Course KW4

Knowing, doing and feeling: communicating with your digital products

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Abstract

Digital products are generally controlled by buttons and icons, an approach which emphasises the user's cognitive skills. We propose to take respect for the user as a whole as a starting point, including his perceptual-motor and emotional skills. Designers should create a context for experience, rather than a product. Aesthetical interaction becomes the central theme. As a consequence, we believe that design tools should also change. To create a context for experience, the designer needs tools, which allow him to explore beautiful and engaging interactions.

In the first section, the theoretical part of this tutorial, we will explain our view on product design and human-computer interaction (HCI). Moreover, we show the possibilities of existing design tools to create contexts for experience and briefly demonstrate our search for new computer aided design tools, especially gestural design tools.

The practical part of this tutorial is composed of two design exercises. The exercise that is performed in the second section focuses on the advantages and disadvantages of design tools. How can design tools and techniques help the designer to 'communicate', i.e. generate, present, discuss, evaluate, ..., ideas and concepts during the design process? We let the participants experience the differences between the design tools that are discussed in the first section. Using one of these design tools, each team needs to design and present a drinking container. During the second design exercise, we focus on the communication between man and product, with the emphasis on experience and aesthetic interaction. The participants need to design an emotionally-aware vending machine for these drinking containers, that is rich and playful in terms of action. The choice of design tools and techniques is free during this exercise.

Section 1:   The power of engagement & respect for HCI:theory, tools and techniques

In this section we would like to seduce you to criticise some of the prevailing ideas and mechanisms in product design and HCI. Ideas such as: products should make life easier, offer infinite functionality, and human-product interaction should be largely based on cognition. We discuss the difficulties of the prevailing design approach, in particular in the area of technological products. We propose to take respect, engagement and experience as a starting point for design. To highlight the difference, we redefine 'a product' as 'a context for experience'. This new proposal includes an emphasis on the beauty of interaction. To support this new design approach, both designers and users are helped by tools which allow them to explore their unfulfilled needs and preferred experiences. Furthermore, they are helped by tools which allow them to explore the poetry of interaction. Therefore, we scrutinise such tools in two ways: by evaluating existing design tools, especially drawing, making collages and modelling, and by developing new digital tools using basic ideas such as poetry, experience and aesthetics of interaction.

1.1. Less engaging products

Everyday, I enjoy the refined details of our Smeg gas cooker. That wee bit of resistance when you turn on the gas by means of the beautiful and functional knobs. That automatic snapping back of the knobs when you turn the gas off. That large cooker for preparing delicious Asian meals. That stainless steel shine, at least when I have cleaned the cooker. But the most excellent and even touching part of our cooker is the sound of the in-built kitchen timer. This sound is so subtle and refined, that it seems as if the cake leaves the oven more beautifully.

Despite my passion for our gas cooker, I yielded to the temptation of fast meal preparation several years ago, and extended our kitchen inventory with a microwave. My problem is, that I can not detect the relation between time and the temperature of my meal. I haven't got a clue how long the microwaves should penetrate my meal to heat it up, without turning it into a dried out, dreary meal. Sure, the microwave has some predefined buttons, but I hardly ever prepare such predefined meals or weights. Furthermore, the pleasure I derive from using my gas cooker, with the refined details on the knobs and the sound of the kitchen timer, is never obtainable with such a white, anonymous and plastic-looking box.

Smeg gas cooker

Samsung Microwave

Digital technology has brought us many new opportunities, such as fast defrosting of frozen food (microwave), waking up in a pleasantly warm house (programmable thermostat), doing the laundry automatically (programmable washing machine) or bringing overseas friends close to us (internet). However, this technological development changed products both in appearance and interaction, and as a result our relationship with products is a less engaging one (Borgmann, 1987).

Digital products are generally controlled by buttons and icons, an approach which emphasises the user's cognitive skills. Examples of such interfaces are a Honeywell thermostat (left), a remote control for SONY hi-fi equipment (right)

This diminished engagement has several causes. The electronics and microprocessors used in products are 'intangible', i.e. they do not relate to our mechanical world. This implies that the functional parts of a product no longer impose a specific appearance or interaction. Designers have translated intangible electronics into intangible products, or in Borgmann's words, the machinery withdrew to the background and control by means of buttons and icons became prevalent.

However, these days, the machinery has withdrawn to such an extent, that it causes usability problems. Electronic products and their controls often have become so small that it is hardly possible to operate them manually. Feedback is reduced, because sound-producing mechanical parts are replaced by silent electronic parts. Moreover, electronic products often do not reveal how they should be operated, making manuals indispensable. The withdrawal of the machinery is exacerbated by increased functionality. The microprocessor made it relatively easy to add new functions, and the interface could by and large remain the same with modal controls, i.e. controls with different functions depending upon their mode. As a consequence, the emphasis was placed even more on the cognitive skills of the user to operate a product and our engagement with products diminished further. We all know examples of incomprehensible and inaccessible products, such as illegible video recorder displays, 'stubborn' personal computers, or car radios with vast functionality. Studies show that users have structural problems when operating electronic products. For many designers, Norman (1988) opened their eyes by showing countless examples of incomprehensible products.

An additional disadvantage of the withdrawal of the machinery is the uniformity of products. For example, all TVs are alike, and there is hardly any difference between a video cassette recorder, a CD player and a thermostat.

But is that what we want? Should products make life easier by offering infinite functionality? Should human-product interaction be largely based on cognition? Ferren (1999) states it perfectly in his speech 'The lost art of storytelling':

> *'All too often the purveyors of new technology are providing really excellent answers - but to the wrong questions. This produces a whole variety of solutions to problems that nobody has. The real challenge seems to be knowing how to ask the right questions in the first place. ... What is in it for them* (the users, C.H.)?'

When one truly wants to start with the user, as Ferren suggests, we believe that designers should respect the user as a whole, with all his skills. Thus, the designer should respect the perceptual-motor and emotional skills of the user as well as his cognitive skills. Because 'the user' does not exist, we believe that the designer should respect Peter, Simone, Claire, ... as a whole.

1.2 An engaging context for experience

When starting from respect for the user as a whole, a product has to be more than a withdrawn machine with buttons and icons. The designer should not think in terms of ease of use, but in terms of enjoyment of the experience (Djajadiningrat, Overbeeke and Wensveen, 2000). We believe he should create a context for experience, rather than a functional product. By this we mean that a designer creates possibilities for a user to do things, to gain knowledge and to be affected in some way, dependent on the intentions of the user and the situation in which the event occurs. He should create an open and engaging system, which tempts and supports users to have an experience. This means that the focus shifts from the result of interaction - e.g. a heated meal, clean tableware, a video recording -, towards the involvement, pleasure, beauty ... during interaction, e.g. the surprising beauty of preparing a delicious meal, the devoted serenity of doing the dishes, the tempting joy of programming and watching a movie. The interaction has become the central theme of design, especially the aesthetics of interaction (Hummels, 2000).

Let us show an example from our second-year design students, to give you an idea what we mean with a context for experience. For this design exercise, we asked our students to design a pager with which a user was able to send the simple message - "I need you" - in a non-verbal manner. The pager had to be context-dependent. This implied that the pager should enable the user to indicate the urgency of his message to be sent, as well as his availability for incoming messages. Furthermore, the pager had to be user-dependent, which meant that it should allow the user to contact two specific friends. In appearance and interaction it had to express the users as well as the functions.

Yannic's pager consists of a central unit with bars and a balloon, and two personal pumps. These pumps are a simplification of the collages, which Yannic made to express Eva and Cees. The blue cube is used to contact Cees and the yellow sphere is used to contact Eva. To contact Eva, Yannic places the yellow sphere on the central unit and pumps. The force with which he squeezes the pump indicates the urgency of his message. A comparable unit owned by Eva is reacting to Yannic's call by a balloon increasing in size, which begins to emit a red light. If Eva does not want to be disturbed, she twists the bars from her central unit, thus preventing the balloon from increasing in size. Yannic's central unit twists simultaneously, blocking the passage of air and complicating the squeezing activity.

The pager designed by Yannic

The collage expressing Eva according to Yannic

How to use the pager

This example shows that a context for experience addresses aspects that are ignored by 'traditional' technological products. This context for experience has an overall expression in which the appearance and the kind of interaction become one. They are adjusted or dynamically adjust to the user and the situation. Finally, this pager shows that intangible electronics do not necessarily have to result in intangible products.

This shift towards involvement during interaction means that the designer's emphasis should be placed on a beautiful, engaging inter-action with a product and not on ease of use or a beautiful product appearance. The focus shifts towards the aesthetics of interaction. In general one could say that the aesthetics of interaction is the sense of beauty that arises during the interplay between a user and a prod-uct in their context. What creates this sense of beauty? Why do some products resonate with a user, while others do not? We will discuss five aspects that we consider essential to evoke this sense of beauty and illustrate with an example of the Sunbeam toaster owned by the first author, what we mean with the aesthetics of interaction.

1.3 The aesthetics of interaction

The Sunbeam toaster

My toaster always kindly invites me to hand over my bread. One slice or two slices, it is up to me how much I want him to toast. He takes good care of my bread. After I have placed them in his metal hands, he slowly and stately transports the slices downwards, thus showing his respect for my slices. The slider at the front of the toaster enables me to communicate how I want my toast done. When he has completed the job, he slowly and almost graciously conjures up the toast. Eating toast on a Sunday morning is always a joy, espe-cially because my Sunbeam toaster treats me and my toast with so much respect. My toaster resonates with me. All the pieces of the puzzle fell into place and even thinking about the toaster gives me a warm feeling.

What makes this toaster so special and beautiful for the first author? Why does it resonate with her? What composes the aesthetics of interaction? Based on design practice, we consider the following five aspects essential:

1. Functional possibilities and performance of the product

A properly functioning product forms the basis of the aesthetics of interaction. A product that does not do what it is supposed to do makes it harder for the user to become intimate and experience the beauty. Clever solutions which work well can smooth the way for inti-mate interactions.

The interior work of the toaster can be easily cleaned by opening the lid at the bottom of the toaster

"The Sunbeam toaster functions more than well. It has a small catch that causes the slices to be automatically transported downwards to a calm pace. The 'tan' can be easily regulated with a small slider at the front of the toaster. The interior work of the toaster can be cleaned without trouble by opening the lid at the bottom of the toaster."

2. The user's desires, needs, interests and skills (perceptual-motor, cognitive and emotional)

Our contextual design approach is based on the experience of the individual. A product may resonate with one person, whereas another person may be indifferent to it. The user's character, skills, needs (short-term and long-term), mood, ... determine the value of the interaction for an individual. This means that the designer should allow for richness on all three aspects: knowing, doing and feeling.

> *"I associate toast with luxury, even when I prepare toast to use up old bread. In general, I want to enjoy making and eating warm crispy golden brown toast. I like to smell the delicious scent of bread and get that sunny Sunday morning relaxed feeling. Pleasure is at least as, if not more important than the ease and speed of preparing toast."*

A sunny Sunday morning relaxed feeling

3. General context
Although a designer is not able to control the general context in which a person will use his product, it can influence the experiences of the user when interacting with the product.

> *"My toaster is placed on my Raymond Loewe kitchen counter, next to other precious products. The marvellous Sunbeam toaster contributes to the overall pleasure I experience when standing and working in my kitchen."*

4. Richness with respect to all the senses

Aesthetic interaction requires richness that covers all senses. Not only does it refer to richness in visual aspects of the product, but the wealth and subtlety of auditive, olfactory, scent, tactile and kinaesthetic aspects during interaction is as least as important to achieve a beautiful interaction and an engaging experience. This richness bears on feedforward as well as feedback. Moreover, designers need to exploit the range and diversity of design solutions to evoke or intensify the range of feelings (although they can never enforce a specific experience).

The Sunbeam toaster is placed on a Raymond Loewe kitchen, which contributes to the overall experience.

> *"For me, (the interaction with) the Sunbeam toaster expresses simplicity, ease of use, reliability, respect, friendliness and a bit of luxury. The toaster clearly shows how it can be operated. It is visually pleasant and the bakelite handles feel delightfully smooth. A single click and a pulsing sound enhance the beauty of the transportation system. The slow and stately transportation of the slices emphasises the value of the toast. Finally, the smell and taste of golden brown toast completes my experience. "*

Current electronic products score poorly with respect to the richness of the senses during interaction. Regardless of function, controls of these products not only look the same, they also require the same actions. Rows of identical looking buttons, all require pushing. Similar looking sliders, all require sliding. Feedback is further reduced,

Contols of current electronic products not only look the same, they also require the same actions.

The current aesthetic sacrifices expressiviness to achieve a unified aesthetically pleasing whole.

because silent electronic parts replace sound-producing mechanical parts. Users are very capable of distinguishing between the functionalities of every day objects on the basis of differences in appearance and interaction, but when these differences are eliminated and everything looks and behaves the same, things become difficult. This is exactly what happens in electronic products and is a major factor in today's usability problems (Djajadiningrat, Overbeeke and Wensveen, 2000).

That is why we propose to enhance diversity and richness with respect to all the senses. So, we challenge designers not to think just visual, but multi-sensorial and multi-modal. Therefore, we would like designers to think beyond buttons and think in terms of controls which are not just differentiated with respect to the visual sense, but with respect to all the senses. and which invite and require rich, motorically differentiated actions. Of course, the goal is not differentiation for differentiation's sake, but the design of actions which are in accordance with the purpose of the control.

We challenge designers not to think in terms of labels with explanatory texts and icons, but in terms of expressiveness and identity. This means a replacement for the current aesthetic with rows of identical controls to achieve a unified and aesthetically pleasing whole, for which the expression of the individual controls are sacrificed.

We challenge designers to show physical components, especially those that are highly informative to a product's operation, instead of designing an alternative representation. For example, a video tape becomes completely hidden inside a video recorder when inserted and is then represented on a display. In photocopiers paper is put inside drawers so that we need sophisticated displays to tell us which paper format lives where.

First the tape is hidden completely inside the machine, to be then represented on a display.

5. Possibility to create one's own story and ritual

Each product tells a story about the user and the relationship between them as it evolves from the moment of purchase onwards (Djajadiningrat, Gaver and Frens, 2000). The intimacy with a product can be enhanced when the product stimulates the user to create his own story and rituals during usage. A product should be an open system, which is not an open book, rather a tempting means for exploration and interaction. Due to the advancing digital technology, 'intelligent' products can even adapt to the user and actively help to create a never-ending story.

"Come, hand me over your bread. I will take good care of it and produce the most delicious toast, specially for you."

> *"The story of my toaster and me started several years ago on a jumble sale in the centre of Delft. It was priced relatively low, 60 guilders, and after some haggling I became the happy new owner for 50 guilders. The toaster has a simple but beautiful mechanism that triggers my vivid imagination. The catch in combination with slow transportation of the slices, gives the impression that the toaster is saying: "Come, hand me over your bread. I will take good care of it and produce the most delicious toast, specially for you." Because I hear, see, feel ... its caring invitation, I take care of my slices of bread. I place them with a gentle, elegant, yet convincing gesture into the toaster, even though the toaster does not detect my behaviour."*

Although this toaster does not detect the user's behaviour, technology offers designers the possibility to create emotionally-aware products. Triggered by the work of Damasio (1994), designers are becoming aware that emotions are not a luxury, but a necessity in rational decision making. Within HCI, this is often translated into the need for sensors for physiological measurements, such as a heart rate, blood pressure and skin conductivity (Picard, 1997). However, we think that the interaction with physical objects opens up ways of detecting the emotional state of the user. For example, the gentle, elegant, yet convincing placement of the slices of bread into the toaster, says a lot about the emotional state of the first author.

To let the user create his own stories and rituals, we believe that designers should not think in terms of (visually) ordering and prescribing, but in terms of temptation. We propose to design open systems which do not impose a predefined way of interacting, but are able to adapt to the situation and evolve during interaction with a specific user.

Consequently, we tempt designers not to think in terms of affordances, but in terms of temptation. Both the HCI and product design communities have borrowed the term affordances from perception-psychology and have hooked into mainly its structural aspects. We lament this clinical interpretation of affordances. People are not invited to act only because a design fits their physical measurements. They can also be attracted to act, even tempted, through the expectation of beauty of interaction.

Finally, due to the emphasis on creating one's own story and the adaptation to the situation, we think the usefulness of metaphor is overrated. The use of metaphor has become common place in both HCI and product design. Gentner and Nielsen (1996) and Gaver (1995) also point out the limits of 'perfect fitting' metaphors. The challenge here is to avoid the temptation of relying on metaphor, and create products which have an identity of their own.

The Phelps tractor (Clymer, 1950), a steam powered vehicle from 1901 which is controlled through reins. It thus draws upon a metaphor with the interface for the familiar horse.
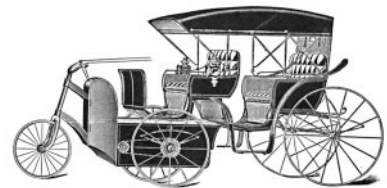
1.4 Existing design tools and techniques

To support a design approach that results in engaging contexts for experience and aesthetic interaction, designers are helped by tools which allow them to explore their and the user's unfulfilled needs and preferred experiences. Furthermore, they are helped by tools which allow them to explore the poetry of interaction. So, to what extent are existing tools and techniques capable of supporting designers and even users to create contexts for experience?
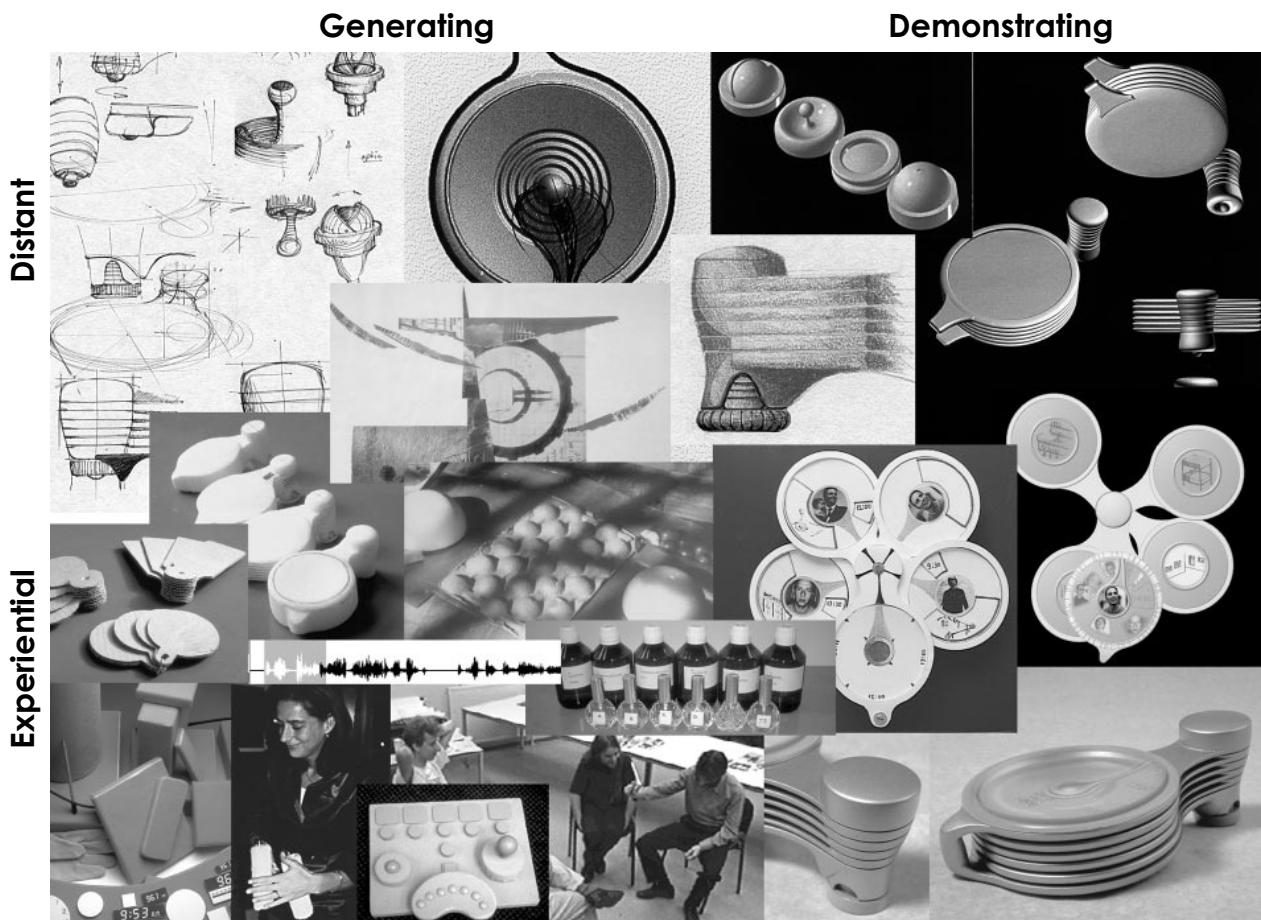
To answer this question, we first made an overview of techniques commonly used by designers, and represented these techniques graphically. The vertical axis refers to the possibility of experiencing the created ideas. The horizontal axis refers to one of the functions of design tools and techniques: generating and demonstrating ideas. Before discussing the different techniques, we will explain why we have chosen these two aspects.

Distant versus experiential

Design techniques can allow a designer to explore solutions in a rela-

	Generating	**Demonstrating**

Distant

Experiential

Overview existing design tools and techniques

tively 'distant' or 'experiential' way. With a distant technique, a

A sketch can tell the story of a product, but the 2D paper does not allow for human-product interaction, which makes sketching a rather distant technique.

designer can visualise a product, but not use or test it; he can only imagine that he is using it. It is almost as if he is telling the product story. For example, a sketch can tell the story of a product, but the 2D paper does not allow for human-product interaction. An experiential technique allows the designer to experience the story as the main character. For example, a working prototype can evoke experiences by the user on all fronts. Focusing on contexts for experience, the experiential way is preferable.

Generating and demonstrating ideas

Design problems have an ill-defined nature which designers try to tackle through 'solution-focused' strategies, i.e. the designer explores the problem through a series of attempts to create solutions. By generating (partial) solutions, the problems become clearer and the final solution(s) for the problems become closer. (Lawson, 1980). This 'solution-focused' strategy not only consists of divergent processes (generating ideas), but also of convergent processes when evaluating, communicating and discussing ideas. Therefore, design tools can be useful to support the generation of ideas by stimulating the designer's creativity and imagination, as well as the communication and demonstration of ideas in order to evaluate and discuss them.

Aiming at experiential design, the communication during the design process should be focused on the experience of users and designers. Demonstration of ideas could enhance the communication both ways. For example, a designer could make a model to demonstrate an idea for the user who can test it, but the user could also demonstrate preferred movements and actions in order to generate ideas with the designer.

The graphical overview of the techniques shows that most techniques are visually oriented. They support the exploration and demonstration of the appearance of products: shape, colour, texture. Modelling expands this visual focus with touch and haptic feedback. Holding and using full-scale models support the designer to explore interactions. Especially with low-fidelity prototypes, both shape and interaction can be easily recreated or adjusted, thus supporting a quick generation of new ideas. The exploration and demonstration of the other senses - hearing, smell and taste - receive less attention within the scope of design tools and techniques, although taste is perhaps less appropriate for design. However, the lack of supporting techniques does not imply that these senses are not important.

The techniques shown in the overview can be divided into three main groups: drawings, collages and models. We will discuss these three commonly used techniques successively.
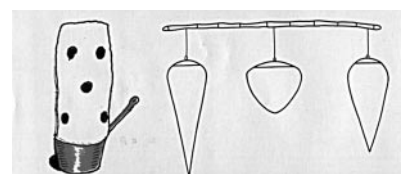
1. Drawings

Almost every designer makes use of drawings to visualise his ideas, because it is a quick, intuitive and expressive way to generate, present and evaluate ideas. Drawings allow the designer to make his first rough impressions, also called sketches, but also smooth detailed renderings (Hummels et al., 1997). Drawings have a broad range of functions such as communicating ideas 'objectively' (e.g. geometry and construction), arousing emotions and even making scribbles with little or no intrinsic meaning to maintain discourse.

Drawing is visually oriented and pre-eminently suited to exploring and presenting the shape, colour, and texture of a product. The other senses are difficult to address with drawings. Moreover, the flat medium paper - hinders the search for possible interactions and calls upon the imaginative qualities of the designer. Nevertheless, sketching is very useful for idea generation, because it stimulates the flow of thoughts. In the Renaissance, sketches were given the appropriate (old) Italian word *"pensieri"*, meaning thoughts (Olszweski, 1981). Leonardo da Vinci pointed out that *"confused things rouse the mind to new inventions"* (Gombrich, 1966). With these confused things he referred to the ambiguous character of sketches. Because of its ambiguity, sketching enhances imagery. Goldschmidt (1991) calls this 'interactive imagery', i.e., imagery through stimuli such as sketches.

Drawing is pre-eminently suited to exploring and presenting the visual aspects of the product, such as shape, colour and texture. When we look at these aspects, drawing is a powerful expressive tool, because of the broad range of drawing tools with different expressive characteristics, such as fineliners, markers, pencils, crayons and pastels. Drawing allows the designer to capture the overall atmos-
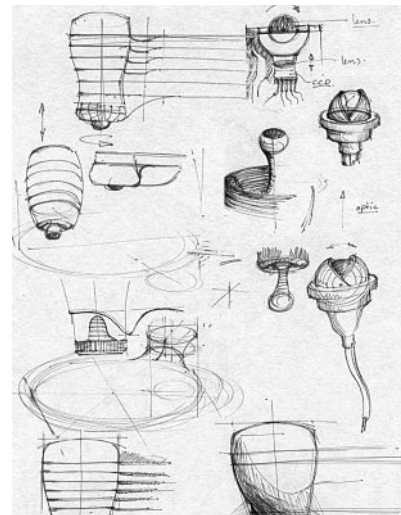
Early skecthes made to design an appointment manager.

The drawing style can strenghten the expression of a design. For example, a simple line drawing can emphasise the fragility of Branzi's lamps "Wireless'
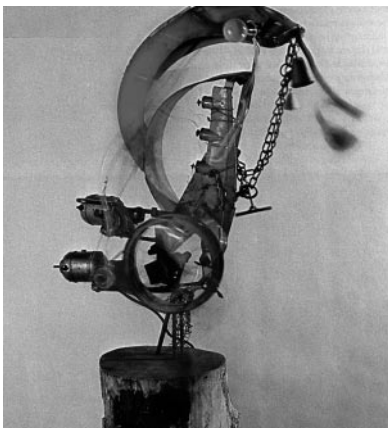
Arad's design sketch for 'The Weeble', later known as 'Easy Big Volume 1', 1988.

Arad's 'Rolling Volume', a later version of 'Easy Big Volume 1', 1989.

Collages are used to facilitate and amplify affect

Baluba No. 3, 1959 by Jean Tinguely (Copplestone, 1985)

phere as well as the richness of the appearance of the product as such. The drawing style can even strengthen the expression of a design. For example, a simple line drawing can emphasise fragility, a crooked colourful sketch can highlight playfulness and a cross-hatched drawing can articulate the beauty of the texture of wood.

Moreover, drawing is a reflection of the designer himself: his skills, his personality and his view on design. It is an instrument which helps him to develop himself as a designer. For example, the drawings of Arad are characterised by plain, powerful, black and white, explicit and almost explosive strokes, thus creating a strong image. In this way, the entire drawing expresses the powerful character of his designs. This power is expressed not only in the shape of his designs, but also in the materials of his products, such as steel and concrete which he welds and casts himself. These drawings and models are not just made by Ron Arad. They are Ron Arad.

Nowadays, we find many commercially available computer-aided sketching tools that often resemble their traditional counterparts. In the sketching packages, the visual effects of various pencils, markers and crayons etc. are simulated; they are typically controlled by the designer, using a pressure-sensitive graphic tablet. Digital sketching largely has the same advantages and drawbacks as sketching on paper when designing a context for experience.

2. Collages

Collages are mostly used in the first stage of ideation. Whereas sketches are used to facilitate and amplify imagery, one could say that collages are used to facilitate and amplify affect. In general, designers use images from full-colour glossy magazines to compose an atmosphere on paper, because the images in these magazines cover an extensive range of expressions. Moreover, it is simple to manipulate the material. The pictures can be easily torn and cut in the desired shapes and moved across a sheet of paper in search of the 'right' composition and feel. This directness of interaction allows the designer to be absorbed in the feelings rather than the interface of the tools used.

Collages are mostly 2D, although some designers prefer to capture the atmosphere in 2,5D or 3D collages. When aiming for aesthetic interaction, designers should perhaps make more use of spatial (3D) collages, possibly completed with sound and scent, because these spatial collages can enhance the poetic atmosphere of interaction itself. When collages allow the user to touch and use them, the atmosphere intended by the designer can be experienced more fully and the user can be absorbed. These collages become more like installations, such as the ones made by the famous artists, Tinguely and Viola.

Making collages is a quick and intuitive way to explore and evaluate a desired expression. It enhances creativity, in the sense that designers can react to images, materials, sounds etc., and subsequently create their own, instead of starting from scratch and inventing the entire expression themselves. Unlike drawing, where the designer has to create the entire expression, the designer making a collage (2D, 2.5 D or 3D) can borrow the subtlety of expression largely

from existing material. The designer has to learn how to find the information and use it to compose the desired expression. Making collages is a skill, but mainly a skill of looking and trusting one's senses and intuition.

Nowadays, collages are also made on the computer, which has several advantages. When focusing on visual aspects, image manipulation is extensively supported by digital photo manipulation software. This software enables the designer to perform transformations, such as scaling, rotating and distorting an image, adjusting the colours, brightness, contrast and transparency, and to employ filters, such as blurring, adding noise, pixelating, stylising or texturing the image. Furthermore, different images can be mixed.

Nevertheless, this digital imaging software has severe drawbacks with respect to traditional 2D visual collages, because of poor physical interaction. A small monitor screen and a mouse or stylus do not support easy scrolling through images and reshuffling them. This indirectness of interaction impedes the designer in becoming absorbed in the expression of the collage. Furthermore, these collages remain restricted to 2D, whereas we propose to create 3D collages that cover all senses.

3. Models

Despite the advantages of drawings and collages, it is more difficult to experience a spatial shape and interaction concepts on paper than it is with a spatial model which can be seized, turned, moved and used. Spatial models are a necessary addition to the visualisation techniques which support the designer developing contexts for experience. They allow the designer to explore and test interactions, to evaluate and develop aesthetic aspects of the design, and to determine manufacturing and marketing aspects (Hummels et al, 1997).

Spatial models come in all kinds of forms throughout the entire design process, from simple paper mock-ups to refined full-scale working prototypes. They range from low-fidelity to high-fidelity prototypes (Rettig, 1994), and they can have a high-interaction or low-interaction relevance. Although models generally require more time than sketches to create them, they yield profit when exploring aesthetic interactions. The designer and the user can get a feel of the final design, long before it is produced.

The kind of experience which a designer or user has depends on the kind of model which is created. With low-fidelity models which have high-interaction relevance, such as paper models, the designer and user can quickly explore and test interactions. Although the shape of the product is not yet explicit, the possibility of grasping and using it is often enough to get a first feel of the interaction.

A designer can study the aesthetics of appearance with more refined models from e.g. clay and polystyrene foam. The designer can intuitively explore the details of the shape to obtain the desired expression and can explore the influence of material, texture and colour.

Detailed working prototypes are suitable to evaluate the context of use, the response of future users and their behaviour when interacting with the product.

Despite the advantages of spatial models, they might be insufficient

Photo manipulation software allows the designer to adjust and mix different images, as in this digital collage expressing 'the perceptual-motor and emotional skills of the designer
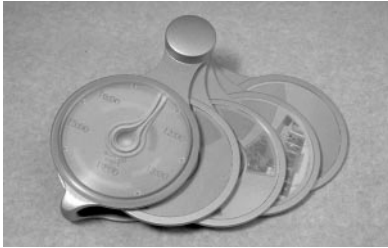

Spatial models are beneficial to create contexts for experience

Simple paper models allow a designer to explore the interactions early in the process.

Clay and polystyrene foam models are extremely suitable for exploring the appearance of products

A working prototype gives the user the opportunity 'fully' to experience the product in his own environment

when focusing on a context for experience as an open system, which can adapt to the situation and evolve during interaction with an individual. Adaptive contexts for experience require multi-sensorial feedback and feedforward, and even the entire product might change over time. Moreover, digital products are often a mixture of a tangible part (hardware) and a virtual part (screen). Spatial models are generally adequate to generate and demonstrate the hardware part, but the flexible, continuously changing software part is difficult to incorporate in the model. One way of paying attention to the virtual part is the use of digital prototyping tools, such as Hypercard, MacroMedia Director or Authorware.

Another way of obtaining a dynamic interaction is the use of a so-called Wizard-of-Oz, adapted from the movie of the same name. The Wizard is the person who impersonates the product or computer. He interprets the interactions of the user with the product and provides him with appropriate feedback. The person acting as the computer is preferably invisible, so that the user can immerse himself in the activity and create his experience. The Wizard-of-Oz approach enables the designer and user to test interaction concepts early on in the design process, without having to rely on a difficult and expensive (financially as well as in time) implementation phase.

An electrician improvises work with a foam block used as a prop to design an industrial PDA (Binder, 1999)

As stated before, drawings are considered to evoke interactive imagery. Models, too, enhance interactive imagery in their own way. Binder (1999) gives a beautiful example of this process. He used simple 'props' to explore interaction concepts for an industrial Personal Digital Assistant (PDA). He provided electricians in his working environment with simple foam blocks and asked them to show with these props how they would use a PDA on location. The block allowed the electrician to hold and use it, and to act out situations, thus amplifying his imagery.

Whereas Binder used simple foam models as props, Djajadiningrat, Gaver and Frens (2000) show with the so-called 'interaction relabelling' technique that everyday products can also enhance interactive imagery. With this method, participants interact with an existing product pretending it is the product to be designed. Graduate student Joep Frens used a toy revolver as a prop when designing his appointment manager.

The toy revolver used for relabelling

When he asked participants to relabel the toy revolver, he found that most participants mapped appointments to bullets. Interactions such as loading blanks were used to plan moments of rest, rotating the cylinder was used to scroll through appointments, firing the gun at someone resulted in a appointment, and emptying the bullets from the gun was used to cancel appointments. Note that it is not the metaphor which is important or interesting, but the resulting richness of the gestures and story.

Binder (1999) and Djajadiningrat, Gaver and Frens (2000) showed that modelling is also a quick and adequate way to let the user participate in the design process, without having to acquire specialised skills.

An interaction relabelling session with the toy revolver

Besides these physical modelling techniques, there are currently many computer-aided modelling tools to support designers. However, when we look at most commercial computer-aided modelling tools, we must conclude that, in general, they do not support experiential

design any better than physical modelling. In fact, they often impede designers to focus on the aesthetics of interaction. The hardware and software set-up places a heavy burden on the cognitive skills of the designer. The separation between the display and manipulation spaces, together with the use of a mouse or 3D equivalent lack the visual, tactile and haptic subtleties of wielding traditional handheld modelling tools. Moreover, the modelling programs have a complex graphical interface with a countless number of menus and icons. Finally, there is hardly any digital equivalent of low-fidelity modelling. Commercial modelling packages are barely supporting early exploration of new contexts for experience, in terms of approach and appearance. The majority of 3D modelling software strives to demonstrate worked-out concepts.

Nevertheless, computer-aided modelling has many advantages, such as the integration with other phases in the design process (e.g. engineering and manufacturing), possibilities for animation and 3D simulation, flexibility in changing colours and materials, and an almost unlimited patience at keeping track of history. Moreover, current trends in the HCI community are beneficial for experiential design and aesthetic interaction, such as:

• virtual reality systems and applications which make the virtual model directly accessible again and, consequently, make the search for aesthetic interaction easier.
• tangible interfacing which seamlessly couple physicality and virtuality, thus taking advantage of the richness of multi-modal human senses.
• expressive rendering and sketch-mapping which expand the expressive range and couple the expression of sketching to modelling.
• interactive prototyping tools, which allow designers to explore and present interaction stories.

These developments are major improvements, but digital technology has more potential for experiential design than digital design tools have had so far.

## 1.5 Towards new digital design tools

Within the ID-Studiolab, we are developing scenarios for new digital design tools. These concepts try to take the beneficial bits of existing design tools and mix them with the advantages of digital technology in such a way that they support the designer and the user in creating contexts for experience. We developed these new concepts especially to show new directions in digital tool developments, using basic ideas such as poetry, experience, aesthetics of interaction, and challenging the user to collaborate in the creative process. We will briefly explain two concepts. The first concept called MOVE ON aims at intertwining the expressive wealth and 'interactive imagery' of sketching, with the spatiality and interaction possibilities of modelling. The second concept, called The Attending Theremin, aims to exploit the arithmetic power of the computer to generate design solutions, thus actively assisting designers and users to explore the richness of all senses.
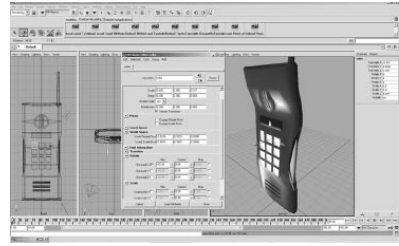

Most commercial computer-aided modelling tools hinder the designer to explore aesthetic interaction. The virtual model is inaccessible, which complicates exploring interaction concepts. Moreover, the modelling actions are cognitive-driven. The resulting model often looks ' hyperreal'

MOVE ON

MOVE ON aims at intertwining the speed, expressive wealth and 'interactive imagery' of sketching, with the spatiality and interaction possibilities of modelling. It is based on immersive VR, to give the designer the impression that he is present in a virtual design studio. The basic principle of MOVE ON is the direct use of spatial sticky sketching material called Glob. Glob is encapsulated ink in a small ball. The designer can release the ink by breaking the cover of the ball with his fingers. As soon as the ink is brought into contact with the open air, it leaves traces behind in space. By stretching the ink and pulling the obtained curve through the environment, the designer can sketch spatially.
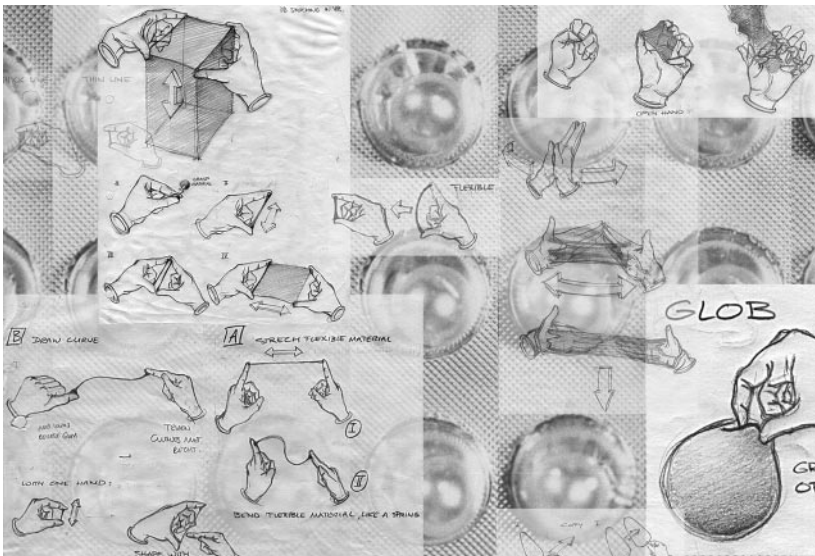

Glob is flexible, sticky virtual material that enables spatial sketching
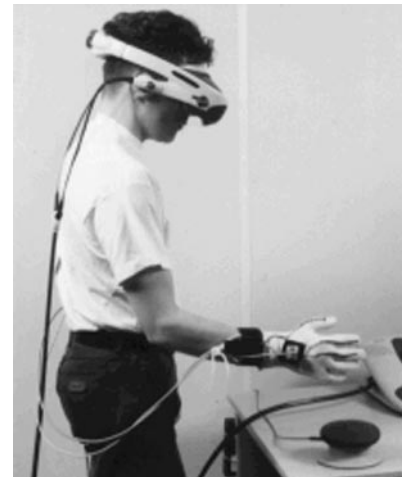
MOVE ON uses an immersive VR system to give the designer the impression that he is present in a virtual design studio

The principle of Glob asks for rather accurate finger movement measurements. A pair of datagloves were especially developed within our lab, which enabled a first simplified implementation of the principle of Glob. Shots taken from one of the interaction sessions are depicted in the storyboard, shown on the next page.

With MOVE ON, the designs are created immediately in 3D, therefore, the designer and the user can (to a certain extent) experience the design from the very beginning. The sketched products can be grabbed, moved and 'used' to explore the aesthetic interactions. MOVE ON enhances creativity in a similar way to traditional sketching. Spatial sketching still allows for 'interactive imagery', especially because MOVE ON supports ambiguity and vagueness. The borderline between creating and demonstrating ideas is fuzzy in MOVE ON, due to the range of appearances - from vague to detailed - the fast interchangeablility of these appearances, as well as the spatiality of the models which support the designer and user to test the designs early in the process. Because MOVE ON aims at implementing the characteristics of the environment, e.g. Glob sticks to surfaces, the dictation of pre-defined gestures is largely avoided. Due to the diversity of the Glob (e.g. elastic, sketchy or detailed looking, erasable, difference in colour) and the smoothness and immediacy when control-
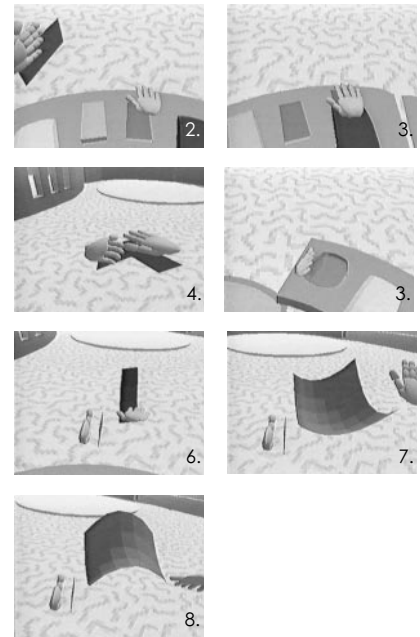
The designer is standing in a virtual design studio, with his tools placed around his waist (1). He grabs a sketching pad with both hands (2) and makes the pad in his right hand deformable by dipping it in a softener (3). Next, he sketches a curve, while using his left hand as a reference and starting point (4). He turns his left hand into a paint reservoir by dipping it into paint (5). He connects both hands and starts creating a surface with his right hand (6). The orientation of both hands determines the orientation of the surface (7). He solidifies the surface by briefly closing his left hand (8).

ling Glob, the designer's personality and skills are guaranteed in the same way as sketching on paper.

The Attending Theremin

The second concept, called the Attending Theremin, aims to exploit the arithmetic power of the computer to generate design solutions, thus actively assisting designers and users to explore the richness of all senses. The Attending Theremin abolishes the need for specific drawing skills to create product concepts. The designer can focus on the poetry of shape, sound and movements by browsing through and adjusting solutions offered by the computer, without having to worry about structural aspects such as geometry and pitch.

The Attending Theremin is derived from a musical instrument called the Theremin. The electronic musical instrument has two antennas to control the pitch, volume and timbre of the sound. The Theremin is played by changing the distance between the hand and the antenna. As the hand is brought nearer to the antenna, capacitance increases by a very small amount, which alters the sound (Glinsky, 1992). It appears as a beautiful and poetic way to create music.

The design version basically works the same: changing the capacitance through movements of the hands around antennas. Instead of creating music, The Attending Theremin is used to adjust different aspects of a context for experience. The design version has an extensive set of antennas, all with their own characteristics, e.g. antennas to adjust the shape, colour, texture, material, size, sound, movements or even the smell of a product.

Lev Sergeivitch Termen playing his own invention, the Theremin (Lemore)

The designer can control two fixed antennas to manipulate the object projected on a screen. Furthermore, he can control a foot pedal to turn the Attending Theremin on and off, and to change the volume of the speaker. MacroMedia Director is used to manipulate the object. This means that all the possible translations are pre-programmed and consequently limited
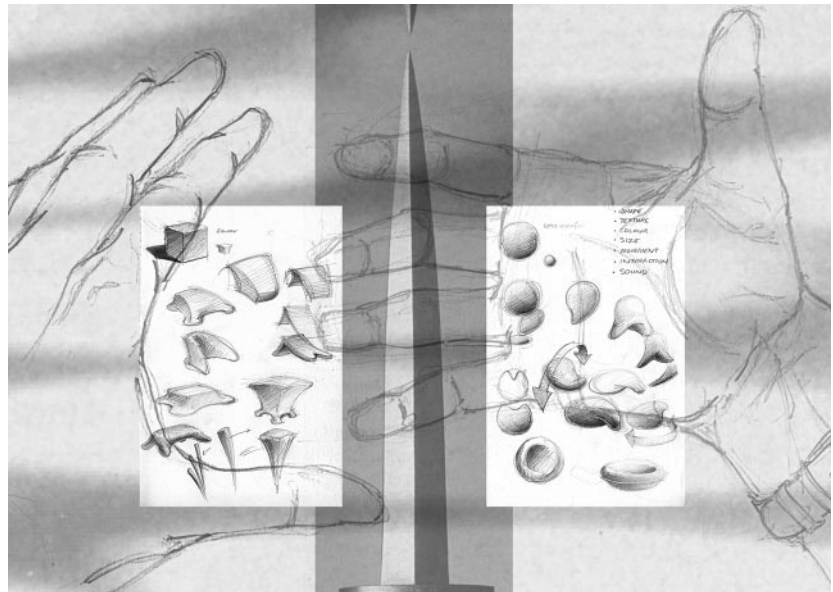
Collage of the Attending Theremin

Although the Attending Theremin contains antennas to alter rather structural aspects of the product (colour, material), the emphasis lies on the 'affective antennas', i.e. antennas which alter the emotion or expression of a product.

A first version of the Attending Theremin is built in our lab to test the technical feasibility of the tool. We are currently building a second version which enables the creator to use a maximum of six antennas simultaneously.

The Attending Theremin makes extensive use of the perceptual-motor skills of the creator and does not require any specific skills. His hands are intuitive tools in the search for the desired expression of a context for experience. Because of the smoothness and immediacy of playing the antennas, the designer can fully concentrate on the expressive character of his design, instead of working out how to construct or represent the design. The designer can intuitively respond to the concepts and stop whenever he is satisfied, which makes it an apt tool for the designer, but also a support for laymen in design. The first test version of the Attending Theremin clearly shows how the users are attracted to the tool, as well as engaged and intimate with it during manipulation.

These two concepts should not be seen as final proposals, merely as indicators of new possibilities to exploit the possibilities of digital technology in the light of aesthetic interaction.

1.6 Conclusions

In this first section we focussed on two aspects of human-product interaction that, we think are often neglected: human perceptual-motor and emotional skills. By focusing on contexts for experience, rather than functional products, the user as a whole can be respected, with his cognitive, perceptual-motor and emotional skills.

Moreover, the aesthetics of interaction concept offers a powerful mindset in human-product interaction. In accordance with this viewpoint, we think that design should not be led by technology, but by ideas which show respect for all of man's skills. As a consequence of this shift towards aesthetic interaction, designers are helped by tools which allow them to explore their and the user's unfulfilled needs and preferred experiences. Furthermore, they are helped by tools which allow them to explore the poetry of interaction. We discussed that existing tools and techniques are only partly capable of supporting designers and users to create contexts for experience. Sketching is advantageous because of its speed, interactive imagery and expressive wealth. Collages are powerful to capture the rich atmosphere of a context for experience. Collages enhance the creativity of both designers and users, because they can employ the expressivity of existing materials. Finally, models are beneficial to explore, present and test all the aspects which make up the aesthetics of interactions. They can address the future user and the setting in which the product will be used. They can address the richness of most senses, and they can address the functionality as well as the interaction story. The current spectrum of digital design tools is rather narrow, and we showed with two design tools that digital technology has more potential for experiential design than existing digital design tools have had so far. We made our first steps in studying contextual and experiential design and have a challenging road ahead.

Section 2: Expressing taste and scent in soft drink containers: a workshop

HCI methodologies often separate the cognitive, verbal, diagrammatic and abstract 'thinking' design phase from the visual, concrete, 'doing' phase, and emphasise the former. In product design, doing is seen as equally valid as thinking, and as beneficial to the design process even in the early stages. Handling physical objects and manipulating materials can allow one to be creative in ways that flow diagrams cannot. In the design of the physical, knowledge cannot replace skills. You can think all you want, but in the end, the creation of contexts of experience, the enjoyment and the expressiveness require hands-on skills (Djajadiningrat, Overbeeke and Wensveen, 2000). Therefore, we challenge you not to think in terms of thinking, but in doing, and use the second and third section for exercises. We like the participants to experience what we discussed in the first section.

The exercise in the second section focuses on the advantages and disadvantages of design tools. How can one 'communicate', i.e. generate, present, discuss, evaluate, ... ideas and concepts during the design process? We invite the participants to experience the differences between the design tools which were discussed. All the participants will be divided in teams and each team will get one of the design techniques discussed in section 1, such as sketching, modelling, making collages, gesturing, 3D-relabelling. Using only this technique, the teams are asked to design and present a drinking container. The container should not only express the taste and feel of a given drink in terms of shape, colour, texture, and so on, but also enhance
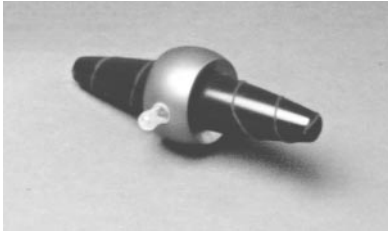
Ice Coffee package

Ginger Ale package
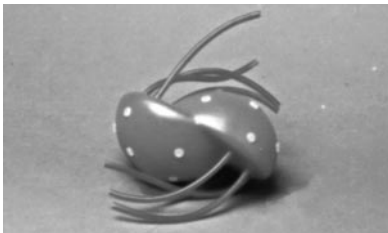
Dr. Pepper package

Most vending machines do not respect the user

the character of the drink by the way in which people are holding, drinking and storing it, and so on.

Let us give an example from our second-year design students. The students mainly focuses on the richness of the senses. The three containers depicted were specially designed for the Ice Coffee, Ginger Ale and Dr. Pepper soft drinks. The Ice Coffee package elicits firmness and strength with its dark colours, the two handles and the small opening to slow down the drinking speed. The Ginger Ale container reflects freshness and sharpness through the taut silver-coloured funnel and the small pinchable capsules which prohibit the consumption of large amounts of liquid. Finally, Dr. Pepper is bottled in a cheerful, exuberant reddish bulgy shape with flexible straws to attain a playful, sweet and exciting drinking experience.

This student design exercise aimed at training expressivity. It was not used for experiencing different design tools, as we will do in this course. At the end of the exercise, each team has to present its favourite design in two minutes to the other participants.

Section 3: Designing a vending machine for soft drinks: a workshop.

The last part of this tutorial covers the second design exercise. This time, we want to focus only on aesthetic interaction and contexts for experience. The participants are free to choose their own tools and techniques.

The shop assistant threw the biscuit at my feet. I bent down and subserviently began to pick up the crumbs. After some fiddling, I managed to get my change out of his clenched fist.

Just image you were treated like this in a shop. No doubt you would be most offended. But this is, in fact, the way in which a vending machine treats us when we buy something from it. Somehow we have come to accept a standard of respect in human-machine interaction which is very different from that in human-human interaction (Overbeeke et al., 1999). Based on our view on design, as explained in section 1, we ask each team to design an emotionally-aware vending machine for the soft drinks that were designed in the previous section. The vending machine has to be rich and playful in terms of action. We ask you to consider all the five aspects that compose an aesthetic interaction, but focus on the richness with respect to all the senses, and on the possibility to create one's own story and ritual. At the end each team needs to present its design concept in two minutes.

Conclusions

We hope that this course offers a new mindset for HCI, in which man's perceptual-motor and emotional skills deserve as much attention as his cognitive skills. We hope that it offers a way to add fun and beauty to HCI using state of the art industrial design techniques. And we hope that you experience the differences between design tools and techniques, each with their own (dis)advantages.

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