

Design space conceptual tool – grasping the design process

This paper concerns an alternative and relatively simple model of the design process that can be used as a conceptual tool for designing a design process. Three different examples are used to test and show the model's relevance. This model takes a quite different turn on the process: instead of describing the process as if it would start from a problem, it suggests that it is actually the solutions that are actively used when designing. These possible solutions are referred to as the 'design space'. The paper also provides a methodological framework for understanding the different approaches with which methods can be used. Here the concepts 'explorative' and 'experimental' are essential. Finally some aspects of 'constraints' are discussed in relation to the design space. The model can be used for reflecting on as well as designing design processes in education, in research and commercially.

Keywords

Design process, design methodology, design tools, design education, design space, interdisciplinarity.

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INTRODUCTION

This paper concerns an alternative and relatively simple model of the design process that can be used as a conceptual tool during a design process. It also provides a simple methodological framework for understanding the different approaches with which methods can be used. Three different examples are used to test and show the model's relevance.

The model uses the 'design space' as a conceptual tool that can be used both for designing and understanding design processes. The design space is here understood as all the possible design solutions. In reality the design space is an extremely complex multi-dimensional space containing an endless amount of solutions, but we are here only interested in it as a concept.

This model claims that all design work supports the understanding of the 'design space'. This means that all the different methods and techniques used during the design process will result in some knowledge about the design space. If a solution seems to work, it lies within the design space. If some method shows that certain aspects will not be suitable these are outside of the design space. The model can be seen as a complement to other models, linear, circular and others.

Key concepts

The key concepts in this paper are *design space*, *constraints*, *exploration* and *experimentation*.

The *design space* is a representation of all possible solutions and here the design space provides a conceptual tool representing what the design work is all about. It serves as something to aim ones intention at during the whole design process. And while working an understanding of it is generated. But it is important to understand that the design space cannot be fully described because of its complexity and size. It is not sure that the design space is one space. It might consist of several non-connected spaces.

The usual way of talking about solutions is to see them in relation to problems but in this paper we will use another approach. The concept of *problem* connotes aspects like that the problem can be fully described and therefore there is a 'best' solution, i.e. the result is measurable. But in all but the most trivial design work this is not the case. Horst Rittel formulated the description of *wicked problems* in an attempt to capture the nature of design problems [11, 2]. Rittel showed that there are no definitive limits to design problems and identified ten aspects. Three of these are:

- Wicked problems have no definitive formulation.
- There is no stopping rule.
- The solutions to wicked problems cannot be true or false, only good or bad.

Although it clearly is important to change bad conditions into desired ones, realising that problems in design are wicked should encourage to stay away from too much focus on the problems. But we must also realise that in a great deal of

design work it is not really relevant to talk about ‘problems’. Possibilities may be a more relevant concept. Take the Sony Walkman as an example. It is not a solution to a problem but rather an idea that uses the technical possibilities. The Walkman is definitely regarded as meaningful and desirable by many of its users and that is probably better ways of looking at the product than as a problem solver.

Whatever aspects are most important, this paper argues that it is the artefact that does not yet exist that is in focus during the work. All these possible artefacts make the design space.

From all work done during the design process we construct knowledge and experience of the design space, i.e. the possible solutions. We learn and get experience of the design space both when finding ‘stuff’ that works, i.e. fit into the design space, as well as when finding ‘stuff’ that does not work.

Constraints are an important aspect of design work. They can be fixed, like those imposed by legislation. Client-imposed constraints are somewhat flexible. And designer imposed constraints are fully flexible. They “become so powerful under the designer’s own command. A well chosen constraint can be very helpful [by] reducing too wide a range of options” [6]

Designers can choose to work with many different methods and techniques. Perhaps more important is that these methods can be used with different approaches. Some of the main approaches can be described as *exploratory* and *experimental*. An exploratory approach has the “emphasis on clarifying requirements and desirable features ... and where alternative possibilities for solutions are discussed” [5]. While when having an experimental approach “the emphasis is on determining the adequacy of the proposed solution” [5]. Experimenting often results in yes or no as answers. Yes, this is within the design space or not.

BACKGROUND

Some background that will help in understanding the paper is presented below. First a brief discussion concerning existing models of design processes. After that some aspects of methods and techniques is presented. Finally there is a short description of the author’s perspective and background. This part also includes the turn encountered by Henrik Gedenryd’s book *How designers think*[6].

Models of the design process

There exists a great amount of different descriptions or models of the ‘design process’. Some are constructed to be prescriptive, suggesting a ‘better’ way of working. Others are written ‘from the outside’ and often describe what happens. A few descriptions are constructed from within the process itself. These models help us to reflect on and teach us a great deal about design processes, since the idea with a model is to emphasize some aspects by deliberately excluding others. But many people claim that these models of the design process do not reveal what design work is really about. Bryan Lawson says:

“We have still not fully explained that most magical of all conjuring tricks, the design process.” [8]

There exists a large amount of literature in this field. Below follows only a very brief discussion of some models of the design process.

Common for most descriptions are that they start with a problem that then is researched or analysed regarding the needs users or companies may have. The requirements are usually defined before generating and choosing ideas. Finally it is time to test

that the suggestion works. This *linear* model is often described as the waterfall model.

Some people find that this is unlikely that you would generate a good enough solution with only one try and propose a circular model often consisting of the same distinct stages, requirements, design, test and evaluation but this loop is gone through several times. Each time the proposal gets more suitable. This suggests that the model can be described as *iterative* or a *circular* or *spiral* shaped model.

These models often suggest that work is done on only one idea, which is developed over time. Some models recognize that there at times can exist several different ideas that the designer considers. This group of models can be seen as *funnel* shaped models. From several ideas one is chosen. This idea is then expanded into several new ones. These newer ideas are thereafter contracted down into one, etc.

Methods and techniques

The models describe the overall process of design work and identify different phases where specific aspects of the work is done, such as ‘understand the problem’, ‘gather information’, ‘analyze information’, ‘synthesize’, ‘wait for the creative leap’, ‘work out solution’, etc. [11]. In these phases methods and techniques are the important tools used for understanding situations, users, activities etc. Often different tools and techniques are suggested for the different phases. This emphasizes the rigidity of the models even more.

The same method or technique can be used with different approaches. Qualitative and quantitative approaches are such distinctions.

The turn

The author, who has a background as an industrial design consultant was often in a situation where he had to describe to a client how an assignment would be carried out. Most clients felt assured by linear descriptions while circular ones seemed to make them nervous. They imagined the costs growing for every new lap and no end in sight.

When the author later tried to teach students about the design processes he had difficulty relating the models to his own experience.

“... these methods ... do not work as prescriptions – people don’t use them... On the other hand they are also inadequate as descriptions...” [6]

He was careful to describe them as models. It was not until reading Henrik Gedenryd’s *How designers think* [6] that the models and experience started to resemble one another. Gedenryd also claims that the different aspects of design in action are not possible to separate from each other in reality. Instead the design work should be considered as an inquiry. And he also proposes that design can be seen as working ‘backward’ from the future situation of use. This triggered the idea of using the design space as a conceptual tool for understanding the design work.

EXAMPLES

This part of the paper discusses the design space model in relation to real activities in order to investigate if it seems to work or not. Here three different design processes will be used and described with the help of this model.

Three examples have been chosen from different fields; research, commercial and education. The examples are the research project interLiving, a project done by IDEO that was shown on TV and the Convivio summer school 2004 in Split.

In one case, the summer school, the model was used to guide the actual work done. The design process was deliberately guided by the use of the model. This was an experiment: should the design space conceptual tool work or not? In the other two cases the model has been applied afterwards and been used to reflect on the process.

interLiving

The EU-funded interLiving project was carried out during three years 2000-2003 [7]. Here only some activities and aspects relevant for this paper will be presented. One of interLiving's objectives was to develop artefacts that use information and communication technology to facilitate intergenerational communication within families. A multidisciplinary team of researchers used a cooperative design approach and worked together with several families throughout the whole project.

Design space

At the start of the project there was no explicit need, desire or problem that was to be addressed. Nor was there any specific technology that was preferred. Compared to most projects this must be regarded as extremely open, i.e. very little was known about the design space. To support that the multidisciplinary team would get a shared view of the design space most work in the field was conducted with researchers from different backgrounds working together.

Explore and experiment

The researchers used many different methods and techniques with the aim to understand the family members' needs and desires i.e. an understanding of the design space. In the beginning of the project most activities conducted had an explorative approach. Like the self-documentation probe-kits that the families completed (figure 1). The activities also

included workshops, interviews, video-diaries, prototypes, etc.. The final prototyping work had more of an experimental approach in order to distinguish specific features.

Constraints

After these initial understandings the researchers decided to prototype a few of the ideas. This was as in most design work an optimistic approach, to constrain the options and proceed by experimenting with some ideas. These experiments resulted in a better understanding of the boundaries of the design space.

IDEO-ABC

ABC News Nightline (February 9, 1999) [1] broadcasted a story called "The Deep Dive" showing the design of a new shopping cart. The design work was done in five days by the design consultancy IDEO. It was presented during the 20 minutes long TV programme which will be used to reflect and test the design space model on. We must all be aware of the fact that the broadcasted story is a representation, a narration, of what the reporter experienced and the cameras recorded.

The story showed a multidisciplinary group of people working together. Several different methods were used both in the design studio and out in the field. The participants were often gathered all together discussing and brainstorming ideas.

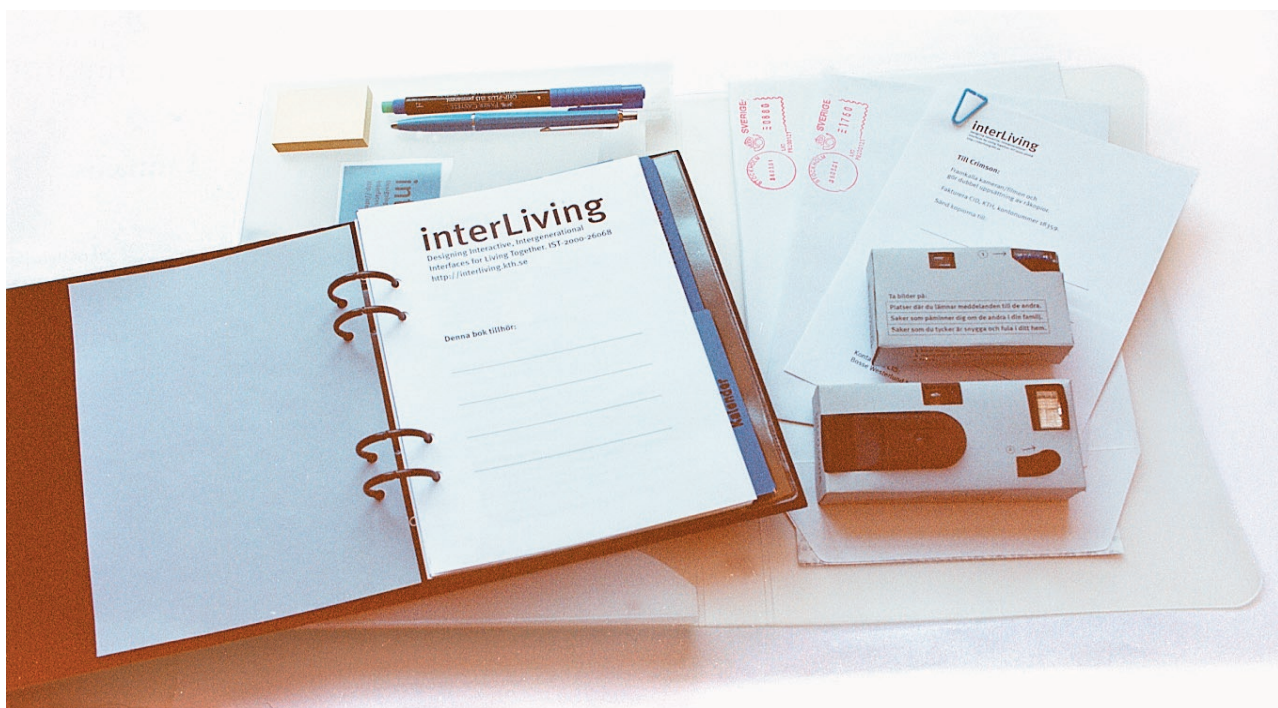
Design space

The awareness of the design space was large during the process. The final product, in this case a redesigned shopping cart, was often referred to in the conversations.

Exploration and experimentation

The designers went out in the field, observed and talked to 'the real experts' i.e. the users and other stakeholders to explore the shopping carts design space. When they all came back to the studio they shared their experiences. In the brainstorming session that followed the group generated many different ideas on the topic of shopping carts. This can be described as an exploration of the design space. The voting that followed was a

Figure 1. A communication probe kit used in interLiving to understand the participating families' needs and desires.



way to describe the boundaries of the design space more precise, i.e. pointing out the most interesting areas.

Prototypes were built which can be seen as experiments. The group wanted to experience which of the ideas that would seem to work or not.

Constraints

Several explicit constraints were present right from the beginning. There was a time constraint; the work had to be finished in five days and the cart should not cost more than current ones.

After a couple of days of work a group of seniors forced the design group to split into four smaller groups and work on specific aspects in order to be ready on time. I.e. the time left constrained the amount of alternatives that could be explored.

The existing carts were not used as a constraint in the sense that not only the functions that were present in the existing carts were redesigned in the new one. (See figure 2) The functionality was altered in several ways. One of them was that the customer himself did the price scanning thus moving some of the then current functions of the cashier to the cart. This shows that the focus of the work was not on the existing cart but more on the future situation of use.

Convivio summer school in Split

The third international interaction design summer school was organized by Convivio, the Network of People-Centered Design of Interactive Systems [3]. It took place in Split, Croatia late summer 2004. The school lasted for two weeks and had nearly 50 participants. They were PhD and Master students mostly from EU countries and the Balkan but there were also participants from the Americas and Asia. In the afternoons the students worked in one of four ateliers. The ateliers all had different focus that was set by the four atelier leaders. The author was one of the four atelier leaders and wanted to test the design space conceptual tool in a prescriptive way with students.

The atelier work

Focus in this description of the atelier work will be constrained to some aspects and parts relevant to the paper's topic and the actual work done will only briefly be described.

The title provided for the atelier was: "Cooperative design, and conscious reflection on the design process". And the abstract presented was: "The idea behind this atelier is that the group together with other people in Split will use a mixture of methods to describe a design space and propose one or more designs to exemplify that space. Besides this work we will reflect and discuss the design process in order to learn more about possible ways to conduct design work."

Constraints

'Communities in Transition' was the theme and there were three sub themes used as initial constraints:

Sustainable Tourism
Reinventing Hospitality
Enhancement of Identities

The suggested designs should be regarded as meaningful by the people going to Split, living in Split and also those participating in the summer school. The work should be seen as mapping the design space with the help of various methods for exploration and for experimentation.

The time constraint meant that the group in two weeks time had to demonstrate at least one concept that complied with at least one of the themes and was meaningful to the stakeholders.

Exploring and experimenting.

A participatory design, explorative approach was chosen and the students went out talking to tourists and locals, observing actions, taking photos of places and collecting artefacts. These different ways of more or less randomly exploring gave an initial understanding of the design space.

The ideas and observations were presented and representations were put on the wall. Thereafter the group generated twice

Figure 2. A prototype for a new shopping cart designed by IDEO. The new shopping cart concept considered issues such as maneuverability, shopping behavior, child safety and cost of maintenance. It has removable plastic baskets to increase shopper flexibility and to minimize theft. The prototype was designed in five days by a multidisciplinary team through brainstorming, research, prototyping, and gathering user feedback.



as many ideas and voted for the ones that seemed to have a potential to be developed into something interesting. Similar ideas were later clustered together into groups and later the ideas were transformed into broader concepts: ‘Sensations’, ‘Changing places’ and ‘KeySpots’. There were many ideas that we thought would fit into the design space but the further work was constrained to these concepts.

When discussing these aspects of the ideas the thoughts on how the interaction would work sometimes was very detailed. For example discussing misuse: “... then somebody would just write dirty words all over the ‘e-board’ and the next person would be discouraged to start using it.” When doing these kinds of ‘tests’ you basically jump into the future situation of use, i.e. focus on the design space. You situate the idea into the future and test it by fantasizing about how the future users would make meaning out of it.

One of the initial ideas felt clear enough to be presented already, i.e. was in the design space. Several of the others seemed to converge into a story-driven presentation. But there were many unexplored aspects of the other concepts.

Since this was a school and not a real design assignment the group’s ‘product’ was the final presentation and it had to be designed to work in this context. A video seemed like an appropriate idea. But before the video could be made the ideas had to be developed both explorative and experimental.

The group developed, built and distributed prototypes both for testing (experimenting) and for collecting stories for another idea (exploring). They also made flyers that encouraged people to write stories directly on the flyers or via SMS or e-mail. The flyers were spread in the city and the other prototypes were put at locations in the city where they could be observed. (Figure 3) Later when the results of the prototyping and testing in the city were presented the design suggestions seemed to work well, i.e. fit into the design space.

Presenting the design space

The result of the atelier work was presented as a short video. It showed how two people, one local and one tourist, would use the four product ideas that had been developed. I.e. they showed four different designs that were examples within the design space.

After showing the video the design process, i.e. how the work had been conducted, was presented. Since the group had used the design space as a conceptual tool when designing the process it seemed natural to use that as a representation even in the presentation. The illustrations, that were drawn by a member of the group, are shown in figures 4–7. They illustrate how the understanding of the design space increased while exploring and experimenting with different methods over the two weeks.

REFLECTION

This part of the paper reflects on how the model proposed in the introduction could be used to describe the three examples presented above.

Applying models

If one would apply almost any model of a design process on the descriptions of the three project/cases above it would be possible to make reasonable descriptions and claim that ‘it was a typical waterfall process’ or ‘hermeneutical’ or ‘fluctuating between expanding and contracting’. That is what is so great with models, they emphasize some aspects and ignore others without ever revealing the whole picture. The objective of this paper is not to prove that the ‘design space conceptual tool-model’ is superior to other models. One aim is to show how the model can be used when describing processes seen in the rear-view mirror.

Another, perhaps more interesting, aim is to show that ‘the design space model’ actually worked to guide and inform the actual work done in the Convivio summer school workshop. I.e. that the model can be used to design design processes.



Figure 3. One of the prototypes for the e-board being tested by tourists in the city of Split.

Across disciplines

Above the design space model's relevance for industrial and interaction design are shown. Thanks to its simplicity the model would most likely work with any design process in any design field. It supports constructing a shared view of what the aim is, i.e. defining one or more instances within the design space. The model also helps understand the ways available to get there, through exploration and experimentation. Of course this does not imply any path at all but instead provides a conceptual tool enabling everyone to understand how to be involved in the process. The non discipline-specific or model-specific terminology has advantages since everyone can contribute without misunderstanding. In other models many concepts are defined differently, like 'iteration', which causes misunderstandings.

Advantages in education

Two problems that students may have are that they do not explore enough before 'finishing' an idea or that they get stuck in the 'research phase' and have difficulties starting the idea generation. Nigel Cross writes:

"Novice behaviour is usually associated with a 'depth-first' approach to problem solving, i.e. sequentially identifying and exploring sub-solutions in depth, whereas the strategies of experts are usually regarded as being predominantly top-down and breadth-first approaches."

"some students became stuck on information gathering, rather than progressing to solution generation" [4]

This model worked well in the Convivio summer school. It seemed to promote thinking of *why* over *how* since it focused on where the students were going instead of keeping track of where they were in the process. Thanks to the model it was clear to the students that the whole point in designing is to generate ideas within the design space. And it was very clear that it would be possible to generate many very different solutions.

Methods vs. the whole picture

"The early stages of product development are routinely described as the "fuzzy front end" of development." [10]

The model described in this paper puts information gathering and other activities into context, not as separate stages that have to be passed through before ideas can be developed, but as one of the available ways of exploring and learning about the design space.

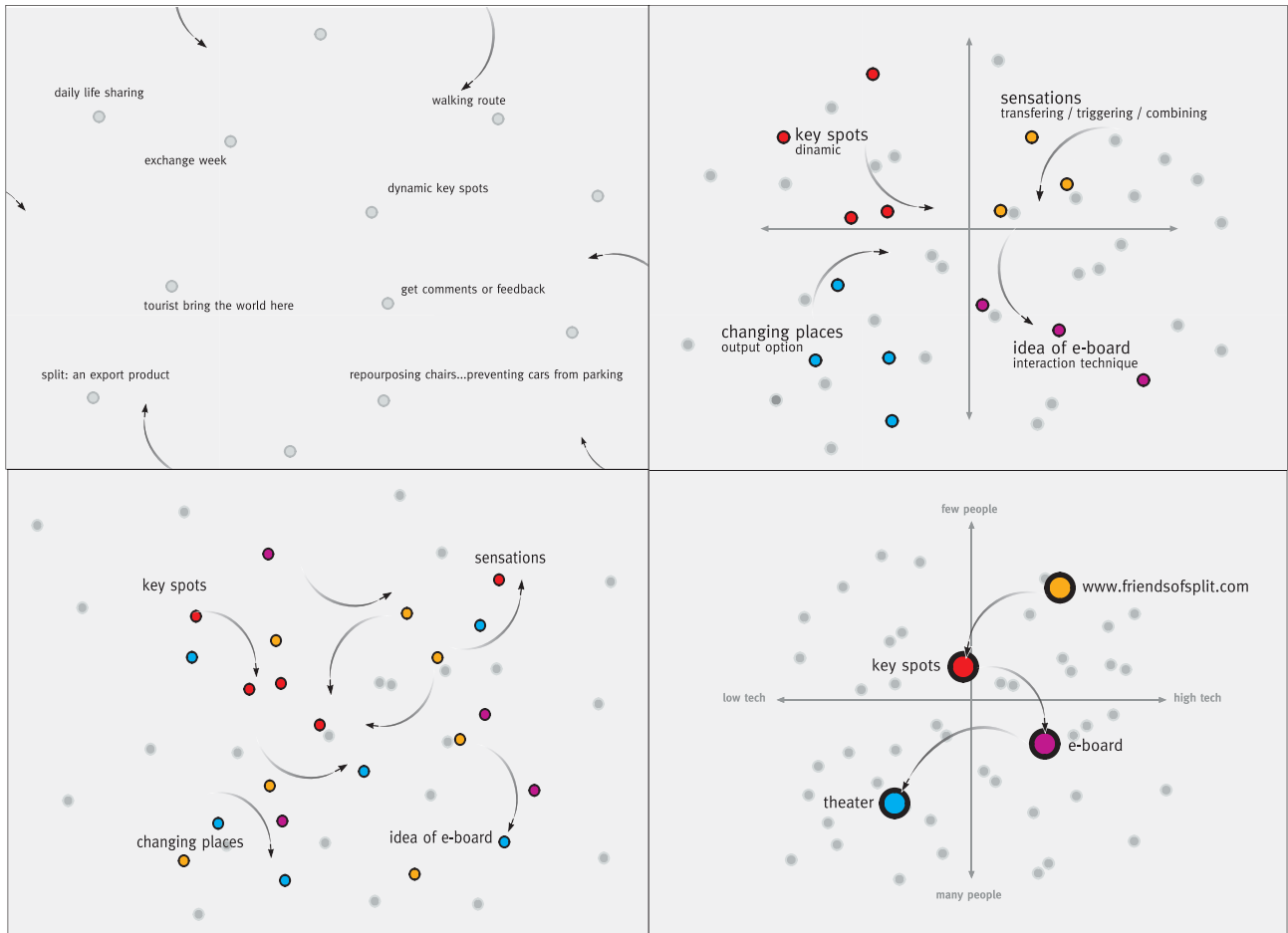
One good way to start a design process is by letting people with different backgrounds use several different methods on the same 'question' or aspect, so called 'triangulation' [9, 13]. The design space model encourages early exploration of ideas but clearly shows that there are many possible solutions. Triangulation is also well supported since it seems obvious that other aspects are

Figure 4-7. Illustrations representing the design process showing how the group gradually constructed knowledge about the design space. Made by Durdica Katic.

4 (top left) Illustrates the first investigations in the city of Split.
5 (bottom left) The first four concepts.

6 (top right) While prototyping in the city the concepts were developed.

7 (bottom right) The last figure illustrates the 'walkthrough' through four of the design ideas that was shown in the video. They are examples of designs that are inside the design space.



observed when looking from different directions. Distinguishing between an exploratory and an experimental approach to the use of different methods helps to reveal the methods contribution to the overall work.

Changing emphasis from an overall conceptual view to a detailed one is typical for designers' way of working. Both views look into the future situation of use, i.e. the design space. The idea is situated into the future and tested by fantasizing about how the future users would make meaning out of it.

"The designer's inquiry concerns the situation that is not present to the designer, and therefore not available to her interactive cognitive process." "...design can be described as an inquiry into this future situation of use." [6]

Many of the examples in Rittel and Webber's work on wicked problems are from large scale planning like freeways, public-works and architecture [11]. Therefore they claim that there is no possibility to try various runs without penalty. But in the kinds of design work that this paper deals with exploring and experimenting in real life is very rewarding. Prototypes are one of the most important tools for a designer. Their role as "learning vehicles" [5] is well supported in the described model. "There is a range of design techniques ... sketching, prototyping, mock-ups, scenarios, storyboards, simulation, and user testing, ... to enable the designer to get at the future situation of use." [6]

One key asset of the design space conceptual tool is its focus on the whole future product in its context of use. This helps to show that all aspects are important right from the beginning. The form and other aesthetical aspects shall not wait until the end [12]. And thanks to that the risk of getting stuck working with one method and its results is lowered.

Setting and identifying constraints

Constraints are one of the most important aspects of design work. They come in several flavours from fixed, like those from legislation, to fully flexible. Examples of the latter are designer imposed constraints. Bryan Lawson recognizes that "one of the most important skills a designer must acquire is the ability critically to evaluate their own self-imposed constraints ..." [8]

This model clearly deals with constraints; actually it more or less implies that design work involves boundary work, understanding the borders of the design space. This is only reasonable on a conceptual level since the 'real' border is infinitely large and complex.

Future work

It would be interesting if the 'design space model' were discussed in relation to more projects. Most interesting would be if the model would be used for designing the processes for the design work involving people from different backgrounds. This could be done in several different fields of design and also commercially, in research and in education.

There can also be a lot more theoretical work done both on the description and understanding the model itself as well as in relation to other fields, like philosophy.

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Notes

The summer school was organized by CONVIVIO, the European Network of People-Centered Design of Interactive Systems, <http://www.convivionet.net/split.html> and <http://www.umass.hr/convivio/>

The shopping cart photo, figure 2, is kindly provided by Ingelise Nielsen at IDEO.

All websites were accessed in February 2005.