# 12. The Delft ID Studio Lab

## Research Through and For Design

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## 12.1 Introduction

The face of product design is changing. Whereas for the main part of the past century, the relation between physical form and technical function has dominated design theory and practice, the last decades show a shift to use and user. The focus of attention is shifting from a technology-driven, product-centred view to a view that is better described as user-centred, use-centred, and interaction-centred.

With this change in focus comes a need for different methods of designing, and for a new expressive design language that can cope with the highly interactive potential of new product categories that are emerging from interlinked miniaturised electronics invisibly integrated into products. All this requires much work, much interdisciplinary work.

In an effort to promote the fusion of ideas between research teams, four groups in Industrial Design Engineering at TU Delft formed the ID StudioLab in 1999. In one way the StudioLab is a physical space where researchers from participating groups work in a way that resembles a design-studio more than a conventional academic department composed of many little rooms. But it also is a statement of the intent to forge and develop links between related, but hitherto largely separate research streams. That statement is built upon three beliefs shared by all members of the Studio.

First, although the original four groups were already interdisciplinary, it is our conviction that breakthroughs and innovative research in the present field of product design requires a level of co-operation that goes beyond all traditional boundaries. To meet this requirement, product and interface designers, psychologists, physicists, specialists in the field of ergonomics and human-computer interaction, work together in integrated design and research teams.

Second, and in line with the changed focus in the field, product design and, as a result, design research must have an eye for the full experience of the user. This experience not only covers the often-studied perceptual-motor and cognitive skills of the user, but also emotional reactions. Furthermore, it is acknowledged that this full experience draws heavily upon the social, cultural, and technological context in which the interaction with the product takes place.

Finally, all research efforts should be designer-driven. That is, projects are either (among others) carried out by designers or directed towards designers. In the former case, exploring new forms of interaction through actual designing constitutes the basis of the research. In the latter case, the research must lead to new techniques or methods that support the designer in addressing the full product experience of the user.

In this paper we present a common stream of thought underlying work in the groups, and illustrate this with a number of projects. In line with the conference millennial theme, the presentation will highlight directions and sample projects, but also sketch the recent history of the groups.

## 12.2 Work of participating groups

In this section we describe some recent projects by members of the ID StudioLab. We present these projects in the form of a sampler rather than as a complete overview. This "historical sketch" indicates the shift from cognitive and perceptual-motor skills to the full experiential context, including emotional skills. For example, Djajadiningrat's work on the Cubby VR system is strongly driven on the level of perceptual-motor skills: what spatial impression do people need to perform a detailed manipulative task. The more recent work of Hummels focuses on emotional skills: what forms of interaction do people need to feel a bond with a product.

### *12.2.1 Cubby, detailed form manipulations in VR (Djajadiningrat, 1998)*

Many of today's 3D systems tease the user by showing highly lifelike virtual objects locked away behind a screen where he cannot reach them, and frustrate him by forcing him to use input devices which ignore the skills he has developed in everyday life. Cubby, a desktop VR system shown in Figure 12.1 left, addresses these problems through unification of the display and manipulation spaces and the use of a tweezers-like instrument. With this instrument, see Figure 12.1 middle, the user can operate on virtual objects where they appear (Djajadiningrat 1998).

Unlike many VR systems, Cubby is well suited to precision manipulation tasks. Possible areas of application include surgical simulation and computer aided modelling. Three orthogonally placed back-projection screens form the workspace. There is one projector per screen. Two are placed on the top surface, one stands below the workspace. The user's head-position, tracked with a device mounted over the workspace, is recorded to adjust the perspective of the images on the screens.

Cubby's tweezer-like instrument consists of a physical barrel and a virtual tip. The tip is rendered as an extension of the barrel. Since the tip is virtual, it can be moved behind a virtual object without occlusion conflicts occurring. The instrument features a single button that makes it behave and feel like a pair of tweezers. Because Cubby's workspace is compact, the positional error of the instrument can be kept small.

### *12.2.2 Two-handed 3D interaction in conceptual modelling (Gribnau, 1999)*

The quick generation, comparison and evaluation of concepts is more difficult with the computer than with traditional materials such as cardboard, foam, clay, etc. This is largely due to the set-up of most computers systems (mouse, keyboard and screen) and the associated interfaces. To improve computer support of the early phases of design, the use of spatial interaction (whereby the hands can move freely in 3D) and two-handed operation was explored. Since most computer systems do not support either 3D or two-handed interaction, alternative interaction devices and new interface techniques were developed to test whether spatial interaction with two hands could help to make computer systems more suitable for geometric modelling.

With the Frog interaction devices and the ID8Model application developed in the project, two rounds of experiments were conducted; see Figure 12.1, right. The results indicated that both 3D interaction and two-handed operation were easy to learn. Working with two hands proved to be faster than working single-handedly and gives the designer more control over the modelling task. In addition, with bi-manual operation, the workload is divided between the hands. The combination of 3D and two-handed interaction can lead to interfaces with a more direct intuitive way of interaction that fit closer to the capabilities and skills of the designer than the interfaces of current computer systems.

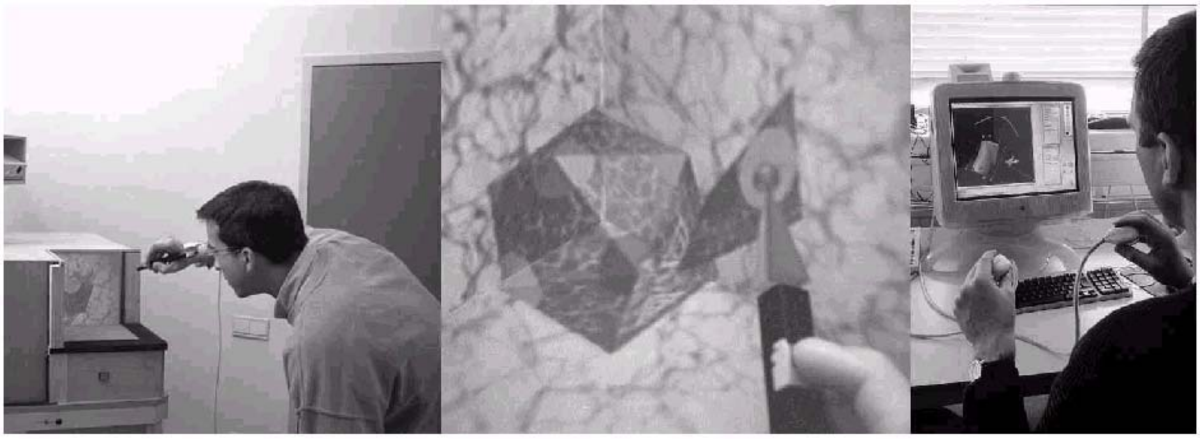

*Figure 12.1: Cubby setup, Cubby's instrument; ID8Model operated with Frogs.*

### *12.2.3 Multimodal interaction (Keyson, 1996)*

Keyson's research before joining the laboratory addressed the role of synergetic and concurrent uses of multimodal feedback. In synergetic multimodal representations, sensory modalities are combined to form an integrated interpretation. Several such interaction styles were developed at Philips Research.

Integrated tactile, auditory, and visual information was used to create multimodal user interface objects for an electronic TV program guide (Bongers, Eggen, and Keyson 1998). The guide presents generic message chips in the foreground of a TV program. The chips can represent voice, video or E-mail. Moving a trackball with force feedback over the objects, to view content, creates the feeling of flipping a chip, with accompanying visual and auditory effects. Figure 12.2, left, shows a tactual-auditory landscape. The user can move between objects while receiving multimodal navigational cues. For example, selection categories are felt, heard and seen as "holes". The distance between the tactual virtual holes can be accurately judged (Keyson 2000). As the user approaches a TV program category the sound from the target selection can be heard while the sound associated with the category being left fades into the background. Visually, the target category comes into focus and a cyclone-like cursor moves into the felt "hole" force fields (Keyson 1997). TV programs are portrayed as a globe. The globe can be rotated using a 3D trackball with force feedback (Keyson 1996), so that users can easily manipulate and roll the ball-like globe object. Each program option is felt when it is rolled into view. Programs can be selected by pressing on the trackball. At this point the program warps into a second smaller ball and can be rolled over or into other objects such as a 'record' basket. User testing showed that users tended to prefer multimodal designs compared over designs where only visual feedback was provided. Studies on concurrent use of multimodal interaction focused on how the user could perform two tasks concurrently using two or more modalities of communication. For example, users were able to search visually for text while guided tactually along a particular course in a virtual space.

To support the above mentioned research a multimodal prototyping tool was developed called TacTool (Keyson and van Stuivenberg 1997). TacTool enables force field objects to be drawn and manipulated as graphic representations. Force fields objects, i.e., touchcons, earcons and icons can be stored in a library and grouped together as reusable multimodal objects.

### *12.2.4 Gestural design (Hummels, 2000)*

Products are more than a withdrawn machine with buttons and icons. They can serve as a context for experience, rather than a mere function-provider. A product should be open and engaging, it tempts and supports users to have an experience. This means that the focus of product design shifts from the *result after interaction* towards the involvement, pleasure, beauty, and so forth, *during interaction*. The interaction has become the central theme of design, especially the aesthetics of interaction.

Hummels explores in her dissertation "Gestural design tools: prototypes, experiments and scenarios" whether and how new computer tools can support designers to create contexts for experience and focus on the aesthetics of interaction. Her thesis is composed of three parts. The first part proposes a new view on design. It discusses on a product, a social and a design discipline level, that designers and users can benefit from new digital tools, such as gestural sketching. The second part of the dissertation scrutinizes existing design tools and proposes scenarios and working prototypes for possible gestural computer tools for design. The last part explores the possibilities of implementing a gestural design tool that adapts to the individual user, see Figure 12.2 middle and right (Hummels and Overbeeke 1999).

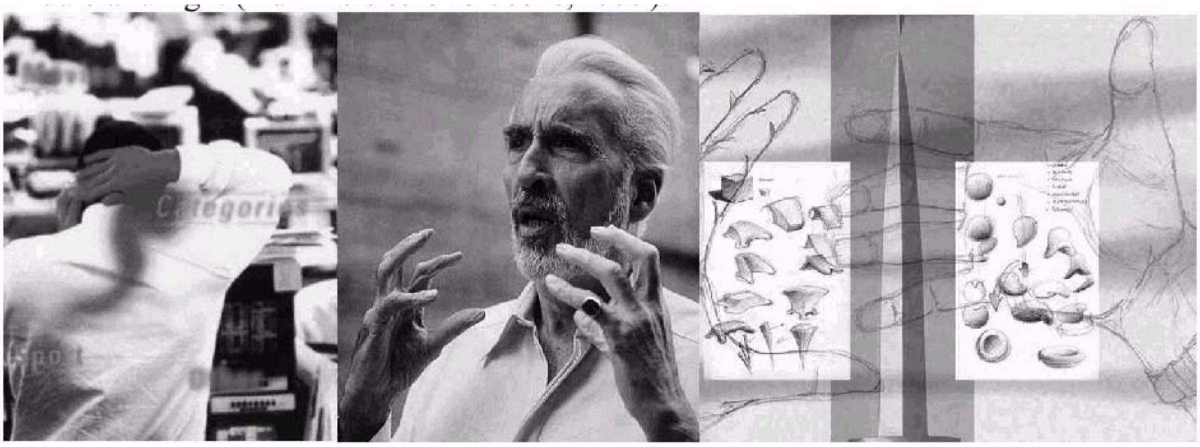

*Figure 12.2: A multimodal landscape; designer gesturing and gestural sketching scenario.*

## 12.3 New directions

The above projects illustrate our interest in the cognitive and perceptual-motor skills of designers and users. However, these aspects only partially address a person. We believe that the starting point for design and design research has to be respect for people as whole. For the sake of analysis, a person's skills in interacting with products, may be considered on three levels, the 'wholly trinity of interaction': cognitive skills, perceptual-motor skills and emotional skills: doing and feeling. Moreover, the social role of the product becomes central to our approach: social interaction is in the first place *between people*, possibly aided by products. In short, we shift our focus from the isolated product and its form toward the experience of designers and users.

When designing for an experience, a designer should not only create the product's function, make this function accessible and the product's appearance beautiful, but also make the interaction with the product beautiful. The designer creates a context for experience, rather than a product.

What are the implications of a context for experience for research? First and foremost, design research has to become research through design. Contexts for experience presuppose diversity, subtlety and richness of design solutions in order to support individual users. To conduct experiments on human-product interaction, one needs to use fairly detailed designs that allow for this diversity, subtlety and richness during interaction. One needs to design wealthy solutions and test them in their context: with users in their environment.

As designing has become essentially contextual, scientific work and results should also be contextual, i.e., lead to conditional regularities instead of general laws. The main challenge for designer-researchers lies in integrating of the different aspects that compose a context for experience. How can functional analyses be integrated with atmospheric collages of the feelings and experiences of a user? How can the characteristics of an individual and a situation be captured and formulated? How can the designer-researcher preserve richness and subtleties of interaction, without drowning in the complexity of the context?

Because experiential and contextual design is a fairly new area in industrial design and still on the frontiers of knowledge, designer-researchers need to find new methods and research techniques to find such conditional laws. In the remaining part of this paper, we will show several of our research projects that try to gain insight in human-product interaction on an experiential level.

### *12.3.1 Evaluating product emotions (Desmet)*

Nowadays, it is often difficult to distinguish products on the basis of their technological functioning or quality. Consequently, emotional responses to consumer products are often a decisive factor in purchase decisions. A product that has an emotional surplus value over other models can incite the customer to pick this particular model out of the row. So far, however, little is known about how people emotionally respond to products and what aspects of a design trigger an emotional reaction. The project aims to clarify the relationship between products and the emotional responses or feelings they elicit. The goal is to develop a model that explains how products elicit emotions (Desmet 1999) and a new set of tools that support designers in evaluating and manipulating the emotional impact of a design.

The model of product emotions is based on appraisal theories from psychology. A method, called PrEmo, was developed that measures product emotions (Desmet, Hekkert, and Jacobs, in press). PrEmo, see Figure 12.3 left, is a non-verbal self-report measure that uses eighteen animations of a puppet as metaphors for the user's emotions that go with a certain product.

### *12.3.2 Emotional intelligence for products (Wensveen)*

Wensveen's contribution to the growing research field of emotion in design starts from an industrial designer's point of view. His research focuses on how 'intelligent' products can adapt to the emotional experience of the individual user. He starts from the following questions:

1) What are the relevant emotional aspects that form a context for experience?
2) How can a product recognise and express these aspects?
3) How should the product adapt its behaviour to the user on the basis of this information?

The first question was answered by using 'probes' to explore user's experiences (see Figure 12.3, right). This technique was developed by Gaver et al. (Gaver et al. 1999; Wensveen 1999) at the Royal College of Art, London. A lot of research on the second question focuses on *detecting* physiological indicators, e.g., blood pressure, skin conductivity and heart rate. However, we do not use this kind of information, as it doesn't allow the user to *express* his emotion to the product. Keeping this in mind, industrial designers can offer an alternative approach to detect and recognise emotions. In this approach a product is designed in such a way that it elicits behaviour which is rich in emotional content. Through his perceptual skills the user perceives the possibility of acting in an emotionally expressive way (the product's affordance) and uses motor skills to express how he feels. Experiments will be conducted to test how the designed product can register this emotional expression and adapt to it.

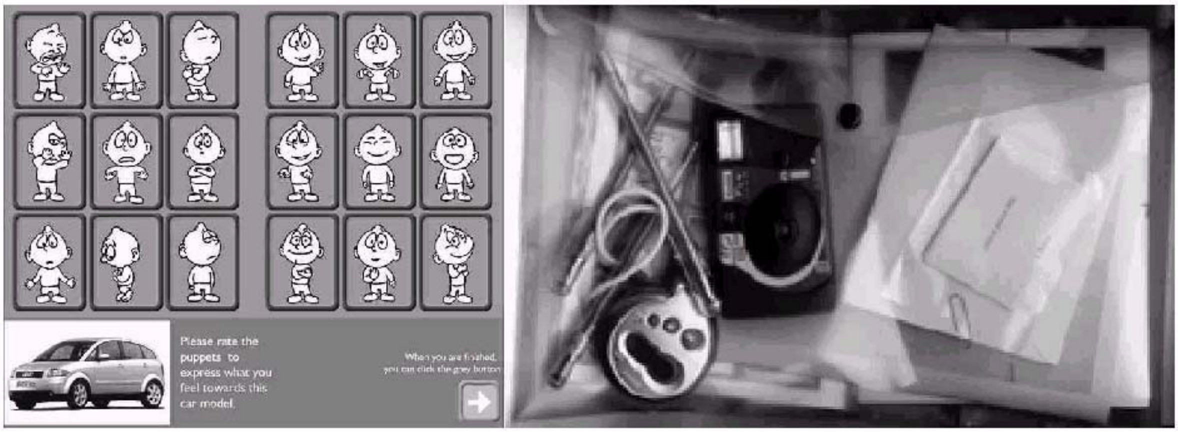


*Figure 12.3: PrEmo interface; experience probe.*

### *12.3.3 Innovating with precedent designs (Pasman)*

Existing or precedent designs form an important source of information in the design process. When faced with a design problem, many designers draw reference to existing solutions as inputs for their idea generation. Thus collecting precedents in the form of product samples, product catalogues, photographs, slides etc. as well as organising them into moodboards, collages or folders is a major activity during the conceptual phase. Pasman's research is aimed at understanding and supporting this activity. From a design-methodological perspective the objective is to gain a better understanding of the role and meaning of precedent designs. What role do they play in the creation of new designs and how can this role be influenced? From a technological perspective the focus is on the development of a computer tool, which assists the designer in developing, organising and consulting a large collection of precedent designs. How then should such a tool be structured and in what ways would the designer interact with it? These issues are being addressed using a variety of research methods. A theoretical framework has been developed, which classifies products on their typical features regarding function, form and use (Muller and Pasman 1996). Based on this framework a method of organising precedents has been proposed. The effects of this method on the results of a design task have been studied in a design experiment, in which designers were provided with examples of existing telephones while designing a new one (Pasman and Hennessey 1999; see Figure 12.4, left). The different ways in which designers organise products and the influence of a specific context such as a design brief on this structuring behaviour, are studied through a number of classification experiments.

Finally a number of design proposals for the user interface of the design tool have been generated, prototyped and tested. So far these studies support our notion that existing designs can be a powerful source of design knowledge if they are organised and represented in ways which reflect the 'thinking and acting' processes of designers.

### *12.3.4 Tools for inspiration (Keller)*

An important aspect of the new design methods is the ability to experience, communicate and discuss not just the form, but also the interactivity of the product. Keller's project looks at different ways to support the communication, visualisation and experience of a product's

interactivity using new (computer-aided) tools. These tools support the sketchy and expressive strengths of the traditional tools, combined with the dynamics and interactivity of the new interactive products. One of the studies explores interactive, dynamic video collages projected in the environment of the designer's workplace, see Figure 12.4, right.
The video collages open up a wide range of explorations. Current studies look at the different ways of displaying the video collages to allow the designer to experience these collages in the corner of the eye, similar to the way the designers hang the pictures, collages and sketching on the walls of their workspace (Keller, Stappers, and Adriaanse 2000). Another aspect of these collages is the direct and indirect ways in which the designer can interact with these video collages. But most importantly, these new dynamic video collages allow for an expressive way to experience, communicate and discuss the interaction experience by using moving images, ambient sounds and immersive projections.

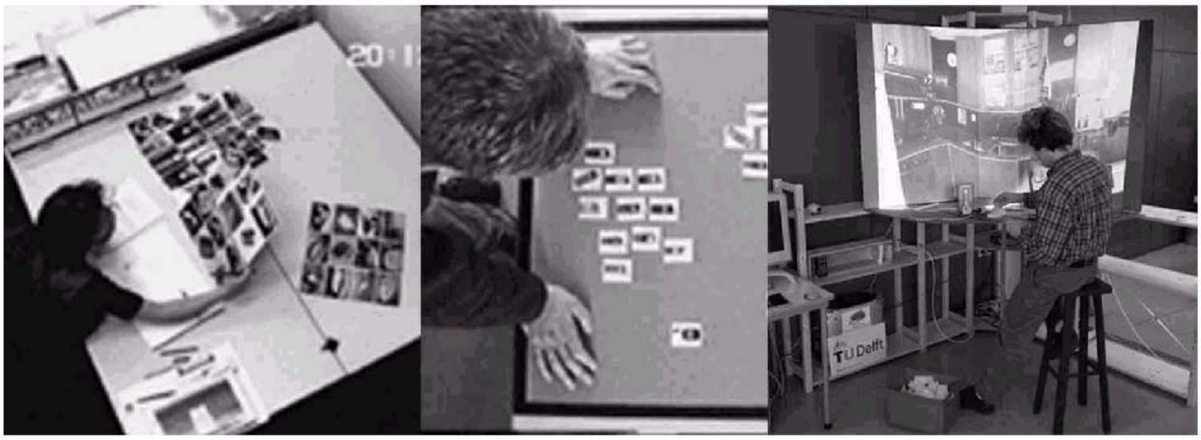

*Figure 12.4: Design experiment, product classification; environmental video-collage.*

### *12.3.5 Researching touch (Sonneveld)*

Touch is an important sense for people to explore and experience the world. Although we intuitively understand the importance of touch in our daily lives, there is little research available on the emotional role of touch in human-product-interaction. Visual aspects had most of our attention. The lack of attention for the tactile aspects is often (negatively) reflected in the design of current products.
However, awareness of the power of the tactile aspects in products will give a product designer the opportunity to enrich the interaction of the user with the product. One of the difficulties one is confronted with while researching tactile aspects of products and their influence on the experience of the user, is the fact that we don't have an established set of research methods appropriate for this topic. Research on touch was mainly focused on psychophysical tactile sensations. But questions as "Why do we want to touch objects? How can we create 'irresistibles'? (see Figure 12.5, left) cannot be answered from the psychophysical point of view.
In this PhD project, different ways to research the influence of tactile aspects on the user's experience of products are explored. The main research questions are:

1) How does touching objects influence the experience of these objects?
2) How can we communicate about these experiences?
3) How can a designer incorporate this knowledge about touch in his work?

The aim is to develop tools for designers, that will focus their attention on the tactile aspects of products, and that will give them the possibility to work on these aspects in an explicit way.

### *12.3.6 Embedded help (Thomassen de Sosa)*

With the increased functionality and intelligence in products, user control is in danger of becoming less explicit. The goal of this research is to create help tools which can bridge the gap between implicit functionality, common to intelligent products, and the user's sense of control. For example, Figure 12.5 shows the classic telephone where the physical affordance of the interface is high compared to newer communication devices containing embedded functionality. The current research is aimed at developing a systematic understanding of the types and levels of errors untrained users make while interacting with complex products, resulting in context-aware help tools which can reduce human errors and cognitive load.


*Figure 12.5: 'Irresistibles'; expressiveness in telephone shapes.*

### *12.3.7 Interaction beyond the GUI "The Thermostat Project"(Dekoven)*

Despite advances in software and hardware technology, the basic principles of windows, icons, and the mouse still dominate human-computer interaction (HCI) styles. Even advances such as speech recognition are primarily used today with computers to drive the GUI or run a very rigid dialog sequence. User goals often have to be mapped to the way the system functionality is presented and choices at the task level are not evident. Typically, the user has to look in system help documentation to find more in-depth information about what is possible or how a certain task can be accomplished.

In Dekoven's Ph.D. research an investigation through product design is being conducted into the acceptability of user-product dialogue coupled with a GUI. Embedded task models of likely user actions support the system's dialogue with the user. To support this study an Intelligent Thermostat interface has been designed (Keyson, de Hoogh, Freudentahl and Vermeeren 2000), as shown in Figure 12.6, left. The thermostat is devised to encourage users to trust, explore, communicate, learn, and achieve a goal, rather than interact at the feature level for the sake of interaction. To support communication with the thermostat, the user is shown a dialog box of "things to say" via speech recognition or by touching one of the sentences on the screen. The "things to say" will be determined by actions performed in the GUI using the Collagen collaboration manager (Rich and Sidner 1998), which refers to task recipe libraries. Several complimentary strengths are expected in the GUI and task based "Things to Say" dialog. Usability testing is currently being conducted.

#### *12.3.8 Vision in product design (Hekkert)*

The Vision in Product design (ViP) project is a design methodology project and was initiated due to unease with dominant design methods (Hekkert 1997). Whereas most traditional methods regard designing as a rational-analytic problem solving activity, the ViP approach places emphasis on the personality of the designer including intuition, sensitivity, and creativity. In the design method, these 'abilities' are addressed to build a personally coloured context in which an expected or desired human-product interaction must fit. A qualitative notion of this relationship between a product and its user (the vision of interaction) is the key of the approach and directs further concept and product development. The basic assumption of the ViP-approach has been empirically tested and shown to result in original design solutions (Snoek and Hekkert 1999). Until now, the approach has been applied in a great number of student design projects. The approach has also attracted the attention of industries and design offices that acknowledge its potential for contributing to the development of original designs that clearly express a vision and the signature of their designers.
The ViP method is applied in a project aiming to increase the life cycle of automobiles by strengthening the bond between user and the car (Figure 12.6, right). This resulted in two conclusions. First, the car should be clean and open to interpretation and change by the user. It should become more meaningful during use, like a carrier for the mix and match lifestyle. This way it will be able to survive and be adapted to many lifestyles by which it becomes more sustainable. Second, at higher driving speeds interaction becomes less human and focuses more and more on signals from the environment and the car. Given a basic car the user can fill his or her own personal preferences. The user-car bond gets closer when the car is personalised during use or exploration. Doing so makes a lightweight car meaningful in technological terms and in user emotional terms as well.

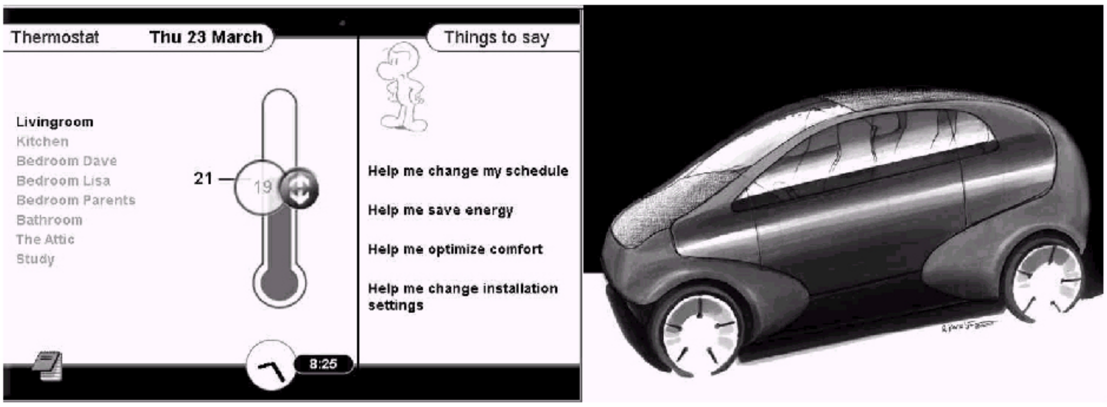


*Figure 12.6: Thermostat interface; mix-and-match concept car.*

## 12.4 Conclusions

Despite the apparent diversity in the overview of research projects presented, the projects share the critical features that were summarized in the introduction. All projects are design(er)-centred in that they either explore the boundaries of design through research or by developing support tools and methods for designers. Most importantly, they all go beyond the traditional function-oriented notion of design in addressing (aspects of) the full experience of the user in his or her interaction with products, and with an eye for the context of this experience.

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