

# Creativity, Cooperation and Interactive Design

Susanne Bødker, Christina Nielsen, Marianne Graves Petersen

Department of Computer Science

University of Aarhus

+45 8942 5630

bodker, sorsha, mgraves@intermedia.au.dk

## ABSTRACT

This paper focuses on ways and means of stimulating idea generation in collaborative situations involving designers, engineers, software developers, users and usability people. Particularly, we investigate tools of design, i.e. tools used in design to get ideas for a new interactive application and its use.

Based on different studies from a research project that we have been involved with over the past three years, we present specific examples of such tools and discuss how they inform design. We frame this discussion through the following (theoretical) considerations: a concern for the past and the present in informing design, for using theory as a source of inspiration in design and for making extremes and multiple voices play a role in innovation.

These considerations are used to structure and discuss the examples, illustrating how it is important for such tools to be concrete, tangible and even caricatured.

## Keywords

Tools for idea generation, cooperative, iterative design

## INTRODUCTION

Many design methods suggest that something new, i.e. the new computer application, arises from a stepwise process describing first e.g. the existing physical system then the existing logical one followed by the changed logical one and ending with the changed physical one [15]. A first reaction to this is that it is difficult to imagine that something creatively new should come out of a stepwise derivation process from the existing. At the same time we do not subscribe to the idea that creative design is a matter of the individual designer's genius nor a strike of lightning, a characterization that seems predominant e.g. in industrial design and architecture of today. Instead, this paper will focus on the systematic and deliberate attempts to create a new design that transcends the current practice of the users, at the same time as it is based on this practice, as well as on the knowledge and skills of designers, engineers, software developers and usability people.

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee.

DIS '00, Brooklyn, New York.

Copyright 2000 ACM 1-58113-219-0/00/0008...\$5.00.

Our experiences stem from the design of a wide range of products: from software to industrial components and TV-sets (see also [4]). Some of these experiences date to earlier projects (e.g. [9]) whereas the examples that we are discussing stem from a project that we have been involved with for the past three years regarding the development of usability design. While the methods presented have been developed and used through several activities in the project, we have chosen to present only one such situation for each.

In [4] Bødker & Buur coin the term design collaboratorium to talk about the overall methodological results from this project. The design collaboratorium is a design approach that creates an open physical and organizational space where designers, engineers, users and usability professionals meet and work alongside each other. At the same time the design collaboratorium makes use of event-driven ways of working known from participatory design [8]. This paper focuses on ways and means of stimulating idea generation in the design collaboratorium or similar collaborative design situations.

In our way of thinking, design, be this of computer systems or other sorts of appliances, is an iterative process involving the active participation of users and of professional designers, engineers and usability people. Hence, design is co-operative. We have earlier discussed how it is of vital importance for designers to understand use so as to build artifacts to support and develop use [6, 7], and how it is essential for users to get *hands-on experiences* with mock-ups and prototypes to participate actively in design [12]. Furthermore, it is important to work systematically to get new ideas to further the design [9]. Because creating something new in design is neither a matter of a stepwise refinement of a description of the existing situation, nor of a hierarchical decomposition of complex problems into solvable ones, new interactive applications must be designed and explored in an *iterative* process. In this paper we focus on *the tools for getting new ideas* in cooperative, iterative design.

## TOOLS FOR GETTING NEW IDEAS

In the remainder of this section we will outline our sources of inspiration for the particular analyses that are to come.

[9, 13] argue that tools for thinking ahead, for supporting creativity is an area which still needs development. It is necessary to understand more about where these tools come from and how they might be used in a systematic and purposeful design activity, and not just at random.

These tools are not detached from the history and present tools of design, neither are they detached from the history

and present activities of work, that are designed for. Engeström's [16] notion of springboard, a "facilitative image, technique or socio-conversational constellation ... misplaced or transplanted from some previous context into a new..." (p. 287), has been important when looking at which technical and social/use-oriented constructions serve usefully as *springboards* in design. The idea is to move away from stepwise derivations to ways of rethinking the whole of the new activity or parts of it in different, yet very concrete, ways. From a similar way of thinking both Schön [25] and Madsen [20] talk about seeing something as something else, and Madsen [20] proposes to use the dissimilarities in two referents of a metaphor as the source for creating something new (by seeing e.g. a library as a meeting place and a warehouse.).

We propose to look for things and notions that in similar ways help us see, or rather do, something in a new and different ways in the context of use. Reminding the reader of the need for cooperation and hands-on experience, such tools need to support action as well as reflection [13]. Furthermore, they are furthermore, as Bertelsen [2] discusses, placed in a boundary zone, where the different practices of designers, engineers, usability people and users meet. In order to support cooperation, they must, accordingly, be boundary artifacts, as Bertelsen [2] calls them with reference to Star's [26] boundary objects. They must in some ways support the joint action and reflection, at the same time as they serve action and reflection of each of the involved groups in their activities.

#### *Past, present and future*

Computer applications and other technical artifacts should, like any other artifact, be seen as historical devices that reflect the state of practice up until the time that they are developed [1]. Thus, to learn something about the present shape and use of a particular artifact, a *historical analysis of artifacts* as well as of practice is important. Furthermore, to find inspiration for future artifacts, the past generations of technology are informative. The history, however, is not just an absolute and given thing, and history does not only concern the past. [9] seeks inspiration in [24]. Mogensen [21] develops his Heidegger-inspired understanding in a similar fashion, to emphasize the relation between the past, the present and the future. The key point is that we are dealing with both experience and expectation as soon as we start researching a practice, and as soon as we e.g. introduce a prototype. Fundamentally, we cannot design from understanding the artifacts alone. Neither can we understand the artifacts only from understanding use as it is carried out "here and now". In this sense we need to go further, as e.g. Carroll's [14] "task-artifact" cycle (discussed in [1]).

For our purpose of finding tools that point ahead, we are suggesting that past generations of technology may inform innovation well.

#### *Theory as a possible source of inspiration*

Bertelsen [3] makes a thorough analysis of how theory in general, and Fitt's law in particular may appropriately be seen as a design artifact. Morgan [22] uses organizational theories as metaphors for diagnostic readings of an

organization, and for what he calls imaginizing, which is basically designing or re-designing organizations. "One of the major strengths of the different metaphors explored in this book is that they open numerous avenues for the ways in which we attempt to organize practice." (p. 335). Interestingly, Morgan suggests a place for theory, and not just for a collection of random metaphors. Furthermore, he uses the effect of theories contradicting each other as a means of creating openings for innovation.

[9, 10] propose to use theoretical checklists as input to CSCW design, an area that we have explored further as regards learning in use (see below). They similarly make use of the contradictions created through systematic application of particular perspectives as a way of pointing ahead.

For our purpose of this paper, the question is how to operationalize theories so as to inform design.

#### *The present points ahead*

We are assuming that the starting point of creative design is some amount of understanding of use, achieved through a combination of more or less systematic field work and participatory design. It is necessary to capture this understanding, to reduce the empirical situations to manageable dimensions as well as to clarify and complete the situations (See e.g. [9,17]). The issue of concern here is how this understanding can be used to point ahead.

[13] discusses how scenarios can be used in this effort. Making scenarios is a creative process: they are hypotheses, or qualified guesses about the artifact [9]. They serve to open the dialogue about future possibilities and current constraints. [13] proposes that we have to work with work situations and scenarios as constructions meant to stage acting in the future or to reflect on and illustrate problems with this action. Selecting and "cutting" the right situations out of many hours of video and observation material is in itself a construction process where the new is constructed, rather than a reproduction of the existing. Mainly the richness of detail, gained from the real situations makes them useful triggers of thoughts.

This paper will discuss further how to "design" present situations so as to serve design.

#### *The right tool for the job, extremes and multiple voices*

There is much more to a good scenario than choosing a characteristic work situation. Depending on the state of the prototype that one is dealing with and of the objective in terms of purpose of the design situation and scope of the prototype, it pays off to be very selective [13]. [9] proposes that representations are containers of ideas, rather than some sort of mapping of an existing or future situation or artifact. This suggests that we need to focus more on a variety of representations supporting different purposes and perspectives in the design activity.

Overemphasizing distinguishing features makes the point more easily understandable for participants. We advocate to create caricatures instead of such that are nuanced. [9, 13] develop the notion of plus and minus scenarios as one way of driving particular features to the extreme, instead of

aiming for a neutral scenario, making it hard to distinguish between the useful and the non-useful. [13] argues that it is much easier for users and whoever else is going to relate to the scenarios to assess things when they see full-blown consequences than when the implications go a bit in all sorts of directions. Not that they “believe” in the caricatures, indeed they don’t, but it is just much easier to use one’s common sense judgement when confronted with a number of extremes, than when judging based on some kind of “middle ground”.

As mentioned earlier, Morgan [22] uses the theoretical perspectives in a way where they may at times contradict each other. Engeström [16] and others have argued that this is actually what creates openings for creative innovation. Similarly, [9] propose to use the checklists to support contradiction and dialogue. The checklists were consciously organized to let different perspectives talk to each other.

[2] discusses how design takes place in a boundary zone where heterogeneous practices meet to create the new, emphasizing the multi-voiced nature of design. Engeström [16], and along with him Bertelsen [2], talk about heteroglossia, or multi-voicedness as a way of letting different voices participate in the creation of the new. Engeström’s [16] notion of multi-voicedness deserves mention as a perspective on bringing the voices of various groups together, constructively, in design/development of a new work activity. [13] gives various suggestions to how scenarios, anchored in specific use/work situations may be used to support bringing these voices forth.

In the present paper we illustrate and discuss how to choose the right tools, in terms of constellations of scenarios, prototypes, etc. for the design activity in question. We will further illustrate how we have made use of extremes and supported the multiple voices of the particular design activities that dealt with.

#### *Tools develop*

Just as any other tools, the design tools that we present and discuss here develop in use, in the particular setting in which they are used. This has consequence, for us, as well as for any reader who might want to use some of these ideas in their own settings. We hope that presenting our own development process to the reader, we will leave ways open for further development of the tools, rather than stigmatizing the reader in a “does it work or not” choice.

### **THE EMPIRICAL EXAMPLES**

The empirical material that we present and use in the following is a result of a project that we have been involved with for the past three years. We have been collaborating with the usability departments of Bang & Olufsen A/S, Danfoss A/S and Kommunedata, in an action-oriented research project that aimed to develop the work practices of usability [4]. The three involved companies do their work rather differently and work with different products ranging from computer software to hi-fi equipment and thermostats. Common to them, however, is that during our joint project they have been moving out of the lab and into the field ([7, 19]). They have committed themselves to collaborating

with users as well as with designers and engineers, and they have moved from doing evaluation of products to doing design together with these groups [4].

Our attempt to *move usability from evaluation to collaborative design* has taken many experimental forms, and this paper will focus on only one of these; the development of cooperative, tangible tools for creation of ideas.

The remainder of the paper is structured as two sets of examples from two projects in two of the three companies. These examples will shed light on the theoretical issues discussed above and lead to a concluding discussion of the possibilities and constraints of such tools.

### **THE PC-TV LIVING ROOM**

The project framing this case was the development of a Bang & Olufsen PC-TV living room. The vision was to provide users of a traditional television set with access to PC functionality and applications when seated in the sofa in the living room. The total number of people involved in the project was around 10, half from the usability group, half from the multimedia department, and one from the communications department. From this case, we look at three interlinked design activities, involving us as researchers as well as Bang & Olufsen usability designers and engineers, and to some extent the users. These activities are: “Talk to your TV”, using workshop-stands and the construction and use of learning checklists.

#### **Talk to your TV**

In this activity we enrolled a small number of users (2 individual sessions and one session with 2 users together) and asked them to do two things together with us:

- a. to find information using the tele-text and remote control of a TV-set provided by us. An example scenario was: how to find out about the weather in Sidney in connection with a trip there.
- b. to find the same information “talking to the TV”. We used a transparent “Wizard of Oz” technology, in that somebody in the room would actually press the relevant buttons on the remote control to get what was requested. In other words, we created an open and flexible prototype out of an existing TV-set.

Some users were proficient users of tele-text and some not, which we believed to be a strength because we wanted to get as many ideas as possible regarding the interaction with the tele-text. All users were also proficient WWW-users. This became apparent through a lot of comments and ideas. The users produced a number of ideas of interest to design. Some of these had to do with sequentiality of sub-pages, some with the overall structuring of the search, some with ways of stepping back, and of retrieving previously used pages, and some had to do with the lay-out of the remote control.

We found that through choosing an extreme, i.e. asking users to talk to their television in b, the users were provoked to think beyond existing possibilities both in terms of technical aspects and in terms of design. This happened especially when b followed a. We experimented

some with the order of a and b, to investigate which setup mostly stimulated creative idea. We found when we started out with b, i.e. talking to the television, the users were quite restricted by existing limitations due to their familiarity with the existing design. When b followed a however, it provided a contrast to the limitations of the existing design, and thus worked better as a springboard for the users in generating ideas beyond the existing design.

The scenarios were used to form an overall “story-line”, which turned out to be a good idea. However, we used the same scenarios, that were rooted in the current tele-text functionality, in both a and b. In retrospect we should probably have chosen two different sets of scenarios for the two sessions, and have made some more directed towards possible future functionality.

We edited a videotape that presented the innovative design ideas which came up in the “talk to your TV” activity. We presented this to the Bang & Olufsen group as a source of inspiration for the design of the PC-TV living room and as an example of how users can contribute with creative ideas for design. Through this material, we sharpened the “voice of the users” not based on any claim of representativity, but as a source of potentially interesting design ideas. The video recordings of these experiments were a useful basis for being selective, emphasizing particular problems or situations when editing the video. The recordings are fictions in more than one sense: First of all, the original use experiments were constructions and nothing that could be called real use. Secondly, they were digested by us into a story that we wanted to tell. The main criteria for selecting what we wanted to tell was to overemphasize distinguishing features, so as to make the point more easily understandable for participants. In accordance with our earlier work [13], we found it much more effective to create simulations that are caricatures instead of such that are nuanced. Furthermore, the story of this material is not any more “true” and objective, by virtue of having been recorded on video. The design ideas developed by a group of designers still ultimately need to be tried out in real use situations in order to prove their worth. And the way we use video material in this case provide no way of escaping that.

The “Talk to your TV” project investigated extreme interaction modalities as springboards [9, 16] for users in generating design ideas. The experiences from “Talk to your TV” illustrate how we can create the new, inspired by the existing, once the setup of the confrontation between users and the technology is carefully considered. Moreover, the project exemplifies how something fruitful comes out in the meeting between contrasts, in this case the different interaction modalities. Finally, this initiative formed part of our contribution to move usability work from evaluation to co-design through experimenting with settings that support users in their role as creative partners in the design process. We did not set up the “Talk to your TV” sessions to extract a representative voice of the users that we could present to designers. Neither did this project focus on actual user involvement, field work and capture of real work situations, nor with other possible ways for designers,

engineers and usability people to cooperate. Rather these simulations are constructions made with a purpose, in this case to illustrate alternative solutions regarding fundamental issues of HCI as outlined above.

In our experience, supporting user participation by giving users means for externalizing their design ideas by providing materials for sketching and modeling as ideas show up would be a valuable extension to the experiment. In this way the users could develop their ideas a little further and express their ideas in more tangible ways.

Furthermore, we see some potential in using the video more actively in the session, e.g. through working with the video recorded in the first part of the session in cooperation with the users as the basis for elaborating or developing on the design ideas expressed.

### Workshop stands

As part of the design of Bang & Olufsen PC-TV living room we arranged a design workshop [18] where different stands served to inspire the design work as described in the following. A group of people from the usability group, the multimedia department, the communications department and researchers met in a room equipped with products and prototypes of relevance to the PC-TV living room. In order to prepare the workshop, the different competencies in the project had been asked to prepare a stand each presenting their favorite related products or prototypes. The participants split in two multidisciplinary teams who visited in turn the stands.

The stands were: The voice of the users presented by the researchers, the prototypes of the technicians and the products of the designers.

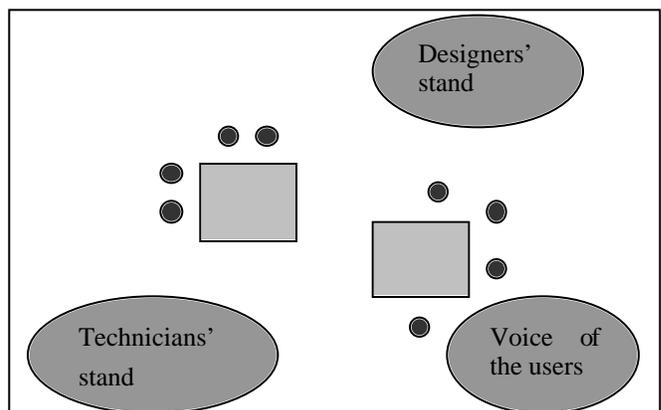


Figure 1 The layout of the design workshop room.

At the stand presenting the voice of the users, the video clips from the “talk to your TV” experiment were presented. The clips were supplemented with posters capturing the design ideas envisioned by the users. Together the video and the posters provided tangible means [27] for the discussions in the group of designers, engineers and usability people. However, we believe that had the video clips been shortened, from 10 minutes e.g. into 2-3 two-minutes sessions they would have been even more

useful for this purpose. The technicians' stand displayed a wide variety of prototypes including various prototypes of remote controls. Finally, the designers presented an earlier product named the PC-TV office, which is the counterpart of the PC-TV living room, in that it brings the TV functionality to the PC for use in the office. At the stands of both the technicians and the designers were also posters capturing design rationale and design dilemmas of relevance to the design of the PC-TV living room.

In the first round of the workshop, the participants were in groups asked to take a round in the room, visiting the stands. At each stand they were asked to comment on the issues raised at the stand and to capture their discussions on post-it notes.



*Figure 2 Discussions around posters at the designers' stand.*

Based on the discussions held in this first round, two specific design issues were chosen for the two groups to work on. Each team was asked to produce their design solution in a tangible form, for instance as a paper prototype. After half an hour, each group presented their design proposal for the other team, and the groups then swapped design topics. For the second round a team could either start from scratch or start out from what the other team had produced. They had at their disposition various design materials including pens, paper, Scotch tape, post-its, etc. In addition, screen dumps from the current prototype of the PC-TV living room were available.

The range of representations at the stands served as sources of inspiration and promoted the different perspectives in the design work. Through having tangible representations, all participants in the meeting were supported in promoting the different perspectives. In this way the different voices were not solely attributable to certain participants but, through the stands, all participants were supported in taking advantage of all perspectives.

For instance, when discussing how to provide access to web pages on a Bang & Olufsen television, in particular how the navigation should be supported using a remote control, one of the participants in the workshop walked up

and grabbed one of the early prototypes at the technicians' stand. He brought it to his group and acted out how he envisioned a design solution. Subsequently, one of the other participants requested the prototype and demonstrated a slightly modified version of this first suggestion. In this way, the discussion carried on for a while with the different parties supplemented and contrasted each other using the prototype from the stand as an important point of reference.

The material at the stands also made reference to the historical development of Bang & Olufsen products. This in turn was fruitful since the old products served as a source of inspiration in the development of the new product. To illustrate this, the PC-TV office product presented at the designers' stand had been developed before the PC-TV living room project started. This product allows users to watch television on their PC. At several occasions the PC-TV office was referenced in the discussion on how to design the PC-TV living room. In this way, on the discussions about whether there should be some sort of menu-bar to access Internet functionality on the PC-TV living room, the remote control representation on the PC version was referenced as a source of inspiration both positively and negatively. Positively, in the sense that the living room product could be inspired by the office version such that they both had the special Bang & Olufsen identity and both appeared to be part of the company line. Negatively, in that at the same time the PC-TV office product served to emphasize the contrast to the PC-TV living room since the two products are designed for very different use situations and each need to have their own identity. Hence, through having earlier products available for direct reference, the workshop participants were offered inspiration for the design both in terms of supporting continuity as of taking up new challenges in design.

The workshop described was set up for a single day event and the stands were removed by the end of the day. An interesting extension to this approach is permanently to equip design rooms with stands or with a rich set of representations, products, prototypes and statements, which allow designers to be inspired from both looking back and ahead when designing new products. At this very moment Bang & Olufsen is working on designing their own design room inspired by some of these thoughts.

### **Learning checklists**

Learning in use, or self-explanatory interfaces is an important topic for the three companies, and Bang & Olufsen TV design in particular (see also [5]). In order to explore how to design more learnable user interfaces for such a setting, we undertook a study of HCI literature about learning, and tried to operationalize these in checklists [9] that would be of use to the design activities in the company.

The development of the learning checklists has been an iterative process where we (the researchers) created an initial version based on literature studies. This version was reiterated in several design workshops in the project, and in one of the latter iterations used for the design of the PC-TV [11].

We developed four checklists that more than anything reflect areas focused on and insights to be gained from textbooks and scientific papers:

- questions of artifact/user interface
- questions of errors
- questions of differences between novices and experts
- questions of use/learning context

Obviously these lists (see an excerpt in figure 3) were not all-inclusive and they were a consequence of choices we made together with the usability people, regarding what would be useful in these particular analyses and design situations. Our idea was that the checklists could be used for focusing on empirical investigations of learning in use as well as for reflecting on possible hypotheses and design solutions.

In the PC-TV iteration, we analyzed a number of trial use situations of TV sets. The use situations all dealt with one or two Bang & Olufsen TV sets that are handlingwise quite distinct.

The analysis of the empirical material was indeed post-hoc as regards the design of the two particular TV sets. In particular, we looked at five interesting situations of trial use, where a problem occurred that could be related to the relation between the user's background and the design of the particular artifact, or to forming and consolidation of operations.

These analyses were used to further inspire the design of the PC-TV living room, which includes a more complex interface than the "plain" TV.

Our experiences from this can be summarized in the following:

- analyzing use background *is* design in that it is necessary to make choices regarding which use backgrounds and relevant artifacts to focus on (see further discussion in [21]).
- in order to look ahead and identify potential competence of the users it is as useful to focus on metaphors and artifacts that are different from the one being designed as it is to focus on those which have similarities.
- confrontation of perspectives was informative for design. Using the checklists emphasizes the important point that one cannot necessarily accommodate for all concerns at once, and that these contradictory concerns need to be considered in the specific design.

To actually design the learnable PC-TV, is a long step from this analysis. However, the checklists helped in shedding light on where or what the users learn from, what analogies are of importance (both positively and negatively), and where learnability issues collide. We are continuing to fuse these findings into our discussions with Bang & Olufsen.

The learning checklists have been thoroughly restructured in their continued use, and in our ongoing theoretical elaboration. This process is described in [11].

#### *Investigation of artifact/user interface*

1. Does the artifact allow for inspection of the result physically, "outside" the artifact? If not, how well will the later end-result be represented in the artifact? (is what you see what you get?)
2. Does the artifact allow for experiments, e.g. through undo? How does the artifact support the user in getting "back on track" after a breakdown in handling the artifact?
4. Does the artifact invite users to use experiences from other artifacts?
5. How extensive is the set of menus or commands? can the user be cut off from the use of certain parts of menus or commands, either through pre-defines settings or by his or her own choice?

#### *Investigation of errors*

The overall hypothesis is that all users err, as part of their exploratory use of an artifact, but that e.g. novices and experts may err in different ways.

1. Is the error conceptual/bound to a misunderstanding, or operational/bound to the handling of the artifact?
3. Does the error result in a breakdown in relation to the handling of the artifact or to an object of scrutiny, or is the error seen through a work-around?
4. Does the error relate to the user's understanding of/acting in the domain of work, the particular artifact, or technology in a wider sense?

#### *Investigation of differences between novices and experts*

1. Does the user approach the artifact as neutral observer, wanting to investigate the artifact, or does she just start doing the job?
2. Does the user apply external theories or a repertoire of flexible strategies?
4. Can the user handle multiple, conflicting purposes of work or only one?

#### *Investigation of use/learning context*

2. Which materials are used for what and how is the artifact applied in relation to these materials and products?
5. Collaboration: is use individual or collective? do novices and expert take part in the same use processes?

Figure 3. Exerpts from the learning checklists

## USING INTERACTION PERSPECTIVES TO TRIGGER IDEAS

The basis for the second example was a design project at Danfoss. The User Centered Design Group at Danfoss and a group of researchers from the University of Aarhus were undertaking a study of work at a combined district heating and power plant. The overall aim of this project was twofold: to investigate the need for and consequently possible use of portable/handheld technology in the plant; and to utilize and develop methods for usability work in the field.

The field study was done over several rounds with 3-8 people from the research group spending several days in the plant following different workers in groups of two with video cameras [23]. This video was analyzed and a small number of key situations were transcribed as the starting point for further design considerations. These transcripts of dialogue between workers in the plant, pictures of the setting and the actual snippets of video constituted the work situation descriptions in this example.

The field study and video analysis provided us with a greater understanding of the work taking place in a process setting like a combined heating and power plant, and pointed out some areas in which mobile technology could be introduced to support their work practices.

### The Museum workshop

As a parallel event to further our understanding of what constitutes a process environment and act as a source of inspiration, a workshop was held at the Danfoss museum. On display at the museum is virtually every kind of component ever produced at Danfoss and the tour through it shows the development of the company tied into the story of Mads Clausen, the man who founded Danfoss. The aim of this workshop was to sketchingly chart the development in Danfoss components, the technology and interaction concepts, as well as the development in the organization ('the Danfoss company spirit', or how Danfoss saw itself), and through the unfolding of the history find new inspiration for design.

In working with the development in technology and interaction concepts, we considered the role of technology in the society at particular points in time, illustrated by the science-fiction literature of that time (inspired [28]). With this timeline, we classified the interaction styles used in the components in relation to the technology view of the specific point in time, and created three character types to exemplify these.

### Design principles

The generation of these characters triggered the idea of using interaction perspectives in a much more structured way as tools for creativity.

Basis for our effort was the four theoretical interaction perspectives (tool, media, system and dialogue partner) described in [12]. Briefly described, the four perspectives map out the basic relations between humans and artifacts as follows. In the Tool perspective, humans use tools to work on material (in analogy to how we use a hammer). In the System perspective, humans and machines are regarded the same type of components, i.e. the human are reduced to the 'language' of the machine. The Media perspective emphasizes humans interacting with humans through machines (seeing "undisturbed, direct communication as an ideal). Finally, in the Dialogue Partner perspective the human's interaction with the machine analogous to a dialogue between humans, i.e. using natural language.

Based on these theoretical constructs, four 'design perspectives' were created as two-page posters with the original, abstract description of the interaction perspective on the right-hand side and a character description to the left-hand side, focusing on his or her use of technology, which served as an exemplification of the perspective. Inspired by our work at the museum workshop, we chose characters originating from the science fiction literature and films, which also served the purpose of making them easily recognizable. We chose Flash Gordon as the personification of the Tool perspective, Spock for the System perspective, The Nethacker (based on various characters from William Gibson's universe) for the Media perspective, and the ship computer 'Mother' on the starship Nostromo (from Ridley Scott's film 'Alien') for the Dialogue Partner perspective.



Figure 4, Spock

We see these perspective/character pairs as a tool for sketching a 'design space' for the further exploration of the setting. The future scenarios and designs we created with them as brainstorming devices enabled us to look at the same setting, use a description or a problem from different perspectives. Utilizing theoretical constructs like the four original interaction perspectives in relation to a character enabled us to exemplify the strong and weak points by imposing them on a scenario in which the character could act. The theoretical description worked as a backdrop to consolidate the characters' behavior.

Furthermore, the coupling of perspective and character gave the participants a concrete anchor into the concepts. We experienced repeatedly that when using the perspective/character pairs, participants would refer to how the character would act in a given situation, rather than how the given perspective would apply, thus considering the concepts within the interaction perspectives as the characters' behavioral patterns. This is hardly surprising because the characters provided a very effective means of relating the abstract concepts to the concrete example of work. It stresses the value of providing good exemplification when working with interaction perspectives to inter-link the abstract and the concrete.

The historical frame, which initially inspired the choice of characters, showed itself as a double-edged sword. We realized that our choices of characters had some unintended negative effects: the sci-fi characters were too fixed within a certain time period, e.g. Flash Gordon made the Tool perspective seem 'old' or outmoded, a limitation which is not inherent in the original theoretical tool perspective. We want to maintain the recognizability of the characters without stigmatizing them by grounding them in a specific, historical context, which we seek to remedy in a later version of the perspective/character pairs.

Furthermore, it was difficult to find already defined characters whose 'personality' fits the perspectives fully. E.g. as regards 'Mother', they do not use normal language to communicate with it in the film but a complex command language and a standard screen and keyboard! However, our only plausible alternative, 'Hal', the ship computer from Stanley Kubric and Arthur C. Clarke's "2001 - A Space Odyssey" seemed to have to many negative connotations attached for it to be used constructively. Some of our characters were simply inappropriate for the concepts they were meant to exemplify.

Following the recommendations from [9] to use extremes to make a point, we plan to extend each of the four perspectives with a 'good guy' and a 'bad guy' description of them to juxtapose their positive and negative aspects. The positive and negative connotations associated with each perspective provide a more detailed image of the possibilities and limitations of them, and serve the purpose of distinguishing the individual design perspective even further from the rest.

### **Using work scenarios to anchor perspectives**

At a second inspiration workshop, a group of interaction designers, industrial designers, HCI researchers, usability engineers and psychologists from Danfoss, Kommunedata, Bang & Olufsen and the University of Aarhus was gathered to work with the first version of the design perspectives in relation to work at the combined heating and power plant. These were immediately nicknamed 'Flash Gordon and friends'. The participants were handed a small number of work situation descriptions. They watched video from the field study at the plant, and were asked to explore design possibilities for a portable piece of equipment from the point of view of the four design perspectives, one perspective in each of four groups. It is in this context essential to note that the work situations used in this workshop were not chosen at random from the vast quantities of video material from the field study, but situations carefully selected because they illustrated circumstances within which mobile technology might support the work [13].

The groups created scenarios based on the work situation description to situate their thinking about possible ways of interaction in this setting - where would the media perspective, emphasizing communication between people in the plant, head? Or, with the tool perspective, which tools would be needed, and for what purposes? The groups were further asked to present their design scenarios by acting them out, and obviously this was easier for some groups than for others. In particular, one group came up with a futuristic design scenario with negotiating sludge-tanks, and for them the specific dialogue of the original use setting was of little use. However, all groups found the scenarios to be a useful way of relating possible interaction designs to what actually happens in the plant, despite the very selective work situations.

We found that the restrictions inherent in working with one specific work situation description and one specific design perspective actually helped define the boundaries and create a common ground on which the participants could use their individual experiences and backgrounds in the negotiation of the design. This 'boundary zone' [2] was first defined through the negotiation between the participants of how the assignment should be understood and affronted. Later it served as a collaborative design space as the participants started sketching design ideas for the future scenario on paper and with simple props like pipe cleaners and plastic cups, elaborating on some and discarding others.

The choice of using the same work situation description across the groups rather than choosing work situation to fit the individual design perspectives provided means of comparing the resulting design scenarios. Furthermore, the use of sci-fi characters, which are arguably caricatures, for the different types of interaction exaggerated the differences between the different perspectives, which made them easier to juxtapose and assess.

The intended outcome of this workshop was not to generate specific design solutions but rather to inspire and aid the

process of generating new ideas for regarding mobile support for work at a combined heating and power plant. We see the use of caricatures in the design perspectives as an important tool in achieving this goal. Because the design perspectives quite clearly did not provide realistic views of the world, it was also clear for all participants that their utilization did not yield the solution to a design problem but rather the unfolding of a design space.

## CONCLUSIONS

We have described and discussed a number of tools and how they support creativity in design. Common to them is that they support, and are developed to support, cooperation in design. Cooperation both at the level where they support meetings in the boundary zone of the overlapping practices of design, and at the level where they are part of cooperative activities in design. They help provide tangible artifacts that the groups of designers, users and usability people can get their hands on and explore in these cooperative activities. They provide input to these sessions, and they are part of shaping the results. And though we talk about creativity, and about what is really thinking tools [9], the results of using these are very concrete and support the next iteration in the iterative design loop.

The proposed tools are different, and none of them serve all purposes equally well. In the following we discuss the described tools from the point of view of how they support our initial theoretical points.

### *Past, present and future*

Using the past to inform design has taken various forms in our work: The Danfoss museum is certainly one, where the relationship between the form and appearance of products were considered in relation to general stylistic trends, pointing ahead (See also [28]). However, as we point out, it is important not to make these past styles appear old-fashioned, if they are to serve design constructively.

In the Bang & Olufsen example, the stands explicitly served for particular groups to extract the positive aspects of a particular past product, and confront these with the future product. In both the learning checklist analysis, and the “talk to your TV” example, people made references to past artifacts that they were reminded of, for good or bad, for reasons of similarity or difference. The latter is an important concern that has come out of our present work: The past does not only inform design as regards the good sides, it is equally, though perhaps less constructively, informative regarding the less attractive sides.

### *Theory as a possible source of inspiration*

The checklists and interaction perspectives are two different ways of operationalizing theory. Through the personification, etc, the interaction perspectives seem much more readily available for being acted out and explored. This does not mean the checklists could immediately be given the same “flavor”, simply because the questions they ask are not as coherent and clear-cut.

However, both of the types of operationalizations have been used, and are useful for confronting particular sets of concerns in a particular design.

### *The present points ahead*

The TV sets in use give useful design ideas. In the “Talk to your TV” example it was clear that by starting with the present, well known use, the users were inspired to think ahead, when asked to talk to their TV. In contrast, when they were asked to talk first, they were much more trapped in the present, perhaps in demonstrating that they knew what tele-text was about. And, as discussed, through the analysis of the present, we are already shaping the future. The present day products which were presented at the stands also acted as tangible means in support of design in the Bang & Olufsen workshop as in other examples we have seen [8].

Using transcribed situation out of use turned out to be a very useful basis for designers to explore the consequences of the interaction perspectives. The anchoring in the actual use made the designers fly, with both feet on the ground, and it was possible to discuss implications of the design choices, without this being pure speculation.

We find that what is useful overall in these examples, is that the references to the present are concrete and quite specific.

### *The right tool for the job, extremes and multiple voices*

The right tool for the job, in our analysis, is one that gives a concrete, and often tangible focus, perhaps oversimplifying matters a bit, so as to illustrate extremes. We have made good use of clear-cutting perspectives, be these in terms of particular perspectives of certain groups as in the Bang & Olufsen stands, or through opening up a broad design space with the different interface modalities in the “talk to your TV” example. We have developed theory-driven extremes as with the interaction perspectives, and we are in general proposing to work with extremes in terms of pluses and minuses, good guys and bad guys.

However, it is equally important to keep confronting these perspectives and not to go off in any one direction. This is indeed why the meeting of perspectives through cooperation of people in workshops is very important for the whole of the creative design process.

### *Tools develop*

As we have illustrated the proposed tools for creativity are in continuous development. It is essential to continuously confront the tools with the particular design situations that one is designing for, and with the ongoing accumulation of experiences in these particular design activities.

## ACKNOWLEDGMENTS

The project “Usability work in Danish industry” is sponsored by CIT/CMT through grant # 23.

We thank all the BIDI-participants for their contributions; Pernille Marqvardsen, Kim Halskov Madsen, and Thea Borgholm for their contribution to the work presented here.

## REFERENCES

1. Bannon, L. & Bødker, S. Beyond the Interface, Encountering Artifacts in Use. In Carroll, J. (Ed.). *Designing Interaction: Psychological Theory of the Human-Computer Interface*. Cambridge University Press, pp. 227-253, 1991.
2. Bertelsen, O. W. *Elements to a theory of design artefacts: a contribution to critical systems development research*, Ph.D.-Thesis, Aarhus University. DAIMI PB-531, 1998.
3. Bertelsen, O.W. Fitts' Law as a Design Artefact: A Paradigm Case of Theory in Software Design. In Blumenthal, B., Gornostaev, J. & Unger, C. (Eds.). *Human-Computer Interaction. 4th International Conference, EWHCI '94 St. Petersburg, Russia, August 1994. Selected Papers*, Berlin: Springer Verlag, pp. 11-18, 1994.
4. Buur, J. & Bødker, S. *From usability lab to "design collaboratorium": Reframing usability practice*, paper presented at DIS 2000.
5. Bærentsen, K. *Intuitive User Interfaces*, paper accepted for Scandinavian Journal of Information Systems
6. Bødker, S. Ehn, P., Kammersgaard, J., Kyng, M., & Sundblad, Y. A Utopian Experience, Bjerknes, G., Ehn, P. & Kyng, M., (Eds.). *Computers and Democracy – a Scandinavian Challenge*, Aldershot, UK: Avebury, pp. 251–278, 1987.
7. Bødker, S. and Halskov Madsen, K. Context - an active choice in usability work, *Interactions*, July+August 1998, pp. 17-25.
8. Bødker, S. & Grønbaek, K. Design in Action: From Prototyping by Demonstration to Cooperative Prototyping. In Greenbaum, J. & Kyng, M. (Eds.). *Design at Work: Cooperative Design of Computer Systems*. Hillsdale, NJ: Lawrence Erlbaum Associates, 1991pp. 197-218.
9. Bødker, S. and Christiansen, E. Scenarios as springboards in design. In Bowker, G., Gasser, L., Star, S. L. and Turner, W. (eds.). *Social science research, technical systems and cooperative work*, Mahwah, NJ: Erlbaum, 1997 pp. 217-234.
10. Bødker, S., Christiansen, E. & Thüring, M. A conceptual toolbox for designing CSCW applications, *COOP '95, International Workshop on the Design of Cooperative Systems*, (pp. 266-284), Juan-les-Pins, January 1995
11. Bødker, S & Petersen M.G. *Design for learning in use*, paper in review for Scandinavian Journal of Information Systems.
12. Bødker, S. *Through the Interface – a Human Activity Approach to User Interface Design*. Hillsdale, NJ: Lawrence Erlbaum Associates 1991.
13. Bødker, S. Scenarios in user-centred design - setting the stage for reflection and action. *Hawaii International Conference on System Sciences 32*. CD-ROM. Version to appear in *Interacting with Computers*, 2000
14. Carroll, J. M., Kellogg, W.A. & Rosson, M. B. The task-artifact cycle. In Carroll, J. M. (ed.) *Designing Interaction: Psychology at the Human-Computer Interface*, New York: Cambridge University Press, 1991, pp. 74-102.
15. Coad, P. & Yourdon, E. *Object-Oriented Analysis*. Englewood Cliffs, NJ: Prentice Hall, 1990
16. Engeström, Y. *Learning by expanding*. Orienta-Konsultit, Helsinki, 1987.
17. Kyng, M. Creating Contexts for Design. In Carroll, J. M. (Ed.), *Scenario-based design. Envisioning work and technology in system development* (pp. 85-108). New York, NY: Wiley 1995.
18. Madsen, K.H. and Petersen M.G. Reflections on three design sessions, Brewster, S. Cawsey, A. and Cockton, G. (eds.) *Human-Computer Interaction - INTERACT'99 (Volume II)*, IFIP, 1999, pp. 185-190.
19. Madsen K.H. and Borgholm, T. Cooperative Usability Practices. *Communications of the ACM*, 42, 5, May 1999, pp. 91-97.
20. Madsen, K.H. A Guide to Metaphorical Design. *Communications of the ACM*, 37 (12) 1994, 57-62.
21. Mogensen, P. *Challenging Practice: an Approach to Cooperative Analysis*, Ph.D. thesis, Aarhus University: DAIMI PB-465, 1994.
22. Morgan, G. *Images of organization*, Beverly Hills CA: SAGE, 1987.
23. Nielsen, C. Testing in the Field. *Proceedings of APCHI 98*, IEEE Press, 1998, pp. 285-290.
24. Ricoeur, P. *Time and Narrative* (Volume 3). Chicago: The University of Chicago Press, 1988.
25. Schön D. A. *The Reflective Practitioner – How Professionals Think in Action*, Basic Books, New York, 1983.
26. Star, S. L. The structure of ill-structured solutions: boundary objects and heterogeneous distributed problem solving. In Gasser, L. & Huhns, M. (eds.) *Distributed artificial intelligence*, vol. 2, London: Pitman, 1989, pp. 37-54.
27. Trigg, R., Bødker, S. & Grønbaek, K. A Video-based Analysis of the Cooperative Prototyping Process. *Scandinavian Journal of Information Systems* 1991, vol. 3, pp. 63-86.
28. Øritsland, T.A. *A Theory of Discursive Interaction Design. Mapping the development of quality and style in man machine interaction*, Doctoral Thesis, Norwegian University of Science and Technology, Department of Product Design Engineering, Trondheim 1999

