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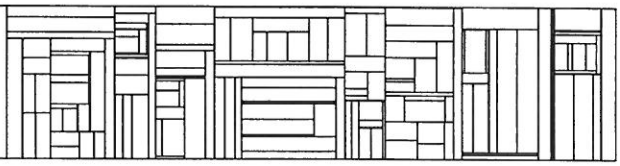

DESIGNING FOR A DOLLAR A DAY

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Abstract

This paper is about the kind of tools and techniques that are accessible to resource weak groups for use in design and evaluation of computer support. "Resource weak" means in this connection, that the economic power and the ability to control the "local environment" of the group is limited. The human resources of such groups are often (potentially) strong, but restrained by the organization of work and society; and although the tools are cheap the activities are demanding in terms of human resources. This kind of work should be seen as a supplement to participation in design processes controlled by others. When end users participate in projects set up by management, these "lay" designers often lack familiarity with the tools and techniques, they lack the power and resources to influence the choice of questions to be considered, and they are not the ones deciding how to utilize the results of a design project when actually changing the workplace.

To give the context of the work on which the paper is based, I first describe the Scandinavian tradition of trade union based end user participation in systems development. Then I discuss some of the issues involved in improving the conditions for independent end user design activities. I go on by presenting a set of "cheap tools" and techniques, including the use mock-up's. This set covers the issues of establishing the possibility of alternatives, of creating visions of new and different uses of technology, and of designing computer support. A central question in relation to the tools and techniques, is their accessibility to end users, and I discuss this based on the notions of family resemblance and "hands-on" experience.

Introduction

For a long time computers have been a part of the transformation of the workplace. A transformation that is planned by management as a way of increasing the profitability of the business. But often introduction of new computer based systems do not meet the initial expectations, and during the last decade an increasing number of people have been looking at the role of the end users in the development process in trying to find ways of improvement, cf. e. g. [4]. As a first step managers and many system developers wanted to get *more information* from the end users about their current work as a basis for developing systems, which to a higher degree met the goals set up by management. Later, as problems continued to occur, users were often tied in more closely with the development process, both as informants and as evaluators of proposed new designs.

As part of the transformation of the workplace working conditions for many end users have changed dramatically, and not always for the better [2, 4, 16]. Especially in Scandinavia these changes were discussed intensively by end users and their trade unions. End user *influence* on the development and use of computer based systems was deemed to be very low, and in many cases increased *participation* did not seem to change the situation. Users participating in development projects controlled by management were unable to create visions of their own or in other ways pursue their interests as a group [13, 14, 22].

To change this situation, Scandinavian trade unions have initiated a growing number of activities covering a very broad set of issues: to question existing solutions, to create visions of different futures, and to design new computer based systems. A key characteristic of these activities have been active end user involvement. Thus it has not been a question of (just) setting up new goals, and work towards them using traditional methods. New ways of cooperating between end users and professional system developers had to be found. The two groups should

learn about and to respect each others backgrounds[1], and the backgrounds, the concepts and skills, of both groups should form the basis for the design work. As it turned out new tools and techniques were needed too. The end users are not professional designers, and the standard set of tools and techniques for system development do not allow them to play an active and creative role [13, 14, 15].

This paper presents the Scandinavian context in which the new activities are developing and discuss some of the emerging tools and techniques for cooperation between end users and professional designers in system development. The tools are cheap and not very fancy. But the activities are demanding. To cooperate in design, especially with resource weak groups, with limited economic power and limited control over the "local environment", requires involvement and dedication over long periods of time.

The Scandinavian scene

Scandinavian experiences with end user participation

Scandinavia has a long tradition of employer/employee cooperation on the shop floor, and for several years this cooperation has been regulated by laws and agreements, and it has included issues relating to new technology [14]. Without doubt all parties involved have benefitted from this cooperation, but at the same time the employees have often experienced severe limits on their influence. When end users participate in design projects set up by management, these "lay" designers often lack familiarity with the tools and techniques, they lack the power and resources to influence the choice of questions to be considered, and they are not the ones deciding how to utilize the results of a design project when actually changing the work place.

Scandinavian experiences from the late sixties and the seventies contains many examples showing extreme bias towards management goals, when joint technology projects move from the formulation of abstract goals to the development and implementation of concrete solutions [12, 23]. In addition a number of cases show, that if participating end users insist on trying to develop solutions, which are not congruent with management policies, they run the risk of being fired or otherwise removed from the design process [1, p. 142].

The Collective resource strategy

In striving for influence Scandinavian workers and their trade unions have, over the past decades, developed their strategy towards new technology. First of all cooperation with management based on agreements continues and develops. Secondly, this cooperation draws on independent end user and union controlled activities both centrally and locally. In the seventies, several projects evaluating the use of computers from an end user point of view were set up by the unions, and a number of one week courses for shop stewards and other interested workers on local union work to influence technology were developed. In the eighties these activities were supplemented by trade union initiated development projects, where workers and computer and social scientists cooperated on design of computer support, with the specific aim of contributing to the further development of skills and democracy at the work place [3, 7, 15].

The first projects in the seventies were instrumental in developing the initial strategy of independent local union work, and large numbers of local projects among end users were initiated. But the high hopes for increased influence via local projects have been dampened somewhat since. First of all, the basic problems of influencing the concrete changes at the company level remains, and if concrete results do not show, the enthusiasm of the users is drastically affected, and so is the personnel resources they put into the work. Secondly, relating short and long term goals continues to be a major problem. Short term goals, like getting rid of computer based surveillance, are easily formulated. So are long term goals like industrial democracy. But whereas many of the short term goals are taken care of in agreements etc., it is often impossible to make any significant progress towards the long term goals, to span the space between the extremes.

Some design projects of the eighties developed comprehensive, concrete alternatives to existing computer support and work organization at news papers [7] and in nursing [3]. In this

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1 "Mutual learning" is one of the key concepts in the Scandinavian tradition. We only touch upon it briefly in this paper. It is covered in more detail in [1] and [7].

way they illustrated some possible "intermediate" stages. But so far they are only "demonstration examples", and strong efforts by numerous groups are needed to if these examples are to be turned into a trend.

One of the major difficulties is that these kinds of activities are indeed new to the end users and their local unions. In trying to influence conditions at the work place they have traditionally focussed on what Sandberg [26] calls distribution issues such as wages, working hours and general terms of employment. They are characterized by well developed union objectives, clearly formulated demands based on the workers' practical experience, and well established practices for negotiations with management. Design and use of new technology are in Sandberg's terminology production issues. These issues are on the other hand characterized by vaguely formulated union objectives, the need to supplement on-the-job experiences with more technical/scientific knowledge, and blurred negotiation situations.

On Computer Supported Cooperative Work

In recent years "Computer supported cooperative work" has rapidly become a catchword. In much of the literature, cf. e. g. [19, 24], the ideal of cooperative work appears to resemble a small research group of the 1980s and it is presented in a way which has strong positive connotations. At times one almost gets the impression of a new technological determinism changing the workplace towards more cooperation and less hierarchy, a change which furthers the interests of all. But as pointed out by Bob Howard in [18], where he discuss these "Mom-and-apple-pie" connotations, things are not that simple. Other important aspects of the same trend are probably transparency and peer control, cf. [17, 18]. The performance of each individual becomes clearer and thus more accountable to the group as well as to the organization. In the presence of conflicts at the workplace these aspects point to both risks and opportunities for the users.

Towards cooperative design

Thus major challenges continue to face the workers and their trade unions in their struggle for influence on the development and use of computer support: how to build up knowledge and formulate demands, how to concretize visions of new ways of using computers and of organizing work, and how to promote their interests. And for designers who want to design for democracy and skill, these challenges carry over to their own work.

There is a need for better cheap tools and techniques, which will be accessible to large groups of end users. Accessible in terms of affordability as well as in practicability and conceptual congruence. They must allow the end users to envision and experience the future work situation. Only by working in the envisioned new situation, using the (simulated) new computer support, is it possible for the users to bring their skills and experiences to bear in an evaluation of a new design [14, 15].

Furthermore many of the design situations and the tools and techniques used should share important aspects with the use situation and with other situations with which the users are already familiar[1]. This allows the users to draw more directly on their professional experience, and to build a common platform for cooperation on design more quickly, than if unfamiliar tools and techniques have to be learned first. Our continued work on cheap tools and techniques is the subject of the rest of the paper[2].

Cheap tools and techniques

In this section we look at some of the cheap tools and techniques, which are developed as part of the Scandinavian collective resource strategy. Most of these have been developed in projects, taught in courses, and applied by end users in local union work for twelve to fifteen years. The exception is mock-up simulations, which are only in the process of being transferred from our projects to the courses.

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1 The notions of "family resemblance" and "language games" and their relation to design are investigated in depth in [7]

2 Several of the researchers from the Collective resource projects, including the author, decided that one of their next steps would be to embark upon a long term effort of developing (better) computer support for cooperative design, cf. [8, 9].

First I briefly describe the organizational setting in which they usually are taught and tried out: Trade union courses on local work with new technology. I go on by presenting a set of tools and techniques, which may be used in activities ranging from initiating work on influencing technology to actual design:

- "True stories and workplace visits" are aimed at establishing the possibility of alternatives.
- "A model for local work" is a simple introduction to some of the activities involved in influencing technology locally.
- "Future workshops" supplement the above model in the area of creating visions of new and different uses of technology.
- "Mock-up simulations" are aimed at concrete design of computer support.

Courses on local work with technology

During the seventies a number of one week courses on local union work and technology were established [22]. In these courses work practices, tools and techniques, which have been developed and tried out in the collective resource projects, are presented to a wider audience. In the first courses emphasis has been on system evaluation and creation of visions of alternatives. These are now being supplemented by new courses on design and participation in systems development. Although we haven't formally evaluated these courses, we consider their impact on the possibilities of the end users to influence technology to be high. In Denmark, for example, approximately 500 shop stewards from the clerical workers union take such a course each year.

A typical course goes from Sunday evening until Friday afternoon. It has twenty participants from ten to fifteen different workplaces, one teacher, who is there for the whole week and a few additional discussants, each participating for half a day or so. During the course a number of subjects are covered in class. These include evaluations of concrete systems, tools and techniques for local work on new technology, and how to influence managerial decisions. A substantial part of the time is, however, spent in smaller groups working on a single task throughout the week: "What activities would you suggest that your local union initiates within the area of computer based systems?". This work in smaller groups is designed with the purpose of creating a coherent process of learning which relates to problems at the workplace, and which allows the participants to work with some of the tools and techniques introduced in class.

"True stories" and Workplace visits

One of the greatest obstacles to end user engagement in technology issues is the beliefs in technological determinism and in the existence of only one way of doing things. Thus one of the first things we do in relation to evaluations of computer based systems is to introduce and further ideas on other ways of using technology than those a group of users know from their own workplace.

There are many ways of doing this. There are several books and pamphlets, and in recent years an increasing number of videos, that touch upon "end user/worker issues" in relation to technology and which have "active end users" as their intended audience[1]. We have found that the most useful material is that which contains concrete examples of situations with some resemblance to that of the users, especially with respect to end user activities. One part of our material for discussion consists of "True stories" from the workplaces of participants in earlier courses. Stories on how they started to investigate the use of a particular computer system, of evaluations of a plan proposed by management, and of their proposals for changes and new solutions.

In addition to these sources more concrete experiences are needed, as are the possibilities of investigation beyond what is presented in a book or video. A simple way of doing this is to have some of the users who participated in the activities described in one of the "True stories" as a discussant.

Visits to different workplaces provide another powerful opportunity. These workplaces should preferably be in the same line of business and have noticeable technical solutions.

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[1] In Scandinavia the Collective Resource projects have produced dozens of reports, which are now used in different kinds of end user education. References to most of them may be found in [1]. The American video [10] describes some of the work in Scandinavia on end user involvement in systems development.

Seeing technology at work, and discussing with end users immediately places the visitors in a situation where they have access to experiences from use, not just from reading descriptions. In some cases it is even possible to arrange for the visitors to work with a system for some period, thus making the experiences from use partially their own.

In the DUE project, where we worked on production control at a shipyard, we visited another yard, with a highly developed computer based system, which the planner used to give detailed instructions to the workers. This served as an important reference point of an "undesirable possible future" for our group in the following discussions. And when a similar system finally was turned down by the workers, reference was made to the other yard more often than to abstract, "logical" arguments.

A model for local work

In this section I present a simple "three component model" used in the planning of new user activities on technology. The components have a certain temporal dimension: analysis is followed by formulation of goals and then by actions; after which follows analysis once more. However, one such "cycle" do not has to be completed before the next can begin and in practice activities relating to all three components are going on in parallel. The model evolved to have the following components:

- Analysis. The users, in small groups, discuss their current situation in order to identify negative and positive elements. Special emphasis is placed on changes related to introduction of new technology over the last years, and in trying to identify recurring problems.
- Goals. In the second step goals are discussed. On what basis do we evaluate the elements as positive or negative? What is the relation between the goals held by the group and those of other groups of employees and those of management?
- Actions. Finally possible courses of actions are investigated. How may the group try to start realizing their goals? What have other groups in similar situations done? What can be done to increase the activity level locally? and what support may the unions supply?

Especially with respect to the last point, it is important not to consider the resource situation as static. When new groups begin to work with technology they begin to build their own body of experiences, positive and negative, and this will contribute to an improved basis for new actions in the future.

One of the ideas behind this three component model is to concretize goals which may challenge management's monopoly in defining the company rationale. On the one hand, this has worked in numerous cases, where simply formulating alternative goals gave new legitimacy to ideas of the group and served as a point of reference in questioning proposals from management. But in many cases the step from goals to concrete suggestions for change was very difficult and it should not be set up as an ideal[1]. If you have some concrete ideas about what you want to accomplish, thinking about abstract goals is often a difficult extra step, which may add only little to ones understanding. As an example of such a goal consider "New computer based systems should increase the possibilities to use and develop skills". Such a goal may play an important role in evaluating systems, but its explicit formulation is no prerequisite to the creation of systems with this property.

Future workshops

The "Future Workshops" of Jungk and Müllert is in many ways similar to the above model, although their workshop idea is far more developed. It is is well documented in literature [20], and I will mainly use it to illustrate some of the difficulties involved in selecting or developing the basic concepts of end user tools and techniques. One of the main differences is in the formulation of the second component, which we labelled "goals". In the "Future Workshop" model the second step is called the fantasy phase, and the idea is to formulate positive visions about the future. These visions are then in the last step transformed into courses for action. Thus "Future Workshops" avoid the formulation of abstract goals, and instead help people work with concrete ideas for future situations.

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[1] The model and its use were developed in the first Scandinavian projects, at a time when production control was one of the major new uses of computers, and the notion of explicit goals was at times over emphasized in our own techniques, cf. the section on "future workshop's".

The main function of the workshops is to allow people to share problems and experiences, and to create situations where formulation of visions, without logical arguments to support them, is legitimate. In this way they contribute to the liberation of the creative resources of the end users. The workshops seldom move beyond the level of "lively discussions". They are, as the "three component model" above, mainly initiators. Practically all the work done in our use of Future workshops consists of talking and writing, but, as discussed below, these are not always adequate means of expression. More concrete "visions" of new ideas is often needed to push understanding and discussions ahead. The mock-ups discussed below represent such concrete visions.

Mock-up simulations: design by doing

Our discussions so far have focussed on activities which new groups of users may embark upon as some of their first steps towards increased influence on the use of computers. Often their main function is as evaluation of management design proposals. Similarly their results, in terms of computer based "products", are in these cases usually corrections and minor changes to systems proposed by management.

However, such activities also constitute an important part of the initial work of our design teams. In a cooperative design process workplace and vendor visits and "future workshops" may be used to open the eyes of the participants to the limits of traditional company design rationale. The system designers learn something about the work of the end users, about the application area, and the end users learn something about technological possibilities and limitations, they enhance their technological phantasy. We denote these activities mutual learning [14].

In the first design projects both end users and system designers played active roles in the mutual learning process: teaching, discussing, and learning about their own work and that of the others in the group. However, when we moved to design activities in terms of writing "traditional" system specifications, the professional designers took the initiative. We tried a number of other approaches, including scenarios describing possible future work organizations and computer based systems, but only with limited success. When we began to use mock-up's the roles changed dramatically again: Cooperation between researchers and skilled workers shifted from situations where the workers read and usually agreed upon descriptions made by the researchers into working sessions where (simulated) computer based tools were tried out in practice, and actively criticized. We were designing by doing.

In the UTOPIA project we built mock-up's of workstations with high-resolution screens and a number of different interaction devices, including some "mice" and tablets, of scanners, and of laser printers. the mock-ups were made from paper, photos, match-boxes, plywood, etc. Based on the preceding discussions a number of proposals for representation of materials and tools/operations were concretized in terms of the mock-up's, and then the end users started to try work with them. Step by step some task was carried out, and the corresponding screen images drawn on paper. During the process changes to screen-layout and tools were made in discussions between the involved users and professional system designers. Their role was to point out possibilities and limitations of the equipment being simulated and to collect and structure the comments.

In hindsight the change in the role of the end users is easily explained in terms of "hands on experience in familiar situations". The mock-up simulations allow the users to draw directly on their skills in carrying out work in the application area. The team may consider also non-describable aspects of computer support and use processes. Evaluations may be based on how it "feels" to work with the mock-up. The group may then try to construct rational arguments afterwards, if or when needed. The importance of family resemblance and hands on experience in relation to end user involvement in design have been discussed in a number of papers from the Collective Resource tradition, e. g. [14, 15], and is related to a growing body of recent work on development and use of computers including [11, 25, 27]. In this paper, I will not go into a discussion of the philosophical underpinnings. Instead I will use the notions of family resemblance and hands on experience as a basis for discussions of mock-up's and simulations.

Hands on I: When to simulate

Cooperative design is a long and complex process. Mutual learning between the participating groups, including visits to different companies and exhibitions, is one of the first steps in this process. Elicitation of existing problems and visions in a future workshop and brainstorming on

possible new designs could be another. Simulations using mock-ups a third. However, there needs to be a mock-up which may be *used* before the kind of design situation we are talking about comes to be. The end users participating in the design are not skilled in working with match-boxes and plywood, but in carrying out tasks in the application domain. Thus the use of mock-ups is not a total "boot-strap" process. There needs to be some (simulated) artifacts related to the application area on which the users initially can "place their hands".

Hands on II: Do it again
Once the first version of a mock-up simulating some design have been build and tried out it should be modified, tried again, possibly thrown out, an alternative design constructed, and so on. One of the reasons for this is, that we build mock-ups early in the design process, to have something to use, to generate new input to the design process. The first mock-ups are there because we need them, not because they are close to what we want.

Secondly, it takes time to get acquainted with a design on a mock-up, and to explore ways of using it. Certain aspects of a new design may be awkward to work with at first. They may certainly continue to be so, but in some cases we have experienced that a week or two is needed in order to get acquainted with the implications of a powerful new idea. At other times a lot of tedious fine-tuning may be needed in order to arrive at a good solution.

Family resemblance I: The role of the users
The main idea of mock-up simulations is to allow the end users to get close to experiencing their future work situation. End users should thus play (future) end users when they use the mock-ups. The tasks and the organization of work will be different, but the assumption is that the present professional experiences of the end users are valuable, and their roles in the simulations must then allow them to exploit these. The rationale behind the argument being that this experience and these tacit skills are crucial to a design, which is to further the development of skilled jobs and democracy at the workplace[1].

The users thus act on the basis of a shared background knowledge pertaining to the work in question. And this knowledge is developed through the cooperative effort of the design group.

Family resemblance II: Maintaining a shared understanding
In most of our earlier work using mock-up simulations, we focussed on those systems aspects, which were related to one persons interaction with the system[2]. In these cases maintaining a shared understanding of the design in question didn't turn out to be a major problem. The shared understanding between end users was not crucial during a "session", and in discussions between sessions etc. the necessary understanding could be reinstated. However, when we focussed on the cooperative aspects of new computer systems, this was no longer the case.

The mock-up's are there to be used, and when a simulation continues smoothly, when the use-situation works, so do the familiar ways of sharing understanding of the situation at hand. Often, however, breakdowns will occur quite frequently during simulations with mock-ups. When this happens the group should evaluate the cause of the breakdown. Sometimes it makes sense to continue after making a short note, but often changes in the design are necessary. In these cases it is important to shift explicitly to a discussion of possible modifications. Otherwise the people involved may make their own personal assumptions about the new state of the mock-ups, and the situation on which an individual acts becomes unclear, since it is not shared with the others.

Family resemblance III: Materials for building a mock-up
Mock-up's may be built from a large variety of materials, such as paper, plywood, matchboxes, overhead and slide projectors, flip-overs and blackboards. Animation is usually provided by auxiliary persons, but in the case of e. g. an automatic slide projector the mock-up itself is capable of carrying out some functions. The main point in the selection of the materials is that they should be familiar to the participants. Users, and professional designers, seem quite capable of treating e. g. a sequence of pre-drawn pictures combined with voice passing through a blind as interactive window sharing over a network combined with an audio link.

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1 This position is described briefly in [14], and discussed at length in [15].

2 How people cooperated was mainly dealt with in discussions supported by tools for visual descriptions of the work organization. The tools we developed is called the organizational tool kit. It is briefly described in [7].

When the materials are familiar, users are capable of distinguishing breakdowns at the level of the materials used to build the mock-ups from breakdowns at the level of the (simulated) computer support. Similarly they usually have no difficulties in distinguishing relevant aspects of the mock-ups from the irrelevant (in the particular situation). They know that the brand of match-box used does not matter, and they know when the size of the simulated screen does.

Concluding remarks

The Scandinavian work on end user influence is founded in a long trade union tradition. Many of the important factors, such as a strong central body capable of supporting local initiatives, e. g. by organizing courses, take time to develop, and specific societal conditions may prevent such bodies from forming. The basic idea, however, of independent local activities have a much wider applicability than the Scandinavian trade union setting[1]. It is a great challenge to develop the capabilities of resource weak groups, at the work place and in the local area. It is a challenge that has to be met if we want to move away from a society, which gives ever greater influence to large corporations and state bureaucracies, and it is a challenge that has to be met by the groups themselves. In addition a useful role may hopefully be played by those professional designers, who are not content with the present state of affairs.

Tradition and transcendence

Our experiences show that the position presented in this paper runs a risk of being accused for conservatism. Although I agree that transcending traditional work practices is a major challenge, the two most common criticisms miss the main point. People associated with management complain that end users resist change, and overlook the fact that changes controlled by management often leaves users in a less favorable situation than before. Under these circumstances resistance to change is the most reasonable action. System designers too complain about the conservative effect of involving end users, and overlook that the slowing down often comes from being forced to pay attention to new, relevant aspects of the application area.

When end users don't fear that the outcome of the work will be used to their disadvantage they are quite capable of participating creatively in a design process. Indeed, we consider the experiences and skills of the users not as an obstacle, but as a prerequisite for a cooperative design process where the ultimate goal is to transcend current practices [3, 7, 14, 15].

Role playing: a different story with some family resemblance

As one of the next steps in our development of cheap tools and techniques we have just begun to investigate the possibilities and limitations of role playing. I mention it mainly to point out some fundamental differences between simulations as discussed above and role playing, and thus to point at some of the problems which may confront us, when trying to combine the two techniques.

In the mock-up simulations discussed above, users "play" themselves in an imagined future work situation, primarily defined in terms of the mock-ups, and their professional skill and experiences form the basis on which they act. Role playing, on the other hand, implies trying new or different roles, where the professional skills of the playing users cover only a small fraction of those of the corresponding "real, professional users". This indicates that role playing is not so much a way of evaluating a new design, as a way of turning the tables. It may be used as an element in a process of mutual learning, where the players get a new understanding of a situation by viewing it from acting in a different role than usual. A related outcome may be a less one-eyed view of the other groups with whom one cooperates[2].

Role playing may be used when new, often very different, ways of organizing work or new tasks are to be explored. It may be used e. g. by a group of secretaries who want to investigate the possibilities of distributing some of the planning and evaluation tasks, which are presently done by the managers of their department, among their own group. However, the lack of the professional skills needed for their roles creates difficulties in evaluating the possibilities being

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1 This is also supported by the experiences with "Future Workshops" reported by Jungk and Müllert in [10].

2 In Scandinavia role playing was in fact a popular part of managerial strategies some twenty to twenty-five years ago.

explored and in keeping the play on the track. In the example with the secretaries, it might be possible to involve people with knowledge of the kind of planning in question, maybe even some of the managers. As for keeping the play "on track", it should be realized that we are playing to developing the participants understanding of a situation.

Cheap is not easy

Cheap tools are usually not fancy tools. But, as we hopefully have demonstrated with the presentation above, they have useful capabilities and offer new possibilities for cooperation in design between end users and designers. Learning a new technique, to use a new tool always requires some work. And, as in our case, when there is no obvious single source from which to learn, developing tools and techniques, as you learn to use them, is a large undertaking. We have just begun to focus on the cooperative aspects of computer support, and our first attempts to combine mock-up simulations with role playing turned to be more difficult than we had hoped. Thus some caution is reflected in the paragraphs above, not because I am pessimistic about the possibilities, but because learning to master cheap tools, and to change them to suit different conditions, takes time and a lot of effort.

Hopefully, designers will find it challenging to work with non-computer supported cooperative design, at least until workstations and powerful software have become the cheap and familiar tools of all of - both users and designers.

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