HACKING A CAR: RE-EMBODYING THE DESIGN CLASSROOM

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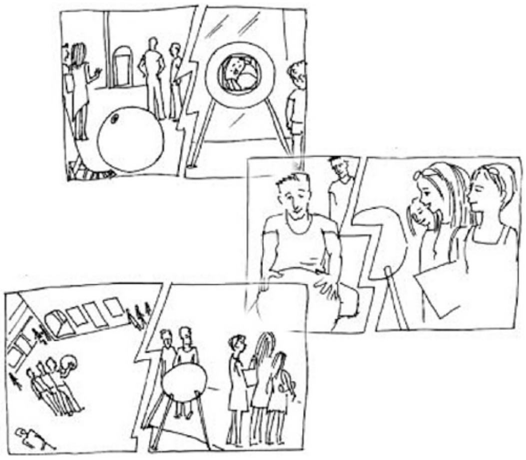
Traditionally, design has been an embodied practice. However, with recent changes, design has become an intellectualist discipline dependent on analytic and representational techniques borrowed from other fields of learning. This paper describes a design class in which industrial design students created and prototyped a concept for an embedded system. In pedagogical terms, the class adamantly pushed the students to use their bodies to understand insights from user research, to develop and understand design concepts, and to construct functioning prototypes.

ON REPRESENTATIONS AND THE BODY

Traditionally, design has been taught to students by masters trough practical exercises, but this model has been changing over the last 15 years. When designers got into designing interactive technologies, they borrowed practices from two other fields of research. The social sciences gave them ethnographic methods aimed at creating an empathic undersatnding of people, while software gave them usability techniques and formal means of representation such as flowcharts and wireframes, merging them into some traditional design techniques such as sketching and storyboarding. Thus, designers are typically taught to do a user study, analyze data, and integrate it into a concept, which is communicated with sketches, artifacts, written presentations, or storyboards.

For example, in a study of how intimacy could be mediated to support communities in the city, Battarbee et al. (2002) created a scenario of “satellites” that people could use to interact in the distance in piazzas. This concept built on a user study, and was communicated with a visual scenario. (Picture 1).



Picture 1. A design concept: maintaining urban communities through satellites

As much as these developments have improved students’ imagination and control over the design process, something has been lost. When design culminates in a representation, design becomes an intellectual rather exercise in which empathy gained in user research becomes processed into a bird's eye perspective that functions as a transcendental understanding guiding the design process. Even criticism of these techniques becomes intellectual. For instance, standard design techniques like sketches, scenarios and use cases have been criticized as inadequate, and often misleading (Buxton 2007, Myers et al. 2008).

From a broader philosophical standpoint, these methodologies represent a creeping Cartesianism in design (see Dreyfus 1993; Dourish 2002). These methods push design into mind games, placing at the center designers' intellectual imaginations concerning people and technology. Today, standard field work methods like contextual inquiry (Beyer & Holzblatt 1998) and probes (Mattelmäki 2006) represent an useful corrective to the Cartesian tendency. However, although they provide designers with a sense of the context as it is lived, field work data is typically processed through representations that decontextualize experience from its lived basis. Mental work is prioritized over physical and embodied experience.

This tendency has opened many domains for designers especially in interaction and user experience design. Still, it has its pitfalls too. For example, with technologies like embedded systems, intelligent spaces, and tangible interfaces, these methods fall short. Often things in design are such that they look and sound good at the conceptual phase, but may not be so when prototyped. Specifically, we interact with embedded systems with our bodies, not just with our fingers, eyes, and ears. One of the difficulties is that people have difficulties in imagining and talking about interaction in detail. How to bring the body back in to design is even more important in interaction design than in those fields of design that are still closer to the traditional studio-based working mode.

TOWARDS NON-CARTESIAN DESIGN

In design literature, the best-known example that situates design into practice is no doubt the notion of reflective practice made popular in design through the writings of Schön (1983). However, Schön's understanding of reflextive practice is essentially cognitive. In his perspective, pedagogical conversation over visual plans are crucial to practice. There is little room for embodied action.

Recently, Overbeeke has described how design has shifted from cognitive to phenomenological thinking. As he argued, designers have to go beyond merely seeing the world in terms of knowledge, and increasingly pay attention to action in the world:

> Meaning... emerges in interaction. Gibson's theory resulted from a long line of "new" thinking in Western philosophy, i.e. Phenomenology (Merleau-Ponty. Heidegger) and American Pragmatism (James, Dewey)... All these authors stress the importance of "acting-in-the-world," or reflection being essentially reflection-in-action. (Overbeeke 2007, p. 7).

When these phenomenological and pragmatist ideas are taken seriously and design methods are built on the idea of acting-in-the-world, two essential drivers follow:

- First, the body gets back its crucial position in methodology. The body is not just an entity in the world; our understanding is essentially and irrevocably tied to it. As phenomenologists have argued, any knowledge is derivative of the more practical exigencies of the body's exposure to the world (cf. Merleau-Ponty 2008). The implication to education is that we need to pay more attention to how students can involve their body in working on designs.
- Second, the body must not be thought in individualistic terms. We live with others and see things as they see; in ordinary existence, we do not construct others' positions in our heads, but live through their words, stories, and gaze (this is the starting point of the symbolic interactionism of Mead and later other symbolic interactionists, cf. Joas 1997). The educational implication is that students must learn to use their bodies in interaction to further their designs.

Thus reconstructed, the basis of design methodology must be built on action rather than to the more intellectualist discussion supported through bird's eye representations that are thought to be more important than more direct experience. Taking our cue from times when design took place in the studio, we need to situate action into the center of design, and see reflection and rationalistic forms like sketches and storyboards only as aids to imagination.

Of course, design cannot be reduced to the pre-reflective only. Rather, we hope to pay attention to a source of intelligence that is taken-for-granted in the more intellectual fields of design. Still, on closer reflection, it is obvious that even interaction design has retained many non-Cartesian features. For example, there is the notion of bodystorming and experience prototyping, in which prototypes are constructed for understanding existing experiences and context, exploring and evaluating design ideas, and communicating ideas to an audience (Buchenau and Fulton Suri 2000). Also, designers routinely prototype ideas and technologies not just to identify technical problems and to optimize production, but also create and explore design ideas early on in the design process (Säde 2001; Ehn and Kyng 1991). At the other extreme, they may do extensive research to go into the role of the user (see Patricia Moore's work at Moore Design Associates).

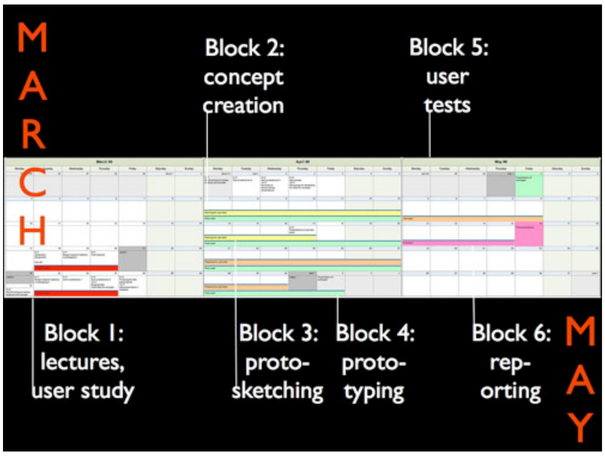
However, when compared with traditional design processes, these bodily activities tend to be isolated instances aimed at informing one phase of design otherwise building on representation techniques borrowed mostly from software design. Still, there is wisdom in the body (see Dreyfus 1993). The question is how to re-introduce the body if not into the middle of the design process, into a pivotal point throughout the process? How to use the body to create crucial empathic insight to inform design?

IP08

This paper reports an attempt to integrate the body into the design process in a class aimed at building embedded interactive systems. Interactive Prototyping (IP 08) is a 9-week design class given at the University of Art and Design Helsinki. In this class, MA level industrial design students go through user-centered design process over nine weeks. Students have to create a design concept, learn the basics of microcontroller (ATmega8535), elementary programming in C, and refresh the basics of electric circuits.

The problem of the class was co-experience (Battarbee 2004) in the car and safety while driving. Interaction between the front and the back seat is a major road safety issue, taking people's focus away from what is happening on the road, causing potential hazards and introducing risks to the driving experience (Summala, Karola and Radun 2003). What kinds of things take attention away from the road? Which ones are potentially dangerous? How could one make driving safer with design? The class turned interaction into a design opportunity though the notion of co-experience: how to make this interaction fun while safe. We made prototyping into a key component for making use of our bodily and social skills for design.

Picture 2 describes the structure of the class. It started with a knowledge packet and user study in March, continued through a concept design phase through protosketching to prototyping in April, and ended with a user study and reporting phase in May.



Picture 2. The Structure of IP 08

In Spring 2008, the class had seven students. Although the class was informed by best practices in other design universities (cf. Dunne and Raby 1999; Frens 2006), what was new in it was its continuous effort to connect the body into designing embedded technology.

SETTING UP THE LEARNING ENVIRONMENT

To make it possible for students to use their bodies in design, we bought an old 1989 BMW for the class. The car was in register, and in full driving condition, but old enough to be rebuilt in the studio devoted for the class. Being located in studio context of a design university meant that students working on the car had an easy access to variously shaped and sized fellow students for user tests whenever they wanted. (Picture 3).


Picture 3. Studio space committed for IP 08

Following the philosophy of the class, we wanted to give students a first-hand bodily understanding of embedded technology, in our case how sensors and actuators work. To get an idea of how one can integrate sensors and actuators into consumer-level products, we borrowed two Wii games from Nintendo, and started the class by playing with them and then looking at the accelometer used in Wii. (Picture 4).

Picture 4. Getting first-hand experience of sensor technology by playing Nintendo's Wii

INTERNALIZING INSIGHTS FROM USERS WITH THE BODY

Following standard practice in design, the first design-related task of the class was a user study that was conducted during the first week of the class. Due to tight time limits, students were instructed to interview and photograph 1-2 families with children. However, they were also instructed to get into the actual context, i.e. the car, and document interaction in the car not just through talk, but also several design-specific means aimed at giving them first-hand experience of what they were told. Students were instructed to:

- ask people to act out typical interaction situations
- photograph these situations
- go into the cars to experience these sitautions first-hand
- play these situations to get feedback from interviewees
- make measurements to understand ergonomics and action possibilities in the backseat.

After this study, students had to go to the studio car and act out these situations to understand them properly and to internalize them. Students were instructed to explore their findings through

- *Bodystorming* (Buchenau and Fulton Suri 2000) in the studio car to understand the interaction patterns reported by users;
- *Role play*. After bodystorming, they were instructed to develop three concepts based on findings, and try these out in the car, varying roles between the driver and the backseat passanger to understand interaction interaction from both perspectives.

Picture 5 shows a series snapshots of the user study process. As this picture shows, students used standard representation techniques, including post-it notes, affinity walls, use cases/scenarios, and also a specifically devoted space in which students could keep their ideas for weeks.

Picture 5. Up: Picture from a user study. Middle: Snapshots from concept design. Down: Discussing interactions.

CONCEPT DESIGN

After user study, students worked in three groups, two having of two members, one having three. Each group created three concepts, but only four were chosen for further development. These concepts were combined from several observations and ideas. At the end, students created three concepts.

The problem was to make sure that these concepts made sense in human interaction. To this end, students had to build rough sketches of their ideas using simple technical means to explore the concepts by interacting with them to find out what worked and what did not work.

To make quick implementation of concepts possible, we provided students with Lego Mindstorms, but students' imagination did not stop there. All groups sketched their systems into the car using available materials like tape, cheap dolls, an cardboard mock-ups of sensors. (Picture 6).

Concept #1: The Car as a Musical Instrument. This idea was based on the notion that people often tap various parts of the car. The idea was to turn the car into an instrument that the whole family could play by placing various types of sensors into the seats and other interiors in the car.

— To elaborate the *Musical Instrument* idea, students sketched various instruments by buying cheap electric musical toys and rewiring them in a search for optimal sensors and sensor placements. They rewired the existing stereo system of the car so that people in the car could listen to what they played through the car's own loudspeakers.

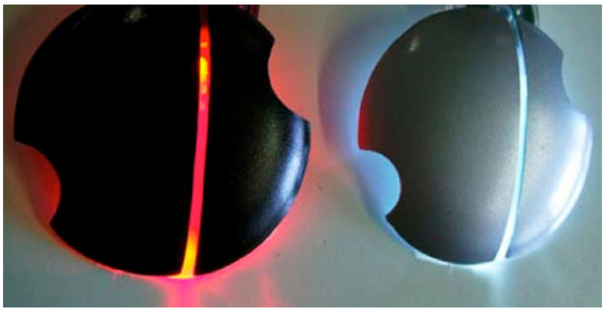
Concept #2: Interactive mirror. The learned through the user study that, particularly with kids, face-to-face communication is important and there is no substitute for it in the car. However, when communicating with kids on the backseat, parents lost sight contact with the street ahead. Intelligence was built into the rear view mirror, using protosketching to search for suitable ranges of behaviors for the mirror.

— In elaborating *Interactive Mirror*, students wanted to know how it feels to communicate via a screen versus a mirror before prototyping a communication system to ease communication between the front and the back seats. To test the screen hypothesis, they first connected a small LCD screen to a video camera. Secondly it built a real two-way video communication based on Skype and laptops. The experience gained from this study lead to an elimination of the screen and a focus on to the mirror, which provided far better user experience.

Concept #3: Bugbugs. User study showed that children want to know what's happening outside the car, and remaining distance to destination. Also, children get restless in the car; it would be good to offer physical activity that does not affect driving. These observations were turned into a game that gave children in the backseat an opportunity to experience the road without the driver's active input. Bug-like cones lighted up in the backseat area depending on speed direction, points came from almost touching the cones, and points were lost upon touching or missing the cone. (Picture 7).

— In *BugBugs*, body-based elaborations consisted of videotaping bodystorming and role-playing sessions with various props emulating possible products, leading students to a do-not-touch game.

Picture 6. Up: from user study to concepts and Mindstorms. Middle: Gaining empathic insight by using a small LCD screen and video camera as a proxy for a mirror and iterating the interactive mirror concept in-situ with Mindstorms in *Mirror*. Down: hacking toys in *Car Body* and testing *Bugbugs*.



Picture 7. *BugBugs*: 3D printed in ABS plastics, with in-built LEDs and proximity sensors.

PROTOTYPING *BUGBUGS*

After all this preliminary work, students had to build functioning prototypes out of their concepts.For reasons of space, we go through only one prototyping process, the *BugBugs*, which became a backseat game in the car for 10-13 years old children.

The concept was based on an observation from the user study. Children want to be involved in the car journey but the current technologies for the backseat are individualistic (like TV screens and games). However, role-plays in the car consistently showed that children and adults continuously interact over the front and the backseat, taking the driver's attention away from the street.

Vignette: *BugBugs* – the game
The purpose of the game was to improve childrens' involvement in the car journeys. For the game, five bug-like plastic cones were installed into the backseat area. The car's steering system was rewired, making it functions as a sensor; actuators were small plastic yo-yo shaped cones with LEDs and proximity touch sensors; a game motor calculated the result; and a screen showed the results. When a bug lights up, a player gets points if he manages to close the light by waving his hand in close proximity of the bug. However, mistakes – like touching the bug or missing the light – cause vibration. One game lasts five minutes, and a screen installed into the back of the front seat told the score. Thus, *BugBugs* became a one-way interactive game, which changes according to the driver's behavior and surroundings. Children who play it on the backseat can feel the interaction from the driver and surroundings but the driver will not be disturbed by the game.

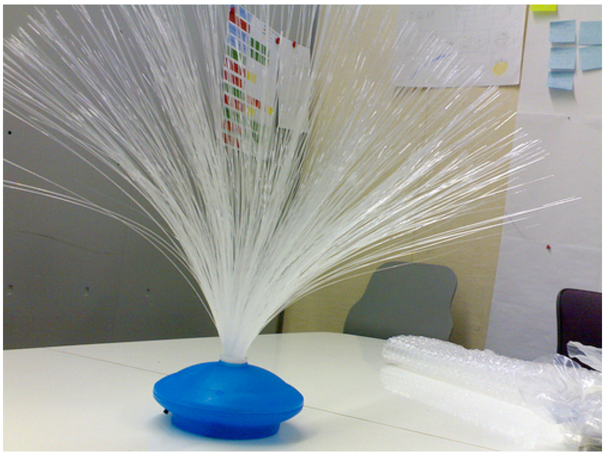
The final design of the game was again informed through bodily explorations in several ways.

Step 1: Exploring the car space. The first task was to get a idea of the car space: how people sit in cars, how they move there, and how they are abe to use their limbs to do things while seated. Students identified design spaces and opportunities by sitting in the backseat, improvising role plays, and exploring details of their evolving concept in the process. These details included identifying places for sensors and actuators from the roof, the backseat, the floor, and the back of the front seat. (Picture 8).

Step 2: Finding the form factor for Bugs. Another problem was the bugs' form factor. The challenge was to design a product that looks attractive but not touchable to encourage children for physical movement. From the very beginning the "almost touching" was the most important feature in the game. The challenge was to find a form people like to reach for but do not want to touch. After exploring several uninviting forms, they settled for an interactive solution. (Picture 9).

Step 3: Finding locations for Bugs. Yet another problem solved through bodily means was finding proper places for sensors, motors, and the screen. To find proper places, students instaled mock-ups of the game and at the end, the fully functioning game into the studio car, did bodystorming, and tested their choices with fellow students working in other studios nearby. (Picture 10)

Picture 8. Exploring the Car Space



Picture 9. Bug Mock-Up (Discarded)

Picture 10. Studying the Placement of Sensors

Step 4: Implementing the design. When the design was implemented, previous explorations went on, but got a technical twist. When students placed functioning prototypes into the car, they also had to find the best places to wires and game motor. (Picture 11)..

Picture 11. Studying Wiring

Picture 12. Testing the Prototype with Fellow Students

Step 5: Studying the concept with fellow students. At the end of the class, students brought fellow students from other studios to the car to play the game and to adjust design details. The original plan was to set up the game into a field test with non-designers, but the plan had to be given up due to delays in getting some of the electric components. (Picture 12).

BRINGING THE BODY BACK INTO THE DESIGN CLASSROOM

Design has traditionally been an embodied practice, and as such, one of the few remaining academic fields that is connects directly to the skills of the hand. A good deal of design practice and teaching has taken place in studios; it has been an embodied, skilled practice. However, recent advances in design research have pushed design into a more abstract direction. User research methods have been borrowed from the social sciences, and techniques of representation from software engineering. Design processes have been organized around user data and a host of representations, and the crux of design lies in dialogue of the classroom.

With these changes, design has gained flexiblility and intellectual agility, but what is at stake with this creeping Cartesianism is the embodied basis of design and wisdom that is in the body. The tradition of making and learning the craft by working in studios has become curiosities in a discipline that is getting increasingly intellectual in its working methods.

To bring lived experience back into design, designers have adopted a host of techniques, ranging from contextual inquiry and (cultural) probes (Beyer and Holtblatt 1998; Mattelmäki 2006) through prototyping (Ehn and Kyng 1991; Säde 2001) to a host of narrative interview techniques and attemps to get under the users' skin (for example, ee Moore Design Associates).

These techniques have the virtue of taking designers away from their studios and provide them a sample of world outside their ordinary thoughts and experiences. However, they are typically used methodically only in the early phases of design. Thus, they represent a dive into lived reality. Still, the results of this dive are analyzed using means like affinity walls, scenarios and personas (Beyer and Hotzblatt 1998; Carroll 2000; Cooper 1999). This analytic vision is created in the studio, it mostly lives in talk in workshops and co-design processes, and is sometimes backed up by things like personas that try to spread the message beyond the boundaries of the design team and keep it alive in company hierarcy.

This paper has explored ways in which it is possible to re-introduce the body back into the classroom over all phases of the design process. That students took the message seriously was a result partly of the studio environment build for the class, partly instruction, and partly a small-scale social movement in which students followed each others' work and picked up practices from fellow students.

The design philosophy of the class was grounded in two notions stemming from phenomenological and pragmatist thinking and two closely linked sociological traditions, ethnomethodology and symbolic interactionism (cf. Merleau-Ponty's (2008) philosophy of the body and Mead's notion of the mind [see Joas 1997]). Two key notions were devised to bring the pre-reflective lived basis of experience back to the classroom:

- Consistent use of the body: in understanding users and user data, exploring concepts, sketching interaction concepts, and prototyping.
- Placing these bodily explorations into social action that, than, was coupled with action, not diverted from it, as in more intellectualist forms of design methodology.

It was through these convictions that we tried to ground design education back into its traditional basis in doing things in the studio.

Naturally, IP08 worked partly in an intellectualist framework; it would be pointless to sacrifice the benefits of new intellectual agility brought by new analytic techniques. However, IP08 clearly shows that one can bring the body back to the design process to enrich studio work, and also the understanding of users and the complex design concepts based on this understanding. Furthermore, design methods used were simple, consisting of techniques like in-situ interviews, bodystorming and role plays during user studies, concept design, and prototyping, making adapting these techniques and the spirit of the class easy in other contexts as well.

There is a deeper message in our experience. We feel that the over-reliance on Cartesian working methods is a peril given recent changes in the scope of design (see Dourish 2002). We feel that standard concept design techniques taught in design schools are not sufficient when one is creating embedded interactive systems. After all, we interact with embedded systems through our bodies, not just with our fingers, eyes, and ears, but have difficulties in imagining nuances of bodily interactions. It was for this reason that the pedagogy of IP 08 originally insisted that students had to get bodily involved throughout the design process. The aim was to make them experience their concepts first-hand, not allows them to create new designs through verbal and logical argumentation alone. That is, through their bodies, not just intellectually.

Crucial to the success was that we built a studio environment that made it possible for students to explore their designs through bodily means in social context. The car was used in multiple ways in the class. It was primarily a prototyping platform, but in IP 08, it was more than a lab. For students in IP 08, it also bacame the stage for bodystorming, role-playing and acting out co-experience in the car, interaction concepts, and later on, prototypes. Similarly, it made ergonomic and interaction studies possible. We feel that we need a prototyping culture in which learning designing embedded systems takes place in the studio rather than on the drawing board alone.

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REFERENCES

1. Battarbee, K. 2004, *Co-Experience. User Experience as Interaction,* UIAH, Helsinki.
2. Battarbee, K., Baerten, N., Hinfelaar, M., Irvine, P., Loeber, S., Munro, A. and Pederson, T. 2002, 'Pools and satellites: intimacy in the city', in *Proc. Designing Interactive Systems* (DIS), London, England, ACM New York, 237-245.
3. Beyer, H. and Holtzblatt, K. 1998, *Contextual Design: Defining Custom-Centered Systems*, Morgan Kaufmann, San Francisco, CA.
4. Buchenau, M. and Fulton Suri, J. 2000, 'Experience Prototyping', in *Proc. DIS 2000*, ACM Press, pp. 424 – 433.
5. Buxton, B. 2007, *Sketching User Experiences: Getting the Design Right and the Right Design,* Morgan Kaufmann, San Francisco, CA.
6. Carroll, J. 2000, *Making Use. Scenario-Based Design of Human-Computer Interactions*, MIT Press, Cambridge, MA.
7. Cooper, A. 1999, *The Inmates are Running the Asylum*, SAMS.
8. Dourish, P. 2002, *Where the Action Is,* MIT, Cambridge, MA.
9. Dreyfus, H. 1993, *What Computers Still Can't Do: A Critique of Artificial Reason*, Cambridge, MA, MIT.
10. Dunne, A. and Raby, F. 2001, *Design Noir: The Secret Life of Electronic Objects*, August/Birkhäuser, Basel.
11. Ehn, P. and Kyng, M. 1991. 'Cardboard Computers', In Greenbaum, J. and Kyng, M. (eds.), *Design at Work: Cooperative Design of Computer Systems*, Hillsdale, NJ: Lawrence Erlbaum Associates.

12.Frens, J. 2006, *Designing for Rich Interaction. Integrating Form, Interaction, and Function*, Eindhoven, Department of Industrial Design.

13.Joas, H. 1997, *G. H. Mead. A Contemporary Re-Examination of His Thought.* Cambridge, MA: MIT Press.

14.Koskinen, I., Battarbee, K. and Mattelmäki, T. 2003. *Empathic Design*, Helsinki, IT Press.

15.Mattelmäki, T. 2006, *Design Probes*, Helsinki: UIAH.

16.Merleau-Ponty, M. 2008, *The Phenomenology of Perception,* London: Routledge. Original 1945 (in French).

17.Myers, B., Park. S., Nakano, Y., Mueller, G., Ko, A. 2008, 'How Designers Design and Program Interactive Behaviors', In *Proc. VL/HCC'08,* Sept 15-18, Herrsching am Ammersee, Germany.

18.Overbeeke, K. 2007, 'The Aesthetics of the Impossible', Inaugural lecture, Eindhoven, Technische Universiteit Eindhoven, 26 October 2007. Available at: www.tue.nl/bib/.

19.Schön, D. 1983, *The Reflective Practitioner. How Professionals Think in Action,* Basic Books, New York.

20.Summala, S., Karola, J., Radun, I., Couyoumdjian, A. 2003, *Head-on crashes on main road network - trends and causation*, Finnish Road Administration, Helsinki.

21.Säde, S. 2001, *Cardboard Mock-Ups and Conversations,* UIAH, Helsinki.