The ID-StudioLab 2000-2005

Gert Pasman, Pieter Jan Stappers, Paul Hekkert, David Keyson
ID-StudioLab
Faculty of Industrial Design Engineering
Delft University of Technology
G.Pasman@io.tudelft.nl

1. Introduction

In 1999 four research groups at the Faculty of Industrial Design Engineering of Delft University of Technology joined their forces in forming the ID-StudioLab, a multidisciplinary research community that aims to acquire and integrate knowledge on products, people, technology and context in order to support designers in creating conditions for meaningful and satisfactory product experiences. Traditionally, products have been designed for aesthetic appeal (aesthetics-driven), usability (ergonomics-driven), and/or for smart functions and possibilities (technology-driven). Well-designed as these qualities may be, they do not automatically lead to favored experiences on the part of the user. Identifying what these experiences should be, how they come about and, subsequently, taking them as starting points for further development radically reshapes the face of both design practice and design research.

The need for such a different approach has become more salient with new technologies and phenomena, such as digital photography, instant messaging and ambient intelligence which enable product designers to design products of seemingly ever increasing functionality and complexity. Knowing what users really want, what their dreams and wishes are, when they get lost, bored, surprised, excited etc, thus is essential for designers who have to translate and integrate all these technologies into meaningful products. To acquire this knowledge users could be involved into the early stages of the actual design process. Moreover, designers also have to manage the assimilation of new technologies into their own working practices. Design information is becoming more and more digital, allowing for fast transfer, flawless duplication, easy modification etc., which makes the design process more complex to manage, but also opens up opportunities for the development of new design support systems and tools.

In order to support the design community with these issues, the ID-StudioLab has taken product-user experiences and the role of the designer in creating these, as its research focus. This implies an integrated type of design research, not just regarding content, but also regarding the way the research is conducted.

In its first five years of existence the ID-StudioLab has established itself as an inspiring and leading research lab in the area of human-product interaction, as reflected through several projects, publications, dissertations, workshops and prototypes. Now, five years after its initiation, this paper presents a flashback of the past period as well as a flashforward of things to come. It describes the objectives of the ID-StudioLab and how these are translated into a specific research approach. Four research themes are described, each illustrated with examples of current Ph.D. projects. The paper ends with a reflection on five years of ID-StudioLab and its future.

2. Research approach and organization

The research approach advocated throughout the ID-StudioLab is a merger of design and research driven ways of working. It is felt that to fully come into contact with, understand and create product experiences the researcher should be actively involved in designing instead of positioning himself purely as an outside observer. To meet this requirement, product and interface designers, psychologists, physicists and other specialists in the field of ergonomics and human-computer interaction, work together in integrated design and research teams.

Furthermore the design researcher must have an eye for the full experience of the user, which not only covers the often studied perceptual-motor and cognitive skills of the user, but also emotional reactions. 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. Building working prototypes of products, experimental stimuli and design tools that are rich in experiential and aesthetic quality is therefore an essential element to this approach. These prototypes with design variables are then tested in real contexts, resulting in the generation of new design knowledge as well as the refinement of research issues.

Thus the objectives of the ID-StudioLab are reflected in the following three ingredients which ideally are present in each ID-StudioLab-project, although this ideal is not always feasible due to the specific character of some of the projects:

1. *SEARCH*ing knowledge and theories, both as input to designing and building, but also as a way of generalizing findings to other applications and disciplines in the realm of user experience.
2. *BUILD*ing experiential prototypes as a method of integrating, realizing, confronting and evaluating, to give flesh to theory, to generate knowledge, to empower. These prototypes are used as research instruments in tests and experiments, resulting in the generation of new design knowledge as well as the refinement of research issues.
3. *DESIGN*ing products with a focus on the user experience, which involves studying work in context in off-site locations e.g. user homes or in context labs.

To enable such multifaceted projects an infrastructure was created to bring researchers and designers of different disciplines together, both in terms of organisation, by having them work together on one of more projects and in terms of location, by putting them together into the same place. In one large space a design studio atmosphere was created, in which researchers, designers, engineers, psychologist etc. sit side by side, thus creating a constant, yet informal awareness of each other's activities. Besides mixing people of different disciplines this space also equips people of different levels of expertise, such as senior researchers, Ph.D. students and Master students working on their final project. Hence the name of this room: StudioMingle (Figure 1).

StudioMingle includes a technical facility, which supports the building of both software and hardware prototypes. Using tools such as Director and Max as well as sensors and other hardware equipment, working prototypes of high quality can be created. These prototypes are placed in StudioMingle, to serve as demonstrators for people coming from outside, but also, and perhaps more importantly, provide a hands-on feel of work, thus evoking feedback and design input from the whole ID-StudioLab community.

Although StudioMingle is the physical core of the ID-StudioLab, most of its members are not located in the space. However, by organizing workshops, lectures, visits etc. in which the entire community is involved, a constant flow of knowledge and ideas is facilitated which goes

beyond the walls of StudioMingle. In addition to research-related activities, more informal events are also organized, such as a monthly "design lunch."

Another ID-StudioLab facility is StudioHome, a large room which has been turned into a living room to conduct research projects focused on interactive home products (Figure 1). Opened in 2003 the lab equipped with a custom built high speed two-way wireless network which enables products to be linked with each other, while offering centralized and decentralized user control of products.

To date StudioHome has supported research conducted as part of the Senter sponsored, Residential Gateway Environment project and more recently is being used to support research for the Bsik program on Smart Surroundings as well as for numerous internal internships, masters level eduction, industry sponsored work and PhD projects.

Figure 1: Studio Mingle (left) and Studio Home.

Studies in StudioHome have begun to consider the design consequences for creating user-system interaction given some level of system awareness of user activities. To this extent a localization system in the lab, together with staff from TU Delft EWI is being developed. Work is also now being initiated in the lab in the area of well-being and home, given the recent shift in application focus in industry research from consumer electronic towards products for personal health care and wellness.

StudioHome has been found to be a useful bridging resource, where by explorative studies in users home can be combined with controlled lab studies. For example studies were conducted with users in their homes to determine what type of atmospheres they would like to have in their living rooms. Physical objects and media from the home were then brought into the lab and used to create a customized content and a familiar physical living room setting. Where possible, furniture in the lab was also moved to match the user's home layout. Furthermore, through this approach contrasts in controlling an interface with initial start content versus a system with familiar user content could be compared.

In addition to these two main studios a number of small rooms have been dedicated to specific activities, such as reading and writing or light design work like making collages or foam models.

3. **Research themes**

Regarding content, four research themes have been defined within the ID-StudioLab, which all are concerned with relations between people (both users and designers), products and technologies within certain contexts, each however from a different perspective: Designing for the Senses, Design and Emotion, Intelligence in Products and Inspiration Engineering.

Designing for the Senses aims at gathering knowledge about perceptual processes that will enrich human-product interaction by broadening the sensorial scope of interaction. While basic visual processes have been widely studied under controlled laboratory conditions, little is known about other sense modalities and about how people perceive everyday products. Example projects: Gestural Design Tools by Caroline Hummels (Hummels 2000); The Aesthetics of Touch by Marieke Sonneveld (Sonneveld 2004); Sensory Dominance in Product Design by Jacco Otten; Surprise in Product Design by Geke Ludden (Ludden et al. 2004), Verbal Attributes of Product Sound Design by Elif Özcan (Özcan and van Egmond 2004).

Design and Emotion investigates what critical factors of human-product interaction contribute to an emotional experience. One can feel happy about the car that functions properly, aesthetically pleased by the gentle curve of a mobile telephone, proud of possessing a particular necklace, feel indignant because the intelligent product used seems to have a (stupid) mind of its own, and angry because the drawer makes a grating sound. Although there is some insight in these critical factors of emotion elicitation, more research is needed to understand how emotions arise from, develop during, and subsequently affect the perception of products and the interaction and relationship between user and product. In the quest for emotionally intelligent products and systems, such an understanding is inevitable. More and more, products, from toys to refrigerators and computers, are provided with built-in intelligence to adapt to user behaviour in order to make product use easier or more pleasant. Example projects: Designing Emotions by Pieter Desmet (Desmet 2002); Affective sustainability: Towards a model of long term consumer-product relationships by Rick Schifferstein (Schifferstein 2004); Embodiment in the Experience of Design by Thomas van Rompay (van Rompay et al. in press).

Intelligence in Products aims at establishing ways in which a product may increase the ease with which a user communicates with a product, e.g. the product's ability to elicit, understand and reflect user intentions. Research work is driven by empirical studies combined with concepts and prototypes. Results are considered in terms of the overall user experience and quality of interaction as compared to existing products. Human-product communication design concepts are sought which are as far reaching as possible, towards exploring new paradigms of user-product interaction. From a hedonic and ergonomic perspective natural and integral paradigms of human-product interaction are being explored. Combined with natural interaction, research focuses on how embedded intelligence can enable task-level communication with the user, thus reducing the amount of mental effort required when interacting with a product. Example projects: Designing collaborative consumer products by Elyon Dekoven (Dekoven 2004); Designing for the intensive care nursing process by Marijke Melles (Melles et al. 2004); Designing Pleasurable Multimodal Interfaces by Marco Rozendaal; Situated Preferences in Aware Environments by Martijn Vastenburg (Vastenburg 2004); Affective Tangible Interaction Towards Stress Reduction by Miguel Bruns Alonso(Bruns, Alonso and Keyson 2005); StudioHome (Keyson et al. 2004).

Inspiration Engineering focuses on the development of tools and techniques for designers and design teams to support idea generation, integration and communication in the early phases of design. Computer technology plays an important part in (1) realizing dynamic and interactive tools for expression, communication, experience, and inspiration, (2) bridging the gap to later phases in the design process, where stricter verbal-representational modes of computer use are the dominant tools. Currently, however, computers are rarely used in the early phases of design, because their user interfaces hinder, rather than support, idea generation and creative activity.

Research in Inspiration Engineering draws on the other research lines for theories, models, and techniques on *what* knowledge the members of the design team need to share in order to design for emotion, perception, or cognition. In cooperation with those research lines this research work aims at building knowledge and methods on *how* integration of required design knowledge in the design process can be supported. This 'how' question is treated within the overlapping theoretical frameworks on design methodology and creativity theory, and by considering the perceptual-, motor-, and cognitive- skills in designer-tool interaction as a special case of human-product interaction. Example projects: Designer Interaction with Informal Collections of Visual Material by Ianus Keller (Keller et al. 2004b); Designing with Precedents by Gert Pasman (Pasman 2003); Communicating User Experience by Froukje Sleeswijk Visser (Sleeswijk Visser et al. 2004); Exploring Materials: Mixed Media in Design Tools by Daniel Saakes (Saakes and Stappers 2003).

4. Example Projects

In this section four Ph.D. projects currently running in the ID-StudioLab, will be highlighted. Each project is carried out within one of the research themes, but the ingredients of building, searching, and designing are present in each of these projects.

Product Sound Perception and Its Implications on Verbal and Visual Communication, Elif Özcan

Sound is an inevitable consequence of operating a product and users are confronted with it each time they interact with a product. It is interesting to see how users benefit from product sounds. A product sound *warns* (low battery of a toothbrush), *alerts* (finish-beep of an oven), *supplies feedback* (key-stroke of a keyboard), *triggers reasoning* (malfunctioning engine), *influences the mood* of a listener (creepy epilator), *informs* (coffee ready in 30 sec), *conveys* brand values (Plop! Grolsch beer bottle), and etc. These examples exhibit a great deal of interactivity between a user and an emitted product sound. They also indicate that a generated sound is a functional feature of a product rather than a consequential event in product usage and it should be taken into consideration for the total design of a product. In this sense Özcan's main aim of her Ph.D. project is to provide designers with fundamental knowledge on how users perceive product sounds, and subsequently, to create a systematic verbal and visual language to support the communication of product sounds among the multidisciplinary design team.

As a first step, the main domain of product sounds was investigated through free categorization and labeling tasks. Afterwards, semantic associations of product sounds were investigated by a series of verbal attributes rating tasks. Finally, all these findings were gathered within a perceptual framework that describes the identification process of product sounds (Özcan, van Egmond, and Jacobs, submitted 2005a). In this framework three main consecutive stages (i.e. perception, recognition, and identification) constitute the product sound identification process which results in three levels of outputs: descriptions of structural, emotional, and

acoustical properties (no recognition); location and/or action description (recognition with loose associations); sound source description (perfect identification).

This framework makes it easier for designers to overview the verbal language that the listeners use during their interaction with sound generating products (Özcan and van Egmond 2005b). However, despite of the support of the framework, designers might fail in the communication of product sounds to the other designers, engineers, marketers, etc. during the design process of a product. This research also explores the suggestion that product sounds are not represented by a unique way in a user's mind. Therefore, Özcan (Özcan and van Egmond 2004) has designed a visual language which describes product sounds using the pictograms of the possible associative meanings of a product sound (Figure 2).

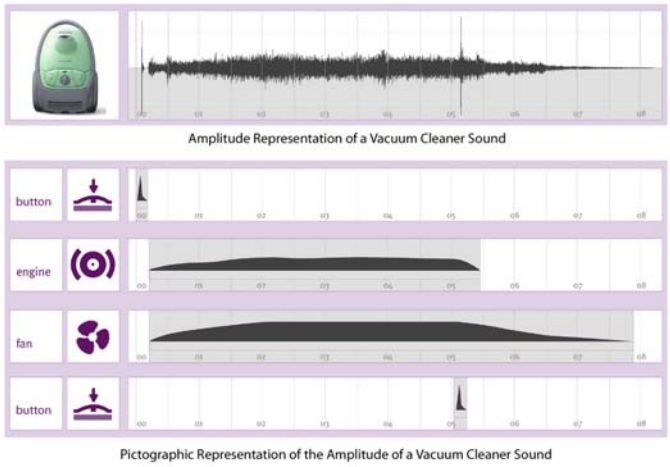

Figure 2: Pictographic representation of a product sound.

In this example, a vacuum cleaner is decomposed into its parts that generate sound (e.g. button, engine, and fan). The pictograms, which represent the sounds of these parts, are attached to the physical property of the sound (i.e. amplitude). The figure depicts four separate sound events, which start and end at different points at the time line.

The philosophy of this pictographic language stems from the knowledge coming from the 'research' into the perception of the product sounds. Some effort has already been put into the 'design' of the pictograms as well, however, to create a systematic language more research into the visual communication area is needed, and consequently the design of the language has to be finalized. In addition, this systematic language should be accessible for the design team. Therefore, it has to be 'built' and implemented as a software application to provide a dynamic information flow. Ultimately, the validity of the created language and its implementation as a software application needs to be tested in international product design offices.

Product Surprises, Geke Ludden

When perceiving an object, people usually perceive information through more than one modality. The information perceived through different modalities may conflict, which can result in a surprise reaction. The Ph.D. project of Geke Ludden focuses on how product experience and evaluation is affected by incongruity between the inputs derived from various modalities. How can a designer evoke a desirable user reaction by designing incongruent sensory information that leads to surprise?

The research builds on theories in experimental psychology and emotion theory. These theories (in particular, theory on design strategies that can be used to design surprising products) will be used to design products and build prototypes that can be used as stimuli in future experiments within this project. In this way, reflection on and evaluation of our theory on designing surprising products can take place, gaining further insight into users' evaluation of sensory incongruities in products. So far, products designed by designers in the field have been used as stimuli. Therefore, it is not certain whether these products were all designed with a focus on the user experience. However, first results from interviews with designers of surprising products indicate that these designers aim to design products that provide 'new experiences.'

Stimuli are used that convey different messages through different modalities. Experiments have been carried out with stimuli that had either visual – tactual incongruities or visual – olfactory incongruities. Other combinations of modalities will be used in future experiments. The experiments typically use the following procedure: subjects first experience a product through one modality (e.g. vision) and consecutively experience the product through another modality (e.g. touch). Users' reaction to the perceived incongruity is measured in terms of emotional responses (i.e. surprise, disappointment, annoyance) and aesthetic appreciation (i.e. pleasantness, interest). Both self reports (e.g. questionnaires and drawing of Time-Intensity curves) and behavioral measures (e.g. analysis of exploratory behavior and facial expression) are being used.

Within the set of products with visual – tactual incongruities, two types of surprising products are distinguished based on the certainty of the expectation users have about how the product will feel. Figure 3 shows examples of products in both types. The vase on the left is surprising because it looks unfamiliar, an observer may have the uncertain expectation that it is soft. The vase is however made of ceramics, a hard material. The vase on the right is surprising because it looks exactly like a crystal vase, an observer will be certain that it feels heavy. However, it feels much lighter than expected because it is made out of plastic. Different design strategies seem to lie at the basis of these different types of surprises in products. For products with visual – tactual incongruities, as well as for products with visual – olfactory incongruities, users' evaluation of the experienced surprises is mostly positive.

Figure 3: Vases with visual - tactual incongruities used as stimuli. Designs by Hella Jongerius and an unknown designer.

Cabinet, a collecting tool for designers, Ianus Keller

Designers collect and surround themselves with all kinds of rich visual material from advertisements and magazines. These materials are traditionally used in the conceptual phase of design to make collages or moodboards, which is on the one hand a way to map form and attributes to the atmosphere or context of use, and on the other hand a way to communicate the design direction to a client.

Though the use of computer tools has increased dramatically in the design process, there has been hardly any development in specific tools for collecting images and making collages. New media tools provide dramatic possibilities in image manipulation (e.g. Photoshop) and the storage and digitization of images has enabled us to fill huge libraries of image data (e.g. Getty Images), yet the tools offer no real way of expressively selecting the right images and making collages that help communicate the design vision. Current software tools for keeping collections of digital images either use an extreme verbal, database approach or they simply provide an optimized interface to the images on your hard disk using the powerful optimized "thumbnail grid". These latter applications organize the images on data that the computer understands, either sorting the images by name or by date. The whole point of making collages is to create categorizations that offer new insights and allow for interpretation in the design process.

As part of his Ph.D. project Ianus Keller therefore developed the Cabinet (Figure 4), a dedicated device designed specifically to support designers in collecting, organizing and communicating visual material in the conceptual phase of their design process. Cabinet aims to bridge the digital-physical divide allowing designers to collect both real pictures and objects and digital imagery in one place. It combines image capturing and organizing facilities into one physical setup, allowing for a rich interaction which can inspire designers while generating new concepts.

Figure 4: The Cabinet, developed by Ianus Keller.

The Cabinet has been built as a one-off experimental working prototype. It consists of a table sized work area on which digital images are projected through a beamer. The light of the beamer is mirrored in the overhead mirror and above the mirror a digital camera is positioned aiming at the projection surface. Below the projection surface a touch sensitive tablet can measure the movements and interactions done with a pen-like input device. All the elements are controlled by a Macromedia Director application running on a portable computer stored below the table.

To get the process of collecting on the surface and to find out how new media tools can enhance this interaction, Cabinet was set out at three design firms for an extensive period of time. Over a period of four weeks, designers were asked to use Cabinet in their current design projects with instructions on how Cabinet worked. Designers were invited to integrate Cabinet in their work process as they seemed fit. Three designers at well-known Dutch design firms WAAC's, Fabrique and Smool have used Cabinet. Through experimental sessions at their workplace, evaluative interviews and analysis of logfiles the importance of collecting visual material in the design process and the possibilities of spatial layout and composition in offering a solution space were made apparent.

Designing for the intensive care nursing process, Marijke Melles

Advances in technology have opened up a vast amount of opportunities for developers of intensive care equipment. Examples include equipment which autonomously adjusts its settings to the altering condition of the patient, or interfaces which can adapt to the nurse's level of experience. Despite the opportunities, new applications do not always seem to match the actual work situation at an intensive care unit. Current systems, for example, present the user with an ever increasing amount of patient-related data without respecting the cognitive limits of the intensive care personnel, or autonomously take actions conflicting with the specific working methods of the nurse. Developers of current systems do not always seem to be adequately aware of the delicate complexity of the work processes involved at an intensive care unit.

The basic assumption of this study is that in order to effectively apply technological innovations in the intensive care unit designers should start from the entire set of work processes involved. The aim of Melles' investigation is therefore to envision how, from a contextual user's perspective, the nursing process can be enhanced by means of future technology. The results of this study are insights into the intensive care nursing process and a design approach implemented as a design proposal and a prototype.

Initial insights into the intensive care nursing process were acquired through observations at a range of intensive care units and interviews with intensive care personnel. Then, in order to get a more precise view of the user needs and requirements regarding intensive care nursing, this research was augmented with methods aiming to make the tacit knowledge of users more accessible (Melles and Freudenthal 2003). For example, during participative sessions nurses were asked to create collages visualizing several topics and to then discuss them (Figure 5). In this way insights were revealed regarding contextual influences affecting nursing routines (e.g. the composition of the nursing team, questions of trainees) and work-related emotional values (e.g. the importance of humour as stress reliever, the attractiveness of the unpredictable character of an intensive care unit). In addition several user needs were identified and classified.

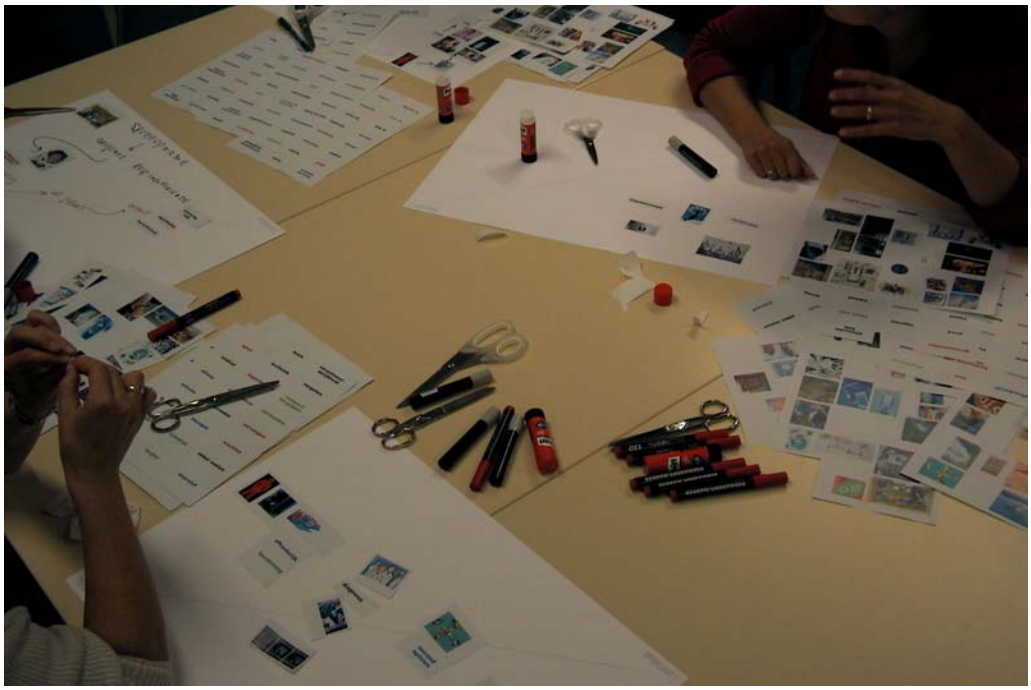

Figure 5: Making collages in participatory sessions.

Based on the insights acquired a computer-based tool has been designed (Melles et al. 2004). Point of departure of our design was that it respects the three different roles an intensive care nurse fulfils; nurse, expert and human being. In each role, the same situation is approached from an entirely different point of view, requiring completely different information. This tool should provide the nurse, being a nurse, with more insight into her actual work process by providing contextual information about her work environment which is needed to assess the current situation and also anticipate future actions. Additionally, this tool should provide the nurse, being an expert in intensive care nursing, with the information required to reflect on and learn from her actions and those of others. And last but by no means least; the tool should provide the nurse, as a human being, with the feedback and communication needed to reflect on personal experiences.

We are currently creating a prototype of our design, which will be tested with intensive care nurses at several hospitals in a simulated intensive care setting. The various design presumptions and product features will be evaluated as well as their effects on the nursing process. These results will be generalized in the form of design guidelines for future intensive care products.

5. Reflection

Despite the apparent diversity in the overview of research projects presented, they all contain to more or less extent the three ingredients that were listed in the research approach. All projects are design(er)-centered 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.

Because of their rich and innovative nature, the projects and activities of the ID-StudioLab projects have received considerable attention from within as well as outside the design

research community. Many visitors to the lab have themselves experienced the many prototypes that are integrated into the lab environment, thus affording quick and easy demonstration. Several guest researchers have participated in the lab for short or long-term projects and research collaborations have been established with companies such as Proctor & Gamble and Philips.

Next to scientific publications, ID-StudioLab projects have also been featured in national newspapers, magazines and the Delft Outlook, which is the research magazine of the Delft University of Technology. With such a large diversity of people, skills and disciplines it is not always easy, however, to present a consistent image to the outside world. A key element in the communication strategy of the lab is therefore its website (*studiolab.io.tudelft.nl/*) which presents an overview of all members and their projects as well as a special newssection only accessible to members, on which interesting news, thoughts or issues are posted.

The ID-StudioLab has also established strong ties with the educational program of the Faculty of Industrial Design Engineering, with its members being involved in several courses on both Bachelor and Master level, especially in the "Design for Interaction" Master, which started in 2003. Students contribute to the research by doing small or final projects or by participating in special workshops or events that are organized or facilitated by the ID-StudioLab staff. Successful examples of such collaborations are the Carrousel by Philip Ross, a tangible interface for navigating through mood-based atmospheres, that won the Zuid-Hollandse Vormgevingsprijs 2004 (Keyson et al. 2004), and the Microsoft Design Challenge, an annual competition in which students from a number of invited design schools participate., which was won in 2003 by a Delft team called the Mama's Boys with their design of the GustBowl, a concept to connect mothers with their sons through an interactive bowl (Keller et al. 2004a).

6. **Conclusion**

Design research, like designing, is integrative by nature. It requires contributions from many perspectives, even if individual projects are carried out in specific disciplinary frameworks. Perhaps the most important aspect of the ID-StudioLab's organization is its value as an informal forum, where researchers, teachers, and students who work on problems of human-product interaction (where 'human' may include 'designer') are aware of each other's problems, solutions and knowledge, and allow each other's views to seep across the boundaries of individual projects. For example, although not all projects are conducted by researchers with a design background, through the specific organization of the ID-StudioLab they can tap into a rich source of design knowledge and skills, enabling them to bring in designerly aspects into their work.

Five years of ID-StudioLab have clearly shown that this brings an additional value to the research. Over this period, connections and integrations have grown, often because of particular interests of individuals across separate projects. Seeing other people's projects 'in the corner of your eye', and meeting them on a variety of topics, generates different connections, and unexpected feedback. Especially projects with a designer-centered character, where design artifacts (prototypes, tools) are visible carriers of what's going on, lend themselves to an undercurrent of ongoing communication.

In this, an informally organized community has different strengths than those of a formal program, where often communication is about global questions and results, rather than on the level of methods, tricks, and unexpected perspectives. Next to the studio as a way of working, the maintaining of a living website, featuring internal newspages, helps to engage and promote the visibility and connections of the group.

The resulting projects show both a coherence of human-product interaction issues across a wide range of application areas, while pointing the way towards future research and design needs. By embedding research in design many of the dreams setout five years ago have come to fruition. In particular, the capability developed in the ID-StudioLab for rapidly building working prototypes, using a range of custom and off-the shelf design tools as well as standard and custom hardware, has proven to be a vital asset in jump starting internal lab and collaborative research projects with industry and academia.

However, the ideal integration of all three ingredients is not yet achieved in all projects of the ID-StudioLab, some projects only including one of two ingredients due the specific nature of the research. In the future a further integration of skills, disciplines and ingredients is therefore pursued, stimulating projects that go beyond the traditional disciplinary boundaries in addressing the full experience of the user in his or her interaction with products within the context of this experience.

7. Acknowledgements

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