# The Envisionment Workshop - from visions to practice

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**ABSTRACT**

How do we design for quality in use across design borders between material aspects like spaces, places and equipment and immaterial aspects like organisation and information technology? How can users participate in this process, and how can different design professionals participate and co-operate? We are a group of researchers and designers with a background in architecture, systems design, work psychology, educational drama and physical work environment who have formed a project to explore these questions in practice.

We all share a commitment to the idea of participation and have for a long time worked with different visualisation methods and techniques including full-scale modelling, prototyping, animation, role playing and future workshops. In the project Design@Work we have combined our efforts and techniques in an "envisionment workshop" (which also include techniques for virtual reality interaction). This paper focuses on our experiences from the first explorative case study carried out in co-operation with workers, technicians and management at a chemical plant. They were planning to build a new control room, to change the work organisation and to automate part of the production.

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**Keywords**

Design, participation, visualisation, full-scale modelling, animation, information technology, architecture, work psychology, work environment, work organisation.

## THE VISION: AN INTRODUCTION TO DESIGN@WORK

### Crossing design boundaries

The process of design at work is contextual where the real challenge for designers today is to design for quality in use. But who are the designers, what are they designing, and how do they do it?

It wasn't until the sixteenth century that the term "design" emerged in European languages. This emergence coincided with the need to describe the process of design and the profession of designing. In particular, the term indicated designing as a separate process from doing (Cooley 1988). In modern times the design process has been studied as an academic field since the early 1960s. This field has been dominated by architectural and industrial design, but the less material design based on information technology is attracting more and more attention.

This development of design approaches can be described as having three generations - an objective, a social and a subjective. The first addresses our "objective world" and the approach has to do with control - with the correct representation and manipulation of objects, facts and data. The second addresses our "social world" and the approach has to do with ethics - with democracy and appropriate social interaction. The third addresses our "subjective world"

and may be described as having to do with aesthetics - with the expressive and creative competence of designers (Cross 1984, Ehn 1995).

Today the separation between design and doing are being challenged in several ways, and so is the separation between technical control, ethics and aesthetics. The second design generation which has a focus on participation suggests that, in a way, users could and should also be designers, and with the new immaterial design materials, a design can be hard to distinguish from the ready-made product.

Furthermore, in retrospect, participatory design still appears to be a very important approach, but the design generations are complementary rather than mutually exclusive, and our ability to design for quality in use may very well have to do with our ability to design across the design generations, and to find an appropriate balance.

Finally, a particularly interesting design challenge today has to do with designing for quality in use across design borders between material aspects such as spaces, places and equipment and immaterial aspects such as organisation and information technology.

**Design@Work**

With this as a background, the project *Design@Work - an Envisionment Workshop* started in July 1995 in order to learn more about how to design across boundaries for quality in use. We are a group of researchers and designers with a strong commitment to, and long experience in, participatory design in our respective fields: architecture, systems design, work psychology and physical work environments (see e.g. Bjerknes et al. 1987, Ehn 1988, Greenbaum and Kyng 1991, Hornyanszky and Rydberg 1992, Lawrence 1993).

The project is organised around an "envisionment workshop" for participatory design of future work and appropriate technology. This workshop has been shaped to integrate methods and techniques for envisioning working environments, work organisation, production technology and premises, within working fields that have a substantial element of information technology. This approach has been implemented in a laboratory environment where real work can be envisioned in full scale simulations and in virtual reality modelling. Hence, the project is aimed at an interdisciplinary laboratory environment for learning and change that can be utilised by people in organisations who want to envision different possible futures at their work place. Though, workplace problems are complex and should be analysed and solved within their contexts it can also at times be appropriate to define specific problems, solve them and put them back in their context.

**Learning and design-communities-of-practice**

During the first phase of the project, the inter-disciplinary research and design team was established. This included such activities as methodological and theoretical studies which were combined from the different participating disciplines as well as the actual development of the joint envisionment workshop.

The visualisations we attempt to achieve in the project can be seen as a means for learning. The kind of learning we strive for is based on discovery, development, experimentation, understanding, action and reflection. Three different, but related, theoretical frameworks are of great importance to this understanding of learning and design: experiential learning, situated learning and reflection-in-action.

Experiential learning (Kolb 1976) emphasises the importance of experience in learning. In the experiential learning model, learning is presented as a four-stage cycle which begins with a concrete experience. This experience is then observed and reflected upon. Conclusions are then made and experimented with in new situations which brings us back to new concrete experiences and so forth.

Situated learning (Wenger 1994, Lave and Wenger 1991) means to learn in communities-of-practice. This view allows for understanding learning as relationships between people, their actions and the environment; a continually evolving social process. Newcomers in a social community learn from the old-timers.

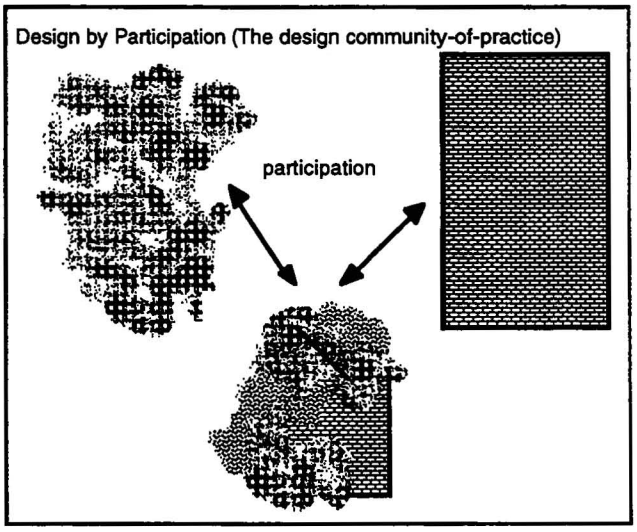



Figure 1: A design-community-of-practice: A communicative and participative view on the design process. Two or more communities-of-practice fundamentally related via shared experiences in a common design community-of-practice witch has a resemblance with the ordinary community-of-practice of both users and professional designers. A fundamental competence of the designer is the ability to set the stage for a shared design community-of-practice that make s sense to all participants.

Reflection-in-action (Schön 1987, 1983) is what we learn while we are doing something and how we ponder over the events and the learning simultaneously. Afterwards we can reflect-on-action, think about what happened, what we have learnt from that and which conclusions we can draw from the experience.

Participatory design using full-scale modelling, mock-ups, prototyping, scenarios, role-playing, animation and virtual reality simulations can, in reference to this background be seen as taking place in a created shared design *community-of-practice* which can be viewed both from the point of view of the users and of the designers (Ehn 1995). In this kind of design communities-of-practice the users learn about possibilities and constraints of new IT artefacts that may become part of their ordinary community-of-practice. The designers become the teachers that teach the users how to participate in this particular design community-of-practice. In order to set up these kind of communities-of-practice the designers have to learn from the users. In participatory design there seems to be a new and fundamental role for the designer as the one who sets the stage for a shared design community-of-practice that makes sense to all participants - designers *and* users.

**Visualisation: Methods and techniques**

To develop shared design communities-of-practice as environments for learning and change the project to combine various methods and techniques for including full-scale modelling, virtual reality simulations, prototyping, democratic meeting technique, drama and future workshop (see appendix). Though different in complexity and abstraction, the common ground between these design methods and techniques is that they all aim at visualising aspects of present and future work situations and allow active user participation.

The full-scale model is a flexible modelling kit with which various types of environments can easily be erected on scale 1:1. The model enables users to act in, experience and manipulate the environment and help to emancipate the user's ideas of spatial organisation and their knowledge of special qualities gained through practical experiences.

Virtual reality is a powerful three-dimensional visualisation tool, in which environments can be modelled within a computer with which users can move and interact. Virtual reality can be used to allow a group of people - designers and users - to work together on an architectural design and the design can be walked through, 'felt', tested for suitability and altered as desired.

Focus in prototyping systems design is on the hardware and software functionality of the future system. Prototyping is both a question of building a prototype and of developing scenarios in which the users together with designers can try it out. It allows for "hands-on experience" and "design-by-doing".

Democratic meeting technique is a simple technique, aiming at visualising participants' points of view during meetings. Visualisation is achieved by use of flip charts where the opinions are written, for all to see. The opinions on the meeting theme are structured according to three headings - positive, negative and suggestions.

Dramatisation is a learning technique where the focus is on learning by feeling, experiencing and doing. It is mostly activating, realistic and provides immediate and concrete feed-back on actions as well as opportunities to test new ways of acting in a more safe environment than reality.

Future workshops is a participatory and proactive planning tool for groups of people to dream up and implement creative ideas and projects. The participants are expected to have a shared experience of a problematic situation from which visions and strategies for change can be generated. The process of a Future Workshop is divided into four phases - preparation, critique, fantasy and implementation. The role of the designers during the workshop is to introduce the theme and to guide the participants through the phases.

The various methods and techniques shed light upon certain aspects of work environments, which motivates a combination. This approach, however, raises several questions:

- How should the different techniques be combined? Should they be added to each other or used together? Are some combinations more preferable than others?
- Some of the visualisation techniques are more perceptual, others more conceptual. Does this have an impact on how they can be combined?
- Most of the techniques can be applied in a more or less abstract way. What decides the degree of abstraction? When the techniques are combined, should they have a similar degree of abstraction or could it differ?
- Should the contextualisation be provided through a process with continuous exchange or carried out in a number of envisionment workshops?
- Which techniques are more appropriate for immediate use in a workshop and which could only be used in continuous co-operation with the users?
- What should the users be able to design and influence? Anything or something?
- To what extent are the users allowed to influence design? Everything or symbolic things?
- Are there boundaries and limitations for the users' participation? Who is defining and making the decisions about these? Where is the power hiding?
- What kind of help and support do users with different backgrounds need?
- What are the motives for operating in parallel and together with all categories? It is important to be anchored in every level to the management. Do difficulties appear when conflicts arise? To whom should the researcher show solidarity? Who is the principal client?

**The envisionment workshop in practice**

To come closer to answers to questions like the ones above the first step in the project has been to develop the envisionment workshop in practice and to create a common practical point of reference by carrying out an explorative case study with a chemical factory, Perstorp Chemitec. In an ongoing development process in the company we joined the discussions on a new control room, automated

production, the skills and role of the operators and a new work organisation. In co-operation with management and unions at the factory, possibilities and constraints in integration of participatory envisionment methods have been tried out (full-scale modelling, democratic dialogue, prototyping, role playing, future workshops and virtual reality modelling). All operators have been involved in designing their future work space - the new control room - using the envisionment workshop. Experiences from this case study form the focus of this paper

## ENVISIONING CONTROL ROOM WORK - AN EXPLORATIVE CASE STUDY

### The work environment

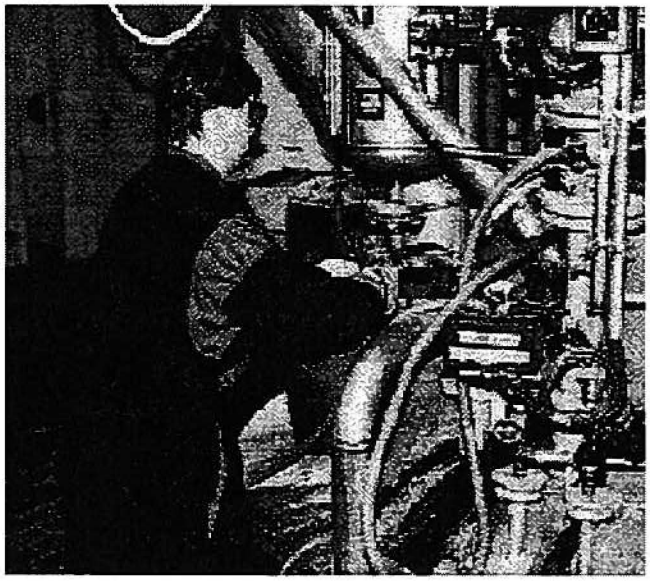
As an independent part of Perstorp AB, a large international manufacturer in chemical industry influencing the whole community of Perstorp, the Chemitec factory engages about thirty employees. Various chemical compounds are manufactured, most of them in liquid form, but some are also transformed to powder. The products are used mainly in other production units within the Perstorp group.

The factory is physically dominated by eight chemical reactors, where raw materials are transformed into finished products. There is also laboratory equipment available in adjacent rooms for testing product samples during the manufacturing process and for quality control in finished products.

One half of the employees are operators, working in three different shifts. The other half are technicians and managers working day-time. There are no female operators. The operators timetable has recently been reorganised meaning that there are no longer permanent working-teams. Four or five operators, each responsible for one reactor during a three week period, form a daytime team while at night only two operators work.

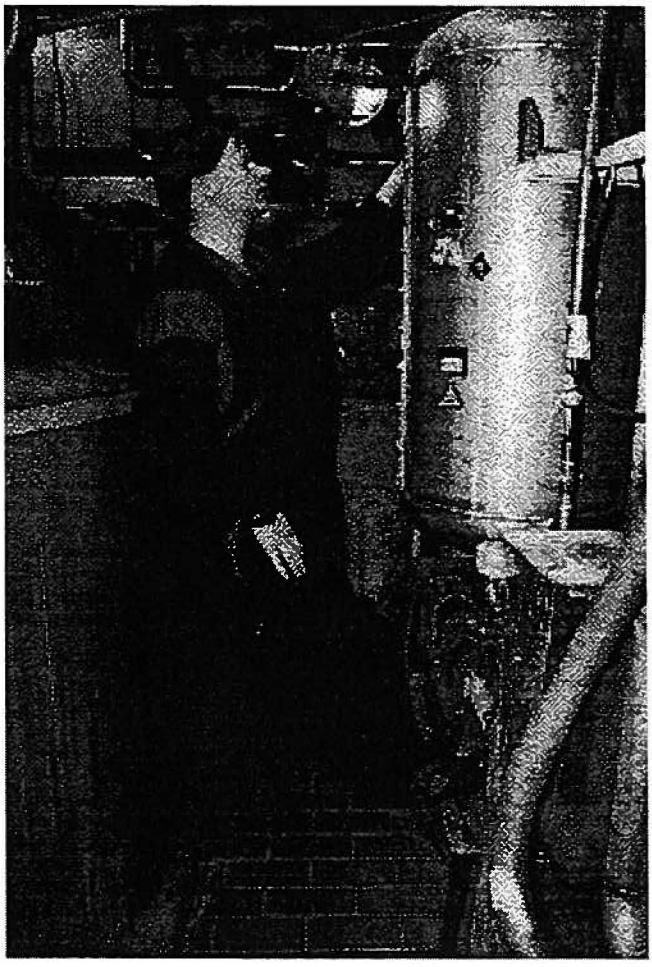
Most tasks still demand "hands-on" manipulation. Only one reactor has been computerised for operation by a standard process control system and is run from a control-room, situated close to the factory hall. Through a window the operators can survey some of the reactors and observe people passing by. The control-room serves as a meeting-place for the whole factory. Since the lunchroom is on another floor, the operators normally have limited opportunities to use it.

Operating the computerised reactor entailes fairly non-active working-conditions, mostly watching the screen with rare interruptions to check the products' quality in the factory hall. In comparison, the other reactors need very intense supervising and steering.



Picture 1

Picture 1 and 2: The boilers offers a rather primitive working environment and demand intense surveillance.



Picture 2

The reactions in the reactors are thermal and could be dangerous if not fully controlled. The factory-hall is noisy and smelly. Most operators wear ear protection and sometimes they also need protective goggles. The work implies a lot of movement.

The procedures for manufacturing a particular product are described in a "recipe", with stepwise detailed instructions for the operator. The reactors have been installed over a long period of time, and even if the fundamental functionality is the same, the differences in manual operation between different reactors is apparently large enough to create an uneven distribution of knowledge amongst the operators. The first apprenticeship for new operators, before they start working without supervision, is only a few weeks, but long after this they still have to rely on more experienced operators for support. Even experienced operators regularly have to ask each other since they forget details, especially for production processes that run less frequently.

The company is about to reorganise and focus on the operator's future working conditions. The production is gradually being changed towards automation and computerisation of three more reactors.

*The participatory process*

The motive for an explorative study was manifold: In the first place the researchers needed to get familiar with each other's tools and methods; in a real case study we could face real users and real problems and during a short time be confronted with situations we could not be able to design.

The character of the explorative case study attracted us because of its limited, well defined, and not to complicated problem space. The duration could be surveyed and the company was a part of a big concern that might be interested in further engagement.

We already had enough experience and qualifications to carry out the mini-project and it would give us the opportunity to reflect on the group, our roles and our techniques.

A proposal for a new furnished control-room served as the starting point for the explorative case study. A team of five people, operators and supervisors, were responsible for the proposal. Another team, partly possessing high technical competence, was responsible for the investigation of the factory's automation.

A consultant had designed a new building attached to the old one with the new control-room on the same floor as before. The position of the new control-room though, makes it impossible to survey the factory hall.

The researchers visited the factory in interdisciplinary teams, interviewed the operators and observed them at work. The working-environment as well as significant working positions and situations were documented in sketches, drawings and photos. The information was mainly collected to be used as a reference for the researchers and the operators in the full-scale study.

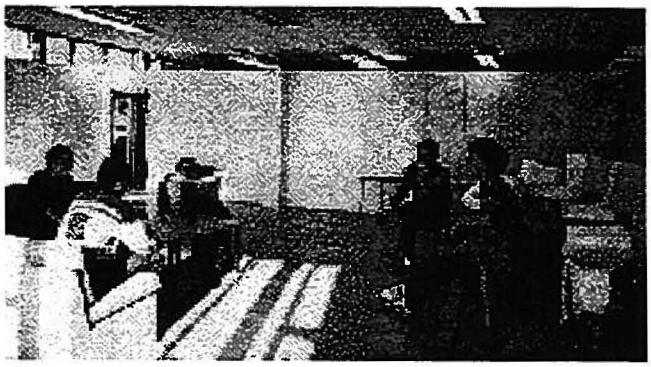
Picture 3: The control-room from witch the computerised boiler is run also serves as a meeting-place.

*The full-scale study*

The full-scale model was the main participatory method in the explorative case study. The study was planned and carried out by the architects in the research group. The other researchers only participated one at a time and only as observers, a decision made to ensure that the employees do not suffer of a feeling of intimidation.

All employees were invited to join the full-scale study. Divided into four groups of 3 - 5 people half of them took part in the modelling work. The groups were haphazardly composed.

The modelling sessions started with a discussion about the operators' work and the design of the new control-room revealing its advantages and disadvantages. In the full-scale laboratory the control-room, with an area three times as big as the present one, had been erected in advance but not furnished. It was experienced as huge.



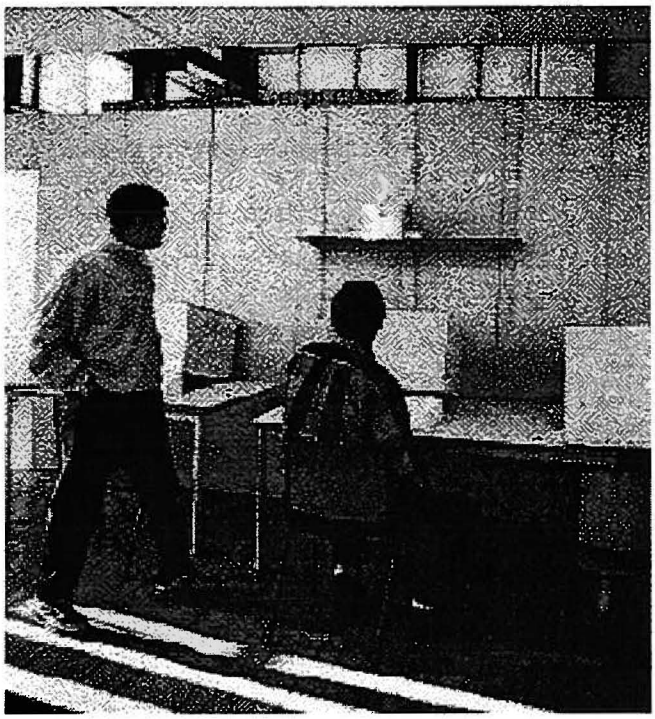
Picture 4: The future control-room modelled in scale 1:1.

The task of the groups was then to furnish the space, taking into account the positions of windows and door-openings. The crucial issue was to organise the operators' desks in relation to each other's functions - a meeting "corner", the entrances and daylight. Most of the discussions focused on computerisation and working organisation; how many

reactors would be automated within the near future and how would the shift-teams be organised then? Several proposals were suggested and every group contributed with at least one new lay-out.

The process was documented with photos, video recording, drawings and notes on verbal statements and decisions. When the full-scale work was finished the drawings were sent to Perstorp to be scrutinised and discussed by the operators.

*Rapid prototyping*
Since the operators regarded lack of visual contact with the factory hall a severe problem, we decided to combine full-scale modelling with rapid prototyping. Systems designers in the research group made a mock-up of a computerised system and demonstrated it in the full-scale laboratory.



Picture 5: The crucial issue was design the computerised working-place.

The idea of installing cameras and monitors to survey the reactors was suggested as a possible solution. Different exposures of camera-pictures in accordance to the production-process were demonstrated and discussed but not evaluated.

*Scrutinising the drawings and Democratic Meeting Technique*
After a few weeks a team with two architects and one systems designer met employees from the Chemitec factory in Perstorp on three occasions. The hours for the meetings were chosen to facilitate the operators participation. A mixed program with drawing examination and democratic meeting techniques was carried out with small groups of employees, mostly operators. Not all of them had been modelling in full-scale but most had taken part in informal discussions based on the drawings.

A selection of drawings, expressing the employees different views and types of ambitions, were discussed. The differences were revealed and the researchers helped to analyse them.

The combination of scrutinising the drawings and Democratic Meeting Technique encouraged the participants to discuss and put forth suggestions on work organisation, participation in the change processes, cleanliness and well-being as well as on the physical design of the control room.

*The concluding workshop*
In the beginning of the explorative case study we had announced to end up with an Envisionment Workshop (Future Workshop in appendix), which could also serve as a start for a second phase. All employees were given the opportunity to join the accommodated envisionment workshop in the full-scale laboratory. It was based on the previous work and included two favoured and fulfilled lay-outs built up on full-scale and summaries from democratic meetings. We had staged four activities to demonstrate different techniques and problem areas. Divided into smaller groups, twenty-one employees including operators, technicians and managers joined the workshop. Most absent employees were spare hand operators and operators that had taken part in the full-scale work. All managers participated.

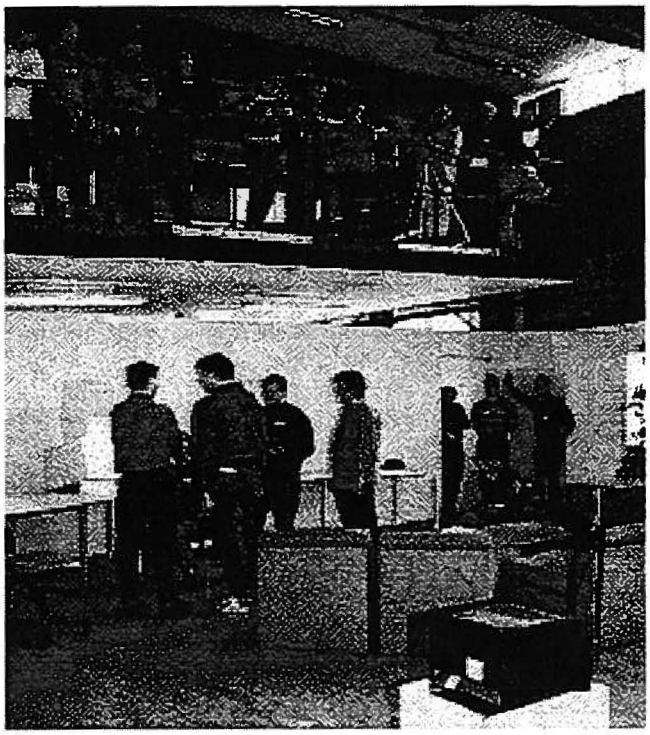
The Envisionment Workshop was organised around four "stations". At the first station two lay-outs for the control-room at full-scale were furnished and served as a stage for directed role playing. At another "station" we showed a video, *On the right track*, from development work at the Swedish Rail workshop in Hagalund (Hägglund and Lindblom 1995). At a third station we demonstrated two different VR-techniques (Superscape and Quick-Time VR). Finally, a video-production showed how multi-media applications can be used to support learning at a fourth station.

All the stations had their own message. Even though we had not been able to design a full program especially designed for the situation at the Chemitech factory, the stations were adequate and seemed to engage the participants.

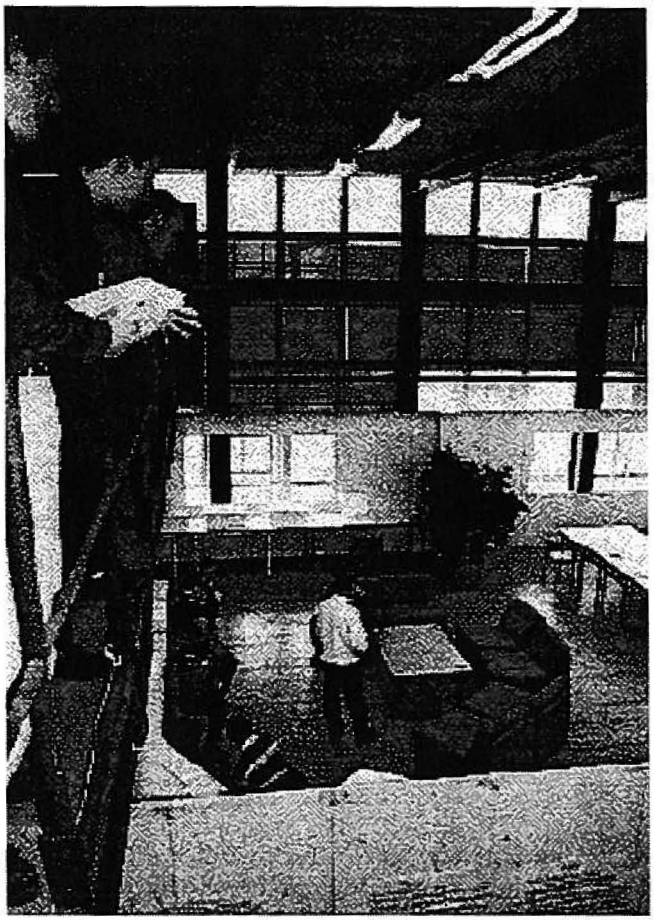
The employees could interpret it in their own way and obviously most stations impressed them and started a process of reflection. The role playing in the full-scale model seemed to be an exception. Shortage of time prevented us from following up the play and it was difficult to carry it through with many people coming from an environment one has a limited knowledge about. The audience, as many people as the players, could because of its size, also have had a negative impact.

The day ended up with group-discussions about the need for changes, primarily focused upon the next steps to be taken. Each group then presented its own priorities for future working conditions in a common discussion. This caused a small riot about decision-making. Amongst the operators there were a strong urge to use this opportunity to make a decision on the lay-out of the control room. The lay-out for

the control-room became a symbol for the operator's possibility to express their power. And, maybe even more contributing to the development at this workshop, a decision on the lay-out was necessary to give meaning to the whole process of the full-scale modelling and the meetings proceeding.



Picture 6



Picture 7

Picture 6 and 7: Some of the operators tested the future control-room with role-playing while others were spectators.

*Computer support for workplace learning*

As a "spin-off" to the Envisionment Workshop with Perstorp, we have engaged in a smaller project around multimedia support for knowledge development and knowledge dissemination among operators in the Chemitech factory, and how computer artefacts can enter into continuous learning processes intrinsically woven into daily work practice. In a participatory design process involving the operators we will investigate the possibilities of designing a multimedia application for knowledge support. The main goals are to broaden the knowledge for operators, make information about critical process operations easily available, and make them better prepared for switching to manual operation in the case of emergency. We also hope to learn more about industrial workplaces as knowledge building communities, and how the introduction of computer artefacts for workplace learning affect work and knowledge development from a user perspective.

## A FIRST REVISION

### An Evaluation of the First Six Months

After six months of work in the project, there was a need of an evaluation of the group's efforts to serve as an guideline for the continuing development of methods. The aim of the evaluation was to examine how the researchers from different disciplines co-operated and supported each other and how well the methods and techniques brought in to the project from each discipline functioned together to form an effective method for visualisation and participatory design.

The evaluation was carried out after the Envisionment Workshop, which concluded the case study in the chemistry company. The study was carried out by a psychologist, until then not actively involved in the project. It is based on interviews with the project members and four key persons in the chemistry company. The results of the interviews were discussed in the research group.

The interviews with the researchers focused upon aims and how different objectives were handled in the group, the function of the group with regards to different roles, communication and co-ordination, what had been learnt during the co-operation and the outcome of the first case study.

The interviews with the people from the case-company focused upon their expectations on the co-operation,

benefits and short-comings of the methods used, the contact with the researchers and upon how this method matched the overall development of their organisation and technology.

*A mixed impression among the researchers*
Two overall reactions, at first sight contradictory, dominated amongst the researchers. The first was that the Envisionment Workshop method works - the case showed that we, by offering such opportunities to an organisation, can improve the quality both in the design process and in the result. The second was: this was not what we had in mind. There was a disappointment in that the group had mainly put together well tested methods in a sequence and not substantially developed them. And still, this seemed to meet some basic need in the chemistry company.

The discussion that followed dealt with the problem of how one can learn from each other when all the researchers simultaneously are trying to change and develop their own methods and theoretical frameworks. This is a classic cross-disciplinary research dilemma. The method used was designed to alleviate learning about different tools and exploration of how they worked together. This was done, with the exception of the VR-methods, and the researchers were eager to further develop their methods, for example by incorporating the still missing VR-technique.

*Positive reactions from the 'case-company'*
The quite strong positive reaction from the participants in the envisionment workshop has many explanations. The different activities during the day worked well and were experienced as meaningful and well prepared. The mix of the activities was appreciated as well. The opportunity to gather and go away for a day was well timed, there was a need to strengthen the group and collect different lose ends after a quite turbulent time with a lot of changes.

The reaction to the full scale models and the drama was mixed. Some indicated that it was good to see how the room worked with different kinds of activities and that surprisingly many of the participants did engage themselves in the drama. Others felt that this exercise was somewhat redundant after the full-scale studies during the fall, and that the drama was too unrealistic to contribute to their understanding. They also felt uneasy about the audience.

The videos shown were interesting and informative, especially, the 'Swedish Rail'-video. This was something they could recognise and the change from resistance to engagement was an inspiration for them.

**Envisioning the future of the project**
*Mutual learning*
What did we learn from this experience? First, we learnt about each other's techniques. We could however, have learnt even more. For example, the "role play" was an experiment partly contradicting the normal procedures for role plays. The physical setting was unknown for the players and the group was split into audience and players, due to the large number of participants. Thus, the other researchers did not learn as much as they could have about dramatisations.

Second, we learnt something about combining different techniques. Our original expectations of developing the existing techniques by integration were, however, not filled. This provided us with an insight that we all know "our own" techniques by heart and thus perhaps think of them as more or less trivial and in immediate need of further development. The case application showed that more elaborate integration might not be needed for case companies to find the combinations meaningful.

The most interesting finding in this case was perhaps the "invention" of the Envisionment Workshop. It came into existence partly by chance, due to time pressures during the workshop and changing plans at the last minute. The Envisionment Workshop proved surprisingly successful. At present, further development of this technique seems fruitful.

In conclusion, the case provided us with an opportunity from which we learned about each other's techniques in practice and developed a foundation for further elaboration of the techniques, both in the form of integration and in the form of sequencing.

Implications for future envisionment workshops are that it is important to take into account the different meanings for all those engaged.

For the people well acquainted with decision making, the workshop is an opportunity to elaborate already prepared suggestions and solutions. The challenge is for them to communicate and listen to new groups with a different experience.

For the ones not normally participating in the decision process this might be the starting point to engage in the development. The video examples serve to encourage and the formation of communication showing that everyone has not only the right but also the obligation to contribute.

For the organisation as a whole the workshop serves as a training in co-operation and decision-making. As such, it can be the beginning for a new way of carrying out developmental work. The change in rules and the distance from daily routine and milieu serve as facilitators.

*Next step*
The case study at Chemitech has, however, answered far from all the questions we set out to explore. We certainly learned about the importance of the interplay between different methods and the fact that all at once both in terms of the different techniques and in terms of all the disciplines and researchers involved is too much for the users.ÊWe also learned about problems of introducing and combining drama exercises and role playing with the other methods. How to co-ordinate and co-operate in detail will however be the subject for further investigations, as will questions about abstraction levels and degree of details in the combination of models.

In order to deal with these problems we are in the coming two years planning a number of case interventions. This includes one extensive longitudinal case study where we

more generally will take part in the organisational development in a company as well as a number of shorter cases focusing on the use of the Envisionment Workshop for visualisation as part of more intensive organisational change strategies.

We certainly also learned that our limited experience with Virtual Reality, and the difficulties for the users to interactively use our VR tools, severely limited the usefulness of this technique for participatory design. Hence, besides studying the combination and co-ordination of design methods and techniques in the case studies we will also conduct experiments and develop the techniques focusing on how to combine real and virtual environments and how to support that several people can work together in a VR environment.

In experiments we will work on questions like: Once an environment has been constructed and furnished, how can it be compared with reality? How can the users be given a proper feeling of scale? And, is it possible to combine the virtual world with a prototype full-scale model?

With the use of the full scale laboratory for the modelling of interiors and full-height 3D projection of a virtual environment using a special projector and 3D glasses, both methods will be combined. This will provide an extra depth - giving the impression of further rooms - to the full-scale model as well as allowing groups of people to work together in the virtual environment.

The idea of many people working together in VR is not new. However, of particular interest is the idea of many people working together *with* VR. This is possible in the following ways:

- Same time and place: One computer with a large screen or projector and many people working together to design a workplace.
- Same time, different places: Many computers, allowing people or groups to co-operate with each other and work on the same model, communicating via networks.
- Different times: People are able to communicate and share models by exchanging disks or via models stored on networked shared computers. This would allow input from many diverse places to be included in the final design.

To explore the above ideas, the following development stages are planned:

- Model the full scale laboratory in the VR environment, allowing the same models to be built in the virtual world as can be built in the full scale laboratory. These rooms could then be furnished and decorated, providing an extra level to the present system.
- Explore the possibility of modelling a manufacturing process within a virtual environment which can then be used as a complement to other design at work methods.
- Design a useful system with a particular emphasis on the development of an easily shareable design environment that can be used on ordinary personal computers and the construction of a protocol for sharing models over a network.

## APPENDIX - METHODS AND TECHNIQUES

*Full Scale Modelling*

The Full-Scale Laboratory, an illuminated and spacious hall (260 sq.), has been an integral component of the School of Architecture since it was built in 1964. The flexible modelling kit includes lightweight wall panels, door- and window frames, and various types of environments can easily be erected and rebuilt. Kitchen fittings, bath-room equipment and some basic furniture is available. Dummies and any kind of complementing equipment can be produced in the school's carpentry. A mobile platform, covering about half the area of the laboratory, can be used as a ceiling as well as a second floor.

The laboratory has been used for teaching programmes, for theoretical and applied research and for professional practice. The potentiality of the full-scale mock-up is connected with its communication qualities. Since the midst 80's it has mainly been used as a tool for participation (Hornyánszky & Rydberg 1992). Projects for construction and rehabilitation have been carried out together with employees, workers and future dwellers. Thanks to the full-scale, it is possible for users to act in, experience and manipulate the environment. This is the dimension which is unique to the full-scale model. The full-scale laboratory is used as a stage, where also the equipment and the working-place organisation can be discussed. By playing their own part in role-games users become more aware and realise how their different ideas will work in reality. In an initial phase, the identified problems are mainly task oriented but during the process relation oriented problems get revealed.

Full scale simulation aims at facilitating user's participation in the design process and the modelling experiments help to emancipate the user's ideas of spatial organisation and their knowledge of special qualities gained through practical experiences (Lawrence 1993). In the communication with the users, concrete experiences can be released both through cognitive associations and bodily events. Thus, full-scale modelling can mobilise laypeople's tacit knowledge. Tacit knowledge gives not only a competence for a skilful performance of the work but is as well a condition for influencing and changing it. The knowledge can partly be transformed directly, i.e., without being analysed, into design.

*Dramatisations*

Dramatisation is a learning technique where the focus is on learning by feeling, experiencing and doing (Hägerfors 1996). It provides opportunities to test new ways of acting in a more safe environment than reality. Use of educational drama techniques complements other learning techniques that focus on for example, thinking, reading, observing and discussing.

Educational drama is a composite concept for a wide variety of exercises, e g role plays, improvisations, motoric and

sensory training exercises. Role plays are suitable for illustrating open and deficient communication, roles in groups, status, norms, decision making, leadership styles and conflict handling. Body language exercises are of use e g when the purpose is to increase the participant's awareness of and improve the interpretative capabilities of one's own and other's body language. Values clarification exercises serve the purpose of increasing awareness of one's own and other's values and possible differences between espoused and enacted values. Drama exercises can also serve the purpose of helping the participants to become a group, to feel close to and to trust one another.

Dramatisations are mostly activating, realistic and provide immediate and concrete feed-back on actions. They can, however, sometimes make participants uncomfortable. The coach has to be prepared to handle strong reactions since drama exercises can trigger reactions based on previous personal experiences. Drama exercises should be chosen with careful consideration of and adapted to the people who participate. For example, constructing a role play might entail investigating participants daily life to find a suitable role play situation with matching roles.

Traditionally, educational drama techniques are successfully used for testing new personal courses of action, personal insights into own values, group development as well as for searching for and finding suggestions for solutions to existing problems and 'cross-fertilisation'.

Other areas of use that might be interesting in this research setting are to find potential problems in suggested solutions and generation of visions.

*Democratic Meeting Technique*

Democratic Meeting Technique (DM) is a very simple technique, aiming at visualising participants' points of view during meetings. The purpose is twofold: to decrease differences in power and influence between meeting participants and to visualise all opinions put forth during a meeting. Differences in power are decreased by use of e g strict turntaking round the table and the Õno critique is allowedÕ-rule. Visualisation is achieved by use of flip charts where the opinions are written, for all to see. The opinions on the meeting theme are structured according to three headings - positive, negative and suggestions (Hägerfors 1995a, 1995b, Hägerfors & BrattgŒrd 1993, Agner Sigbo et al 1993).

*Future Workshops*

Future Workshops is a widely used participatory and proactive planning tool for groups of people to dream up and implement creative ideas and projects. The participants are expected to have a shared experienced in a problematic situation from which visions and strategies for change can be generated. The method was originally developed as a planning tool for resource-weak citizen groups e.g. in traffic planning, environment protection, and child care (Junk and Müllert, 1981). For the last decade Future Workshops have also been used in participatory systems design projects in working life settings. (For an overview see Greenbaum and Kyng, 1991.)

The process of a Future Workshop is divided in four phases - preparation, critique, fantasy and implementation. Information about the workshop and the theme for it is distributed in good time for all interested parties to have a chance to participate. The preparation also include work place visits by the designers. The role of the designers during the workshop are to introduce the theme and to guide the participants through the critique, fantasy and implementation phases. This implies among other things to make sure that all participants have equal opportunities to make their voices heard and to follow the discussions. The layout of the room is also important for this 'democratic brainstorm process', so for example, all statements are made available to everyone on large paper sheets. When used in systems design projects, the focus of a Future Workshop is on critique and fantasy. In the critique phase the whole group focuses on short-comings and problems in the current work situation. In a few hours more than one hundred critique statements may be generated. These are then grouped into main critique themes in a negotiation and selection process among the participants. The participants then select the most important of these for further work. This further work takes place in smaller groups during the fantasy phase where a critique theme is reformulated as a positive vision and developed by the group. The vision is a utopian one, since there are no restrictions on resources. These utopian visions are later presented to all the participants, and the implementation phase can start. At this time the visions are confronted with economic, technical, political and other restrictions and a strategy for implementation is developed. This last implementation phase is seldom part of the workshop as such in systems design projects, since the time used is often just half a day, whereas a full Future Workshop typically last for a whole weekend.

In the Design@Work project we try to use the Future Workshop as a frame for integration of different visualisation techniques in the Envisionment Workshop.

*Prototyping*

Prototypes and mock-ups have for the last decade been used in participatory systems design approaches as a replacement or complement to blueprints and written specifications. (See Greenbaum and Kyng, 1991 for an overview). This kind of design tool allows for active user involvement as opposed to the use of traditional specification documents. For good and bad, they actually help users and designers transcend the borders of reality, and to imagine the impossible. They allow for "hands-on experience" and "design-by-doing", hence user involvement beyond the detached reflection that traditional systems descriptions allow for.

Some advantages with mock-ups as design tools are that they are understandable, hence there is no confusion between the simulation and the "real thing", and everybody has the competence to modify them. They are also cheap, hence many experiments can be conducted without big investments in equipment, commitments, time, and other resources, and last but not least, they are fun to work with.

As compared with industrial designer's, focus in systems design is more on the hardware and software functionality of the future system, than on the ergonomic aspects. Industrial designers often make very elaborate aesthetic and ergonomic designs of keyboards, but the display is black, and no functionality is simulated or mocked-up. In the Design@Work project these different kinds of competencies meet in a participative design effort to create even more "realistic" envisionment of future work. We also try to make it possible for the future users to actively participate in designing these mock-ups. With computer-based tools for "rapid prototyping" the visualisation can be made even more "realistic", since the prototype is built with software, the same material as the envisioned system will be made out of. This may, however, also confuse the user who may expect a fully functional system, when all there is a simple prototype.

Prototyping as a tool is used in many design traditions. Our use is closest to what is known as storyboard prototyping or scenario-based prototyping. Storyboard prototyping uses the method of storyboarding from film production. The users can click around among screens with the right look and feel, but with limited functionality. Just as important as the computer-based storyboards are their use in realistic scenario-based design sessions. Prototyping is both a question of building a prototype and of developing scenarios in which the users together with designers can try it out. The Design@Work project offers good opportunities to develop realistic contexts for the use of prototypes. A special interest is also to explore the possibilities of virtual reality prototyping

*Virtual reality*

Virtual Reality (VR) is a powerful three-dimensional visualisation tool, in which environments can be modelled within a computer. People can then move and interact with the environment using input and output devices specially designed for different human modalities. This is the least integrated technique in the envisionment workshop, and since our current focus is to find out more about this integration, this description is more detailed.

Nowadays, the applications of VR are almost limitless, ranging from such areas as air-traffic control to virtual manufacturing (Kalawsky, 1993) and include the visualisation of abstract as well as concrete information. One area of particular interest is the visualisation of architectural designs for workplaces in a way that allows people to get a real feel for the proposed surroundings.

There are two basic types of VR:

- Immersive Virtual Reality (IVR) which uses a Head Mounted Display (HMD) and human-friendly input devices to allow a person to 'get into' and directly control the virtual environment. This coincides with the popular image of VR and is frequently used in games where more realism is desired. Flight simulators are another form of IVR which have had much publicity.
- Desktop Virtual Reality (DVR) which uses a computer screen and mouse to control the same environment, allowing groups of people to work together even on an ordinary personal computer, often without special equipment.

A further type of VR which uses special polarised or 'shutter' glasses allows users to view the screen as if it were in fact 3 dimensional. This is, in some way, a combination of immersive and desktop VR (Kalawsky, 1993).

These forms of VR work by the computer containing a 3 dimensional model of the environment within its memory. By contrast, another form of VR called QuickTime VR™ is a tool that assembles a "virtual scene" from a sequence of overlapping pictures. By photographing a room using a wide-angle lens and a tripod, and turning the camera 30 degrees between each picture, a "virtual room" can be created. This "virtual scene" is then displayed on a conventional computer screen, allowing the user to look around in the room and zoom in on different parts. One is restricted to looking from one viewpoint at a time, but by combining a number of overlapping "virtual scenes" larger models can be created.

All these forms of VR can now be found on ordinary personal computers. It is no longer necessary to have a high-end graphics workstation. Perhaps, more accurately, it should be said that personal computers are becoming more able to cope with the demands of VR, making it possible to add it to the developer's arsenal; thus turning it more into a computerised visualisation tool than a scientific curiosity.

It is as a tool that Virtual Reality is becoming of great importance to Design@Work. Desktop VR can be used to allow a group of people - designers and users - to work together on an architectural design, then using Immersive VR, the design can be walked through, 'felt', tested for suitability and altered as desired. QuickTime VR™ has applications in envisonment of pre-existing environments or visualisation using scale models. Using the Virtual Reality tool, there are a number of research areas which we will be looking into further:

*Rapid Prototyping*

In the VR context, this refers to the ability of quickly building a virtual work place with which to interact, alter characteristics of and furnish in order to get a feeling for how it might look. This should be possible within a matter of a few hours, preferably with useful tools. Within this area there is much work to be done in the design of a suitable user interface and construction of facilities to simplify and speed up the process. One facility that is expected to be of use is the inclusion of libraries of objects - furniture; wall, floor and ceiling segments; wall and floor coverings - that can be used as a starting point.

We have also considered the possibility of using QuckTime VR™ as a tool for rapidly creating "virtual scenes" of interiors. Even if the resulting models have restricted navigation possibilities, they can provide a photographic realism that would be time-consuming to create using other

VR-tools in prototyping work. The resulting models can be used as documentation of interiors modelled in the full-scale laboratory, providing an opportunity to compare different solutions.

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