could be linked together as hypertext. At the same time, the other designer had opened a Guide™ hypertext document on the workstation to illustrate the kind of system we were discussing³. A brief demo of Guide was given and one of the caseworkers tried to follow some links in the document. This example shows that it was possible for the caseworkers to relate already articulated problems concerning the material conditions and instruments of the work activity to the use of a prototype, and to be creative with respect to changing the situation. The conclusion of this session was that we, the designers, for the next session should come up with an example of a hypertext structure representing the long-term plan for the following prototyping session. In the following session the caseworkers were provided with a hypertext structure representing the long-term plan.

There is, in the material, many situations where caseworkers worked rather painlessly with hypertext facilities without much introduction. They easily adapted to the idea of browsing through text, using buttons, instead of keyword search facilities that were otherwise more common in the computer systems they were familiar with. The designers' introduction of hypertext represented a more advanced form of text representation than what the caseworkers themselves knew about, or would have imagined to be implementable, on the computer. At the same time they, however, there was a clear need to impose a structure on the current texts to support efficient traversal and reminding of crossing dependencies. The cooperative effort brought hypertext into to the zone of proximal development for the caseworkers.

Augmenting the current prototype

The session with one of the caseworkers, B, quickly turned the focus from a worklike evaluation to idea generation and augmentation of the prototype. The work task frame was an environmental case of checking out hidden oil tanks and drinking water conditions on a site. To get started on the task B found the data of the fictitious site with a keyword search on the database. She examines the example data already there and said: "how do I find the site map?" We explained that we had not scanned a site map for this task. Then she explained how she would have examined the site map. Then she started entering some fictitious data reflecting the examination of the site map and existing data. In the middle of her formulation of a request for the owner of the site, she said: "In general we would like to be able to subtract a "list of requests" on house owners - nowadays we have to remember the requests ourselves". B on her own initiative also took over the mouse and attempted to use the existing key-word search function to search for house-owners having a request put on them. Now the focus shifted from the work task to a discussion of how a reminder facility could be designed. As a first attempt to designing the facility was made by the primary designer who grabbed the mouse, entered "Design mode" in the tool⁴, reorganized existing fields/buttons, and added two new fields

³Guide is a hypertext system running on the Macintosh. It mainly supports replacement links and pop-up notes as discussed in (Bannon & Grønbæk 1989)

⁴We had customized our HyperCard environment with a "Status" menu that allowed us to make quick switches between "Design Mode" and "Use Mode". In "Use Mode" the environment was restricted to consist of only menus and windows that were familiar to the caseworkers. In "Design Mode" two windows and some menus that among other things made a number of application oriented and general objects available for reuse/specialization in the session. Unfortunately HyperCard did not allow us to remove all the system menus, such as "File" and

"Deadline for fulfilling request" and "Description of request" to the current screen image. B tried to reformulate the request and used the fields. Then we discussed how we for a following session could prepare a report to generate the list of reminders on requests with deadlines in the current month. We also discussed that the reminder facility might be useful in general for the tasks that the other environmental caseworker, D, was performing. But, B, did not know at what level D made his request, thus we decided to discuss this issue with D in another session. We turned the focus back to the initial work task.

Later in the same session B needed information from the buildings file, a file that was kept on paper. B pushed the button that brought her to the current representation of the buildings file in the prototype. B examined the data on the screen and realized that there was no representation of the change applications/permissions that had been made for a building. B explained that each applications/permissions case consisted of a folder with letters and architectural drawings sent in by the various house owners. According to B it would be of no use to enter this extensive material into the computer, but it would be nice to have an overview list of all the cases on a building and for each case a brief abstract describing the case and telling where to find the material in the paper files. We agreed to make a proposal for that facility. The primary designer entered "Design Mode", and used some already developed application oriented objects. One of these objects was a scroll-able item list field that could be used as an index of abstracts for the applications/permissions cases. An instance of this object was placed on the screen. B suggested a prototypical headline for an applications/permissions case and we added an abstract card carrying this headline and link that to the item on the list. Now the abstract could be brought up by a single click on the item in the list on the overview screen. B tried to perform that operation and seems satisfied with the solution.

The examples described here shows that B, the caseworker, got a number of ideas when confronting a certain work task with a sketchy prototype that was supposed to support her work. The focus shifts in the session were not caused by breakdowns in the simulated use situation, but rather by ideas that came across to B when she had to imagine the prototype being part of her future workplace. This way, the prototype was used to create visions concerning the future computer application and changed work practice. Some of the proposals and ideas, might have come across in a paper-based design session, but it seems as if the confrontation with the prototype triggered a more extensive idea generation. One explanation could be that the prototype was associated directly with the work task and not viewed as yet another technical facility or thing to be brought into the office.

In the modification situations the prototype got the role as an instrument to facilitate a concrete discussion of visions. Both the caseworkers and the designers were pointing at objects in the prototype and various facilities were discussed. Instead of using terms from the application domain there was a high frequency of computer oriented terms such as "screen image", "fields", "buttons" and "arrows". This distance to the work task was reduced a bit when reusing parts of the prototype already familiar to the caseworkers, but it was quite seldom that the parts to be reused were referred to with a name familiar to the caseworkers. For instance B could recognize how to use the scroll-able item list field when she saw it, but she did not have a name for it that she could refer to because it did not as a unit correspond to something familiar from her work domain.

Investigating current work practice

"Go" that were not familiar to the caseworkers. But in "Use mode" the complexity of the screen-layout was reduced considerably.

As mentioned earlier, in some situations the focus shifted away from design of computer support towards more analysis like situations, because contradictions between the participants' understanding of the work task occurred.

An example of such a situation occurred in the session with D, when he was examining the 'inspection visit reports'. He realized that in the prototype there was allocated space only for making one request on the company owner per visit. D, explained that he typically made a number of request on particular aspects such as chimney size or heating. In his current forms he was making a reminder of these request in the margin. This showed a contradiction between the designers understanding of these requests and how they were used in practice. The focus of the session shifted towards an quizlike situation, where the caseworker was teaching the designers about his work and designers were questioning the caseworker about the different ways requests were used.

This is an example of situations where the designers were taking analyst roles, and the prototype got the role of an instrument for learning about the caseworkers current work practice. This is, however, an example of a situation where it might have been more beneficial to step away from the prototype and use other techniques to achieve a more common understanding of the current work practice, before focussing on the prototype again. Sitting in front of the prototype making basic investigations of current work practice endangers that premature changes of the prototype are made. Such changes may contribute to more confusion than clarification.

In the above situations the framing work task and the prototype were used in different ways to help the caseworkers articulate problems in the connection between their current work practice and the future use of computers. The situations were different with respect to the role of the prototype and the framing task, one of them was one where the caseworker directly taught the designers about his work task, and another one where the prototype was used to provoke articulation of work actions.

Focus on the prototyping environment and session

In a number of situations we experienced breakdowns that moved all participants focus towards the prototype and the prototyping environment as a "thing" totally detached from the work task that constitute the frame of the session. Regarding the actual design activities focussing on support for casework these focus shifts are of little use as openings for learning. But with respect to improving the designers understanding of how to prepare prototypes and improve prototyping tools they can be quite useful openings for learning. We will give a few examples of that kind of focus shifts. In several situations we also see focus shifts where the designers get concerned about getting the session moving. These shifts are necessary to keep within time limits, but they can, as we shall see, easily disturb the prototyping activity.

Lacking tool support

In situations where the prototype was augmented, breakdowns due to mismatch between the designers ability to make modifications and the caseworkers needs occurred. An example of such a situation happened with respect to use prepared objects in the prototype. We had prepared a number of general objects such as general search buttons that could be parametrized and fields with special hypertext supporting features. These objects were suitable to go on already existing screen images⁵, but a breakdown occurred at some point where we wanted to start from scratch with the design of a screen image. In that situation we needed a totally blank

⁵"Cards" in HyperCard

HyperCard card that inherited properties similar to already existing cards. However, the way we had set up the environment, it was not possible to get a totally blank card, preserving for instance the browsing capabilities that all the cards in the application were supposed to have. Either you would get a totally blank card with no functionality, or you would get one with contents similar to one in use. This breakdown taught us to be better prepared for following sessions by providing blank screen images that preserved operational properties for each card type we could expect to reuse for design from scratch.

Bugs in prototypes or example data

Breakdowns due to regular programming bugs occurred in sessions. Viewed as an opening for learning these were usually not among the interesting breakdowns, not even for designers to learn about their own environment. Some of these were simple bugs in details that caused little trouble. Either the fixing was simple or the bug could be ignored when continuing the session still focusing on the users work task. In a session with one of the architects we had swapped two pieces of example data in the hypertext structure, but after realizing that it was not his fault he said on his own initiative: "let's just pretend it was right". Other bugs though were more serious. For instance a kind of breakdowns happened, as described also in (Bødker and Grønbaek 1989). We were evaluating a report design that the designers had made before the session. However, the report generator would not select the data requested in the query. After three attempts, the report generator answered with a system bug that required reinstallation of the program in order to get started again. Meanwhile, the caseworker, who was in the beginning interested and active, became more and more passive, as the designer moved into areas of the prototype that the caseworker did not understand. In that situation we were forced to shift focus and jump to another part of the prototype and continue evaluation there.

The focus shifts described here share the property that they make the prototype and prototyping get the role of "things" that do not function well. The designer get the role of a repair person, a programmer, that uses only computer specific instruments to solve problems that are outside the scope of the caseworkers instruments i.e. their understanding. The caseworkers get the role as passive observers that watch a professional doing a complicated task. This kind of breakdowns are not very productive with regard to improve understanding of computer support for casework. Thus this kind of breakdowns should ideally be kept to minimum in cooperative prototyping sessions. Careful preparation and good understanding of what can be done in sessions is needed on the designer side of the table. This issue is developed a bit further in section 6.

Conducting the Session

In several situations we saw these focus shifts. Frequently the designer who had the secondary role in the session, the one not "next to the mouse", realized that the session activities were not serving its purpose, and started intervening into the situation.

One example is the following. The caseworker, A, was deeply involved in typing some piece of information into the hypertext structure of the prototype, whereas the designers got impatient and finally interrupted the caseworker. The caseworker was concerned with correct spelling of words and language correctness. In contrast the designer was concerned about time frames and the evaluation as such: it was a pity if the caseworker spent all the time typing away on some details, instead of getting into some of the more "interesting" aspects of the prototype.

In other situations the designers "pulled" the caseworker away from his/her focus, because they wanted to get through the agenda for the session or simply because they were eager to explore some particular features of the prototype. In these situations the designer often intervened and encouraged the caseworker to "have a look at this", "try this.." or "try to write something

here". This kind of designer intervention was not planned from the outset but happened often in situations where there was a break, a moment of silence, in which one of the designers lost his/her patience.

In these situations the focus moved away from the work task towards the sessions as an object or rather an activity that goes on within certain frames and serves certain aims. These focus shifts were not openings for learning about the caseworker's work task and the computer system under design. But they were openings for learning about how to plan and conduct sessions. One lesson that we learned from these focus shifts was that taking the time limits serious it would be useful to be able to evaluate future worklike situations in a theater and movielike fashion, where a scene indicates that some activity begins and quick scene shifts give the illusion that some long lasting activity has taken place. Activities then continue in a following scene assuming that time has passed and things are changed. For the moment we do not have concrete ideas on how to do that, but we find it important to consider this issue when setting up simulated work situations. We are actually facing a more general problem of how to reduce complexity of real work tasks without losing the important points, that lead to good design.

We have seen two different types of situations where the design situation as such determined the focus of the participants, and thus created (potentials for) breakdowns. In one of the situations, a breakdown in the unhampered activity of the designers, in this case a situation where the prototyping tool stopped working, caused the designers to move away from the common activity, leaving the caseworker in a state of irresolution. The other situation was one where the designers were reminded of their role as conductors of an experiment with limited time resources. This caused them to try to pull the caseworker out of the actions that were currently carried out, and thus arrest the fluent acting.

We find that these situations have helped shed some light on the different learning actions going on in the prototyping session. Learning with respect to the activity, the actions and the operations of the users, and both with a growing concern for the limitations of the current work practice, and with respect to the possible changes when a computer application is introduced. How we can more deliberately make use of these different types of learning actions in prototyping remains to be discussed.

6. Beyond Sessions

We have now discussed various types of situations that we observed in cooperative prototyping sessions, but there is of course more to cooperative prototyping than what goes on in front of a prototype in a series of sessions together with users, caseworkers in the example of this paper. Before sessions preparation and planning is needed, between sessions clean up and maybe reconstruction of the prototype is needed, after a series of sessions results need to be collected and documented in order to propagate them to continuing development activities. In this section we will briefly discuss issues related to what happens before and between sessions.

Each session needs to be prepared dependent on the stage at which the design process is for the moment. Issues concerning preparation of prototyping sessions were discussed at a general level in (Grønæk 1989a), but the analysis in this paper has improved our understanding of the richness of cooperative prototyping sessions. We have seen that prototyping sessions are somehow unpredictable due to inherent properties of creative activities. We have seen that, although sessions were prepared to be rooted in a certain framing work task, the focus shifted in a number of situations due to either breakdowns or more or less deliberate "pulling" of the focus by participants. We have analyzed a number of such situations and focus shifts that occurred in the situations. From these analyses we conclude that users and designers should view focus shifts as openings of learning in the prototyping sessions rather than trying to avoid

them. Of course it is not all kinds of focus shifts that are particular fruitful openings for learnings, as we have pointed to in a number of places in the analysis.

An important lesson learned from our current analysis is that there is a tension between careful preparation of sessions and the inherent unpredictable character of the prototyping sessions. Being aware of this tension, the main contribution from our analysis is an improved understanding of the variety of situations that may occur in prototyping sessions. This understanding can be utilized in preparation of sessions - not to put a tighter steering on the session, but to be prepared to better handle some of the most common and most important types of focus shifts that may occur.

We briefly discuss a few examples of such focus shifts that it would be a good idea to be prepared for. An example of a type of situation/focus shift that we ought to have handled differently in the project was the one called "investigation of current work practice". In this type of situations we realized that the designers needed to learn more about the actual casework. The action changed from design to analysis. But in one of the sessions described we kept sitting by the prototype doing interview like inquiries about current work practice without proper tools and techniques to handle that kind of analysis. In order to be better prepared for that kind of situations the designers could set up the sessions in a room with e.g. a whiteboard (or other kinds of appropriate material) and the designers should be prepared to move away from the prototype and use these other tools and techniques. It is important that we do not conclude that we should move away from the prototype in every such situation. But being aware that this kind of focus shift is quite common the designers can encounter the possibility to move away from the prototype in the session when the focus shift seem to take place.

A second example of a situation type that the designers could be better prepared for is the situations where the focus shifts towards conducting the session. In that kind of situation it is typically one of the designers that starts acting to get the process going. It is important that the designers on beforehand share an understanding of what they do in situations when for instance time limits seem to be violated in the session, or when either one of the users or one of the designers seem to jump to a level of detail that seem to be irrelevant for the purpose of the session. Again it is hard to give general guidelines on what to do, but having discussed such issues previous to sessions may help in smoothening possible regulations in the middle of sessions.

A third example is situations where ideas move the focus towards technological solutions that goes beyond the current prototype. We experienced a quite successful example of such a focus shift where we jumped out of the prototyping environment and experimented with the Guide hypertext system. Guide happened to be installed on the computer that we were using in the prototyping session. We were not at all prepared for making such focus shift, but in that situation it worked out quite well. We all got a common example hypertext to reference to in the following activities, before we actually built some tailored facilities aimed at the particular work task. In this case it was a coincidence that we had this possibility in the session. More generally we would claim that is a good idea to prepare to be able to go beyond the current prototype. Such preparation require some amount of good guessing on behalf of the designers, it is of course impossible for the designers to keep all sorts of example applications and to be familiar with those. Thus it requires some attention during preparation of sessions to think of what repertoire of good example applications to have in stock for the next sessions. This correspond to an attempt to anticipate the zone of proximal development for the group in the following sessions. Such anticipation is hard and cannot be directed by general guidelines, but it is of course based on the previous experiences of the designers.

There are other ways of preparing such situations than trying to anticipate all sorts of example material. We see less fancy prototyping support such as mock-ups (see e.g. Kyng 1989, Bødker, in press) as a handy support in these situations: From other cases we have experiences in using anything from simple paper screen images to more advanced color slide based simulations to support design. With a bit of experience such mock-up simulations are easier set up in a situation than "real" prototypes.

A final example of a type of situations that it is maybe harder to be extensively prepared for are the situations where the focus moves towards the prototyping environment. This happens in situations where we reach the limits of the prototyping environment or when regular bugs are found. Bugs cannot be totally avoided and no prototyping environments are without constraints. But it can be discussed on beforehand what the designers should be aware of when such focus shifts are about to happen. For instance questions such as: "When is worth to fix a bug in-session? When and how should unsuccessful programming attempts be stopped?" could be considered on beforehand. Already experienced focus shifts may lead to more general ideas on how to prepare following sessions. For instance we experienced several breakdowns in a session caused by the fact that we could not pick a blank screen-layout that inherited certain properties. We prepared to avoid that kind of breakdowns by making it possible to pick blank screen layouts for all the different categories we had in the prototype. Such general sources of breakdowns could be anticipated to some degree. The other side of anticipation is, as we have discussed in our previous work (Bødker & Grønbaek, 1989), that the designers should know when to stop, that is, when the situation has become meaningless to the users, and to complicated for the designers to get out of within a reasonable amount of time. In the case study described in this paper, we have seen situations where the designers support each other in getting out of the situation, and situation where they do not. Clearly the decision about when to stop, must be held up against the importance of the change. In any case the designers may need different means to continue the prototyping activity, in some of these mock-ups are useful, in others, the important thing is to get the users going again.

The above examples are not claimed to span the space of possible situations and focus shifts, but they are meant as illustrations of how focus shifts in prototyping sessions can be viewed as openings of learning. Taking these openings seriously they can make us improve our understanding of the cooperative design process in general. With respect to specific projects this understanding can improve our ways of setting up cooperative prototyping sessions.

7. Conclusion

As we mentioned in the introduction there is more to prototyping than rapid development of prototypes and demonstration of their features. To gain benefits from prototyping in systems development it need to be carried out cooperatively by users and designers. This kind of cooperation is a confrontation between two groups of subjects that from the outset possess different kinds of instruments and are used to deal with different kinds of objects aiming at different purposes. However, we claim that the purpose of designing computer support, new objects, tailored to the the users needs have to be temporarily shared between the two groups, or two skills. This implies that we as designers need to develop our instruments in a direction that make us able to deal with the objects of design as objects for a shared purpose. This is not easy, but trying out techniques to perform cooperative system design experimentally is from our point of view the best way of improving our instruments in this direction. Similar to the observation that the best way to improve the understanding of the usability of design proposals is to have it tried in use. The project that we have set up and the analysis of situations documented in this paper is from our point of view a contribution to an understanding that can make the development of designer instruments go in cooperative direction. In particular we

have discussed the tension between needs for careful preparation of prototyping sessions and establishing good conditions for user and designer creativity. The message with this respect is that we need to be open to learn from focus shift in sessions and not prepare in order to avoid them.

Compared to our previous work, the present study has shown to us that prototyping as a way of achieving evaluation in worklike situations may be hard to get to. At least the idea of what "worklike" means needs to be modified some. We find it inspiring to think of the prototyping activities as plays, where the participants act out some situations, but skip others. The timing of which situations to act out, and which to skip or condense in time seems to be of major importance for the development of this idea. In continuing this research we hope to get inspiration from role plays and the like.

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Figures:

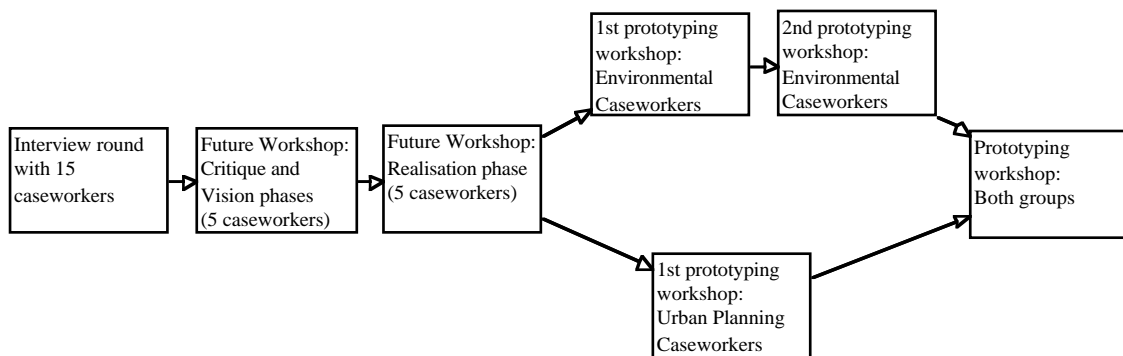


Figure 1:

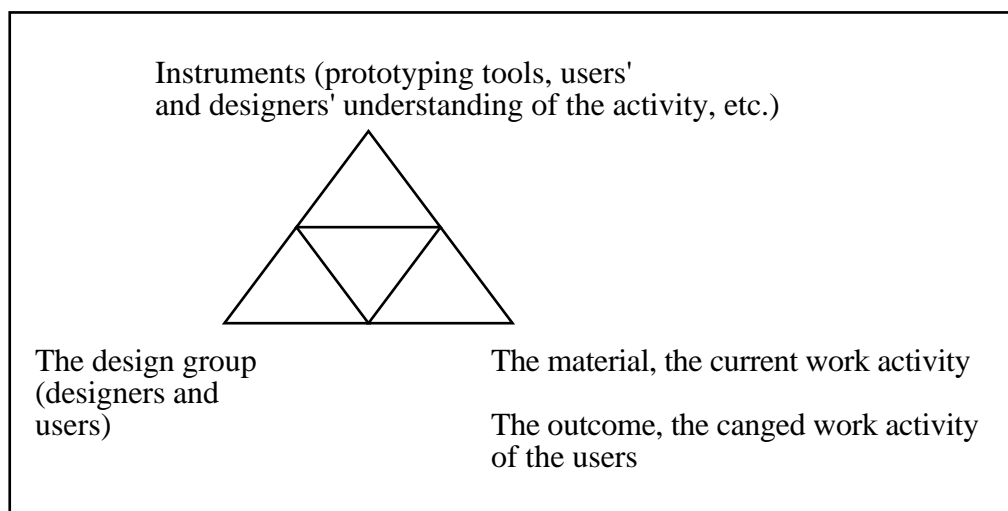


Figure 2:

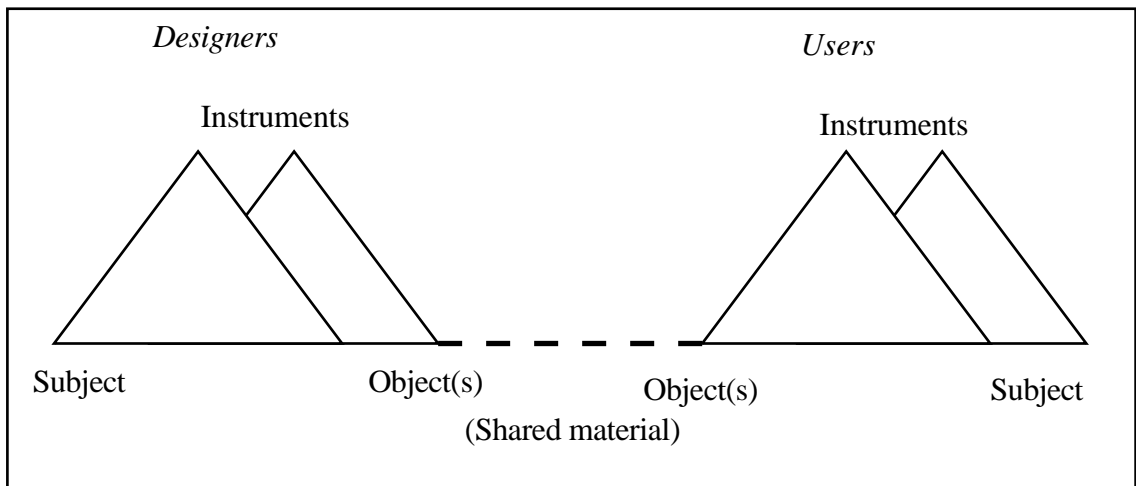


Figure 3:

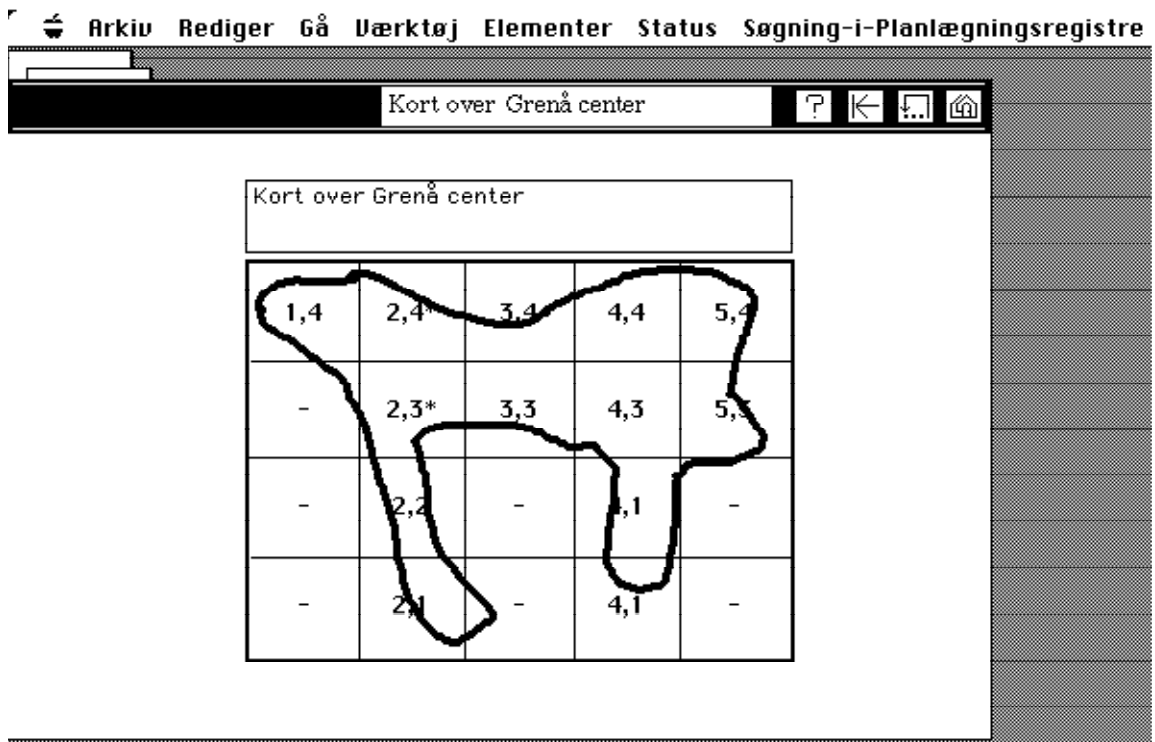


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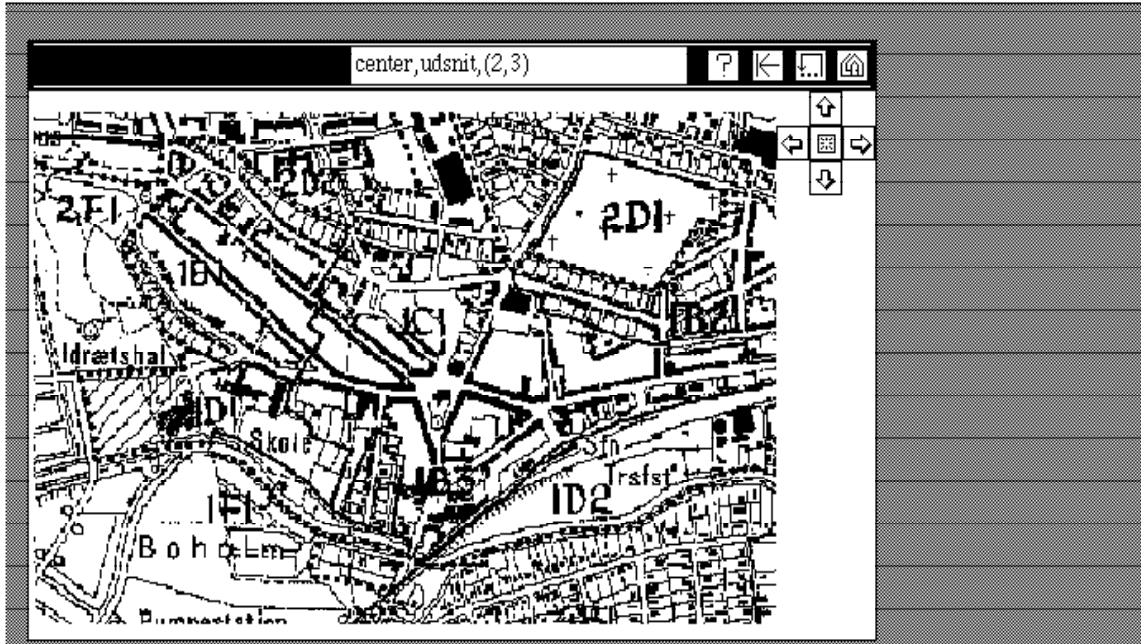


Figure 5:

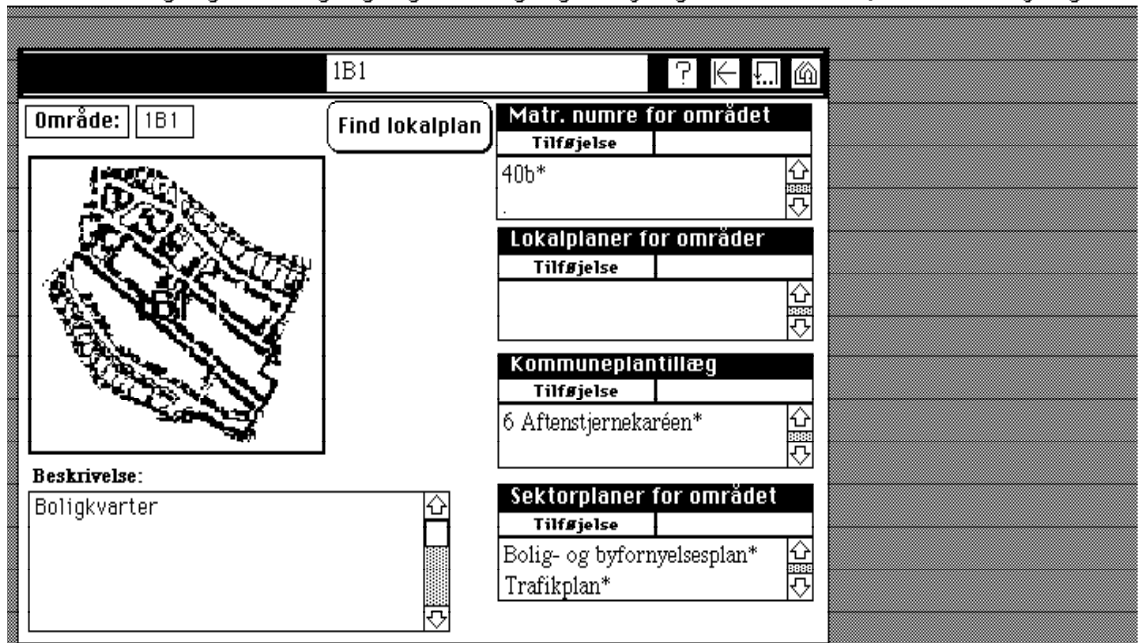


Figure 6: