Designing for Interactional Empowerment

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“Hjärnan är kompis med kroppen och jag är kompis med hjärnan. Kroppen talar om för hjärnan allting (vad jag vill ha och vad jag vill äta)”

Albin, 8 år

Abstract

This thesis further defines how to reach *Interactional Empowerment* through design for users. Interactional Empowerment is an interaction design program within the general area of affective interaction, focusing on the users' ability to reflect, express themselves and engage in profound meaning-making. This has been explored through design of threes systems eMoto, Affective Diary and Affective Health, which all mirror users' emotions or bodily reactions in interaction in some way. From these design processes and users' encounters with the system I have extracted one experiential quality, Evocative Balance, and several embryos to experiential qualities. Evocative Balance refers to interaction experiences in which familiarity and resonance with lived experience are balanced with suggestiveness and openness to interpretation. The development of the concept of evocative balance is reported over the course of the three significant design projects, each exploring aspects of Interactional Empowerment in terms of representing bodily experiences in reflective and communicative settings. By providing accounts of evocative balance in play in the three projects, analyzing a number of other relevant interaction design experiments, and discussing evocative balance in relation to existing concepts within affective interaction, we offer a multi-grounded construct that can be appropriated by other interaction design researchers and designers. To illustrate evocative balance early on, the screenshots in the figure below is supposed to portray anger using evocative form elements that we are familiar with. To the left we can see an example where the evocative elements are unbalanced, evoking experiences of romance through portraying a rose. To the right the same expression is more evocatively balanced in its design. This thesis aims to mirror a designerly way of working, which is recognized by its multigroundedness, focus on the knowledge that resides in the design process, a slightly different approach to the view of knowledge, its extension and its rigour. It gives a background to the state-of-the-art in the design community and exemplifies these theoretical standpoints in the design processes of the three design cases. This practical example of how to extend a designer's know ledge can work as an example for design researchers working in a similar way.

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Stockholm, November 2014
Anna Ståhl

Included Publications

Paper A - Published as Anna Ståhl, Petra Sundström, and Kristina Höök (2005) A Foundation for Emotional Expressivity, in the Proceedings of Designing for User Experience (DUX'05), San Francisco, CA, USA.

Paper B - Published as Petra Sundström, Anna Ståhl and Kristina Höök (2007) In Situ Informants Exploring an Emotional Mobile Messaging System in their Everyday Practice, Special issue of IJHCS on Evaluating Affective Interfaces, vol. 65, issue 4, pp.388-403, April 2007.

Paper C - Published as Kristina Höök, Anna Ståhl, Petra Sundström, Jarmo Laaksolahti (2008) Interactional Empowerment, in the Proceedings of the International Conference on Human Factors in Computing Systems (CHI'08), April 5–10, 2008, Florence, Italy.

Paper D - Published as Anna Ståhl and Kristina Höök (2008) Reflecting on the Design Process of Affective Diary, in Proceedings of the 5th Nordic Conference on Human-Computer Interaction: Building Bridges (NordiCHI'08), 18-22 October, Lund, Sweden.

Paper E - Published as Anna Ståhl, Kristina Höök, Martin Svensson, Alex S. Taylor, Marco Combetto (2009) Experiencing the Affective Diary in Journal of Personal and Ubiquitous Computing Volume 13 Issue 5, June 2009, Springer-Verlag London, UK.

Paper F - Published as Anna Ståhl, Kristna Höök and Elsa Kosmack-Vaara (2011) Reflecting on the Design Process of Affective Health in the proceedings of the International Association of Societies of Design Research (IASDR2011), 31 October - 4 November 2011, Delft, The Netherlands.

Paper G - Published as Anna Ståhl, Jonas Löwgren and Kristina Höök (2014) Evocative Balance - Designing for Interactional Empowerment in International Journal of Design , Vol. 8(1) April 2014.

Related Publications

Kosmack Vaara Elsa, Ståhl Anna, Höök Kristina, Mercurio Johanna (2011) Tracing Behaviour Video article, Tracing Behaviour, ACM Computers in Entertainment (CiE).

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Contents

PART 1

introduction

1 Introduction

In our everyday lives, our decisions, interpretations and actions influence and are influenced by our emotional processes and experiences (Castelfranchi 2000, Katz 1999). In fact, emotional processes are inseparable from both our everyday encounters with the world and our bodily experiences. Without emotions we are not capable of rational thinking (Damasio 1994).

These emotional experiences are much richer than what is expressed in the actual words we say, our facial expressions, body postures or actions. Emotional processing cannot be isolated to some small part of our brains, but instead resides in our whole bodies (Sheetes-Johnstone 1999). In addition, emotional expressions and experiences are complex phenomena co-evolving with and dependent on who we are, our history, culture and the context surrounding us.

In our everyday lives, we are not always aware of exactly what we are feeling or expressing to the world. Bodily experiences such as gestures, body posture and tone of voice cannot only contradict what we say, but can also reinforce the experience. They can also be used to show other emotional experiences than what we actually feel, or they can be constructed to express other complex social acts, such as irony.

Emotional experiences are important and interesting to us in our daily lives. We express emotions to other people, but we often also discuss our emotions with others and reflect on our own emotions. The whole spectra of emotions are important to us, negative and positive, strong and weak, simple and complex as well as personal and social.

It is this importance and enormous complexity of emotions that makes it interesting to try to address them explicitly in design, especially given the low status emotions have had in western society. There has been both a lack of research focus on emotions until as late as the 90s, and a strong, prevailing view that emotion should mainly be seen as a problem (Damasio 1994). Emotion has been said to get in the way of rational decision-making in, for example, stressful situations. In design, this has caused ample work on how to deal with, e.g., control-room personnel or pilots who become stressed or frightened and thus start to make the wrong decisions. In our western society, emotion has belonged to the less valued pair of male-female, rational-irrational, mind-body dichotomies (Grosz 1994). This division can be contrasted with some of the eastern philosophies in which body and mind are considered

to be one. Throughout the western tradition we can now see a shift towards re-evaluating the role of body, emotion and rationality, but we still have a long way to go (Höök 2012).

The aim of the research presented here is to move a bit closer to designing for emotion in ways that attend to their full complexity – including body, mind, sociality, expressivity and culture. I want to empower users of digital media to express or reflect on their own emotional experiences, thereby spurring interesting experiences. In the longer run, I wish my design work to serve as a bridge to emotional experiences and expressivity better integrated with our everyday lives, communication needs, and allowing for richer, varied, complex emotional experiences by not separating mind from body, but intimately coupling the two.

To achieve this goal, the digital material needs to be shaped and enriched to better afford carrying our expressions and experiences thereby empowering people. The intention in my work is to provide users with digital material based on some of their partly bodily data expressed (through pressure, biosensors and/or context) in a way that does not narrowly label their emotions thus reducing our experiences to a few emotion expressions, or attempts to draw conclusions of what is subjectively experienced. My aim is to allow people to share a certain emotional experience without missing out on the complexity of what they are or the on going social acts that define them. To mirror this emotional complexity, we need to provide our users with delicately-balanced, expressive, digital material, allowing for personal interpretation and reflection, while still recognizing our everyday social and bodily encounters so that we admit ourselves and each other in and through the interactions.

Our special focus has been on one possible design concept that we have named Affective Loops (Sundström 2010, Höök 2008, Höök 2009). In an Affective Loop design, we design for bodily interaction that can create strong affective experiences. These digital systems both can be influenced by and influence users bodily. In an affective loop experience, emotions are seen as processes, constructed in the interaction: starting from everyday bodily, cognitive or social experiences, the system responds in ways that touch upon end-users' physical experience and thereby pull the user into the interaction. Throughout their use, the users are active in meaning-making and creating their own experience individually. The digital system is not responsible for the interpretation. We have built several systems that attempt to create af-

fective loop experiences with more-or-less successful results. The Affective Loop design concept captures not only how to get the message through, but also how to live and actually feel the experience of the communication as we construct it.

An important value that runs like a thread through all the work presented in this thesis is the idea of users' empowerment in and through interaction (Höök et al., 2008, Boehner et al., 2007, Boehner 2006). This notion deals with how to empower users in their interaction with digital systems and in particular how to portray the feedback practically from the digital system of an Affective Loop experience for users to get into this loop with themselves or others.

Before getting into the problem definition I will shortly present my background knowledge, since this colour my view on what research is and can be.

1.1 My Background

I am educated as an industrial designer at the Institute of Design at the university in Umeå. This education is non-traditional in an academic tradition of teaching and measuring knowledge. For example, the admission to the educations is by a portfolio, where you also have to make some assignments decided by the school. Later you go through a test of writing a short essay and finally an interview with teachers from the school and practicing designers from different design companies. Already at this stage they judge your aesthetic skills and your ability to develop as a designer. The work at the school is to a large extent based on practical work and training aesthetic skills always in close co-operation with a company from industry, which together with an external tutor and an internal supervisor forms the project. It could for example be, IKEA office, and the design space is then office furniture. Within that design space you are, by studying people's offices, fairly free to formulate your own problem that has its ground in the background research. In addition to this project there is a theoretical course in human anatomy and ergonomics, so you can apply what you have learned in the project. Except from supervision from tutors you have two design crits with the whole student group and the company (a mid-presentation and a final presentation). On-going during the whole education is artistic training and form theory always with practice and the ability to articulate aesthetics. So during the education of five years you have worked with 10 different companies from industry.

The education does not rest upon a theoretical background or only have its

own methods. It sprung out of the Scandinavian tradition with user-centred design and is probably closer to the field of HCI than other industrial design educations, (at least in Sweden) which are closer to freer art form.

Designers reading this thesis already have insight into this, but people from other backgrounds might not. And being taught to do design in this tradition, the design process and the aesthetic skills become very important and as you will see this has had an influence on this thesis.

1.2 Problem Definition

The research question explored in this thesis is: How to design for Interactional Empowerment. A sub question to this is how to make this a knowledge contribution for design research practitioners. Interactional Empowerment and its background is presented in more detail in the next section. These research questions were not defined before the work begun, but have evolved during the work in the same manner as described below.

In 2003 when I started my thesis work, the field of Human-Computer Interaction (HCI) had begun to show interest in other values and design goals in addition to those leading to efficient work situations. The prior main focus in the field had been interaction with a stationary computer, working alone or together with others, to accomplish work tasks in an efficient manner. In 2003, it was apparent, however, that this focus did not cover many of the activities we could see happening with digital interactions: games, mobile interactions, leisure time applications, time spent on the Internet to chat and have fun were all prominent activities that also needed academic attention. In this new landscape of technologies that were moving out of the office into people's lives, it became important to address emotional experiences. Mobile devices had also become ubiquitous, blurring boundaries between work and private life. These changes set the scene for my research contribution, which revolved around designing for bodily emotional experiences in a mobile setting.

More specifically, my work currently explores how to design for Interactional Empowerment. The designs described in this thesis rest upon and explore Interactional Empowerment and try to answer the question of how to design for an Interactional Empowerment experience in affective interaction.

To better frame the problem, in the next sections I will elaborate on the origin of this work and present some of the values an Interactional Empowerment design "program" entails.

1.2.1 The Origin

The work on how to design for Interactional Empowerment originates from work done back in 2002, when my supervisor, Professor Kristina Höök, started to formulate her ideas on what she called the Affective Loop. Höök had been involved in designing and evaluating two systems: the art-installation called Influencing Machine (Höök and Sengers 2003) and SenToy (Andersson et al, 2002, Höök et al., 2003).

The Influencing Machine is an interactive art installation by Sengers and colleagues (Sengers et al., 2002). The overall intention with the system is to trigger fundamental questions regarding computer technology having and expressing emotions – to explore the "enigmatics of affect". To influence the machine, users could choose from a set of postcards with evocative, expressive art on them and post them in a big wooden box. This action in turn influenced the machine that could be likened to a small child, going through early emotional development. This "child" would respond by dynamically generating drawings expressing emotions in colour, shape and animation as well as generating a dynamic jazz-inspired soundscape. The idea was that this would in turn engage users in "talking" and interacting with the machine – inserting more postcards to see their effect – engaging in a relationship or affective loop with the machine. (see Figure 1.1)

Figure 1.1: The Influencing Machine.

The second system, SenToy, was an input device used to play a game, FantasyA. SenToy is a plush toy with sensors inside the body. The player holds it and by acting out various gestures, based on theories of bodily expressions of emotion, this player can influence the behaviour and emotional processes of their avatar in the game. Since SenToy is fairly large, the emotional gestures engaged almost the whole body of the player. For example, happiness was expressed by vigorously moving SenToy up and down, making it dance on one's lap. Sadness was expressed by bending the SenToy into a slumping, sad posture, and the users would often follow this gesture by leaning their upper body. Players would be strongly influenced by these gestures as well as by how their avatar expressed their emotion. The avatar's gestures and movements were often mirrored by the player – creating a strong identification between them. (see Figure 1.2)

In evaluating these systems Höök and colleagues found that, in those cases when Influencing Machine and SenToy worked well, they managed to get users strongly involved both bodily and emotionally. To achieve these moments of being involved and engaged, the system had to respond (1) exactly at the right moment and (2) with the corresponding response for the user to interpret it in the given situation. Another important finding was how users became engaged and influenced by their own movements, but also by mimick-

Figure 1.2: SenToy and FantasyA (Paiva and Prada et al. 2003).

ing emotional behaviour of the avatars in the computer game (Höök 2008). They became engaged in a bodily emotional way, almost like living the emotions of the avatar. From these insights, Höök started to formulate the initial idea of the Affective Loop experience. The Affective Loop embraced the whole emotional involvement when interacting, using gestures as input and feedback tightly coupled in a loop, where we get more and more involved as we interact. Our expressions are mirrored in the system, but the system also provides feedback that influences our experience. Höök's idea was that it should be possible to move outside the game and arts domain, where, in a sense, emotional expressivity was a given. What would happen if we applied these ideas to communication systems, either between people or as an internal loop, mirroring users in a system, making them reflect on their own emotional process? In particular, at the time, it seemed likely that mobile technology in the future would have sensors that could pick up on various aspects of emotional expressions. Mobile phones had also, at the time, rapidly moved into our everyday lives and into our pockets, in a way that seemed to warrant further attention to emotional expressivity and ways of creating interesting experiences. This was the challenge Höök put to me when I became a PhD-student in 2003: can we design for and involve users in some kind of Affective Loop experience that resonates with their emotional and bodily experiences?

The exploration of the Affective Loop idea started in 2003 in a small team consisting of Kristina Höök, Petra Sundström, an engineer, and myself as her PhD-students. The heretofore fairly immature idea of the Affective Loop experience was first applied to communication between two friends in the eMoto system (paper A and B). Later there were two strands that developed from this first exploration, one of which was led by Petra Sundström, advancing towards communication amongst a whole group of friends, with the research aim to develop, refine and define these Affective Loop experiences (Sundström et al., 2009, Laaksolahti et al., 2011). In her thesis, Petra Sundström describes Affective Loop Experiences in the following manner (Sundström 2010):

"An Affective Loop experience is an emerging, in the moment, emotional experience where the inner emotional experience, the situation at hand and the social and physical context act together, to create for one complete embodied experience. The loop perspective comes from how this experience

takes place in communication and how there is a rhythmic pattern in communication where those involved express themselves but also ever so often stand back interpreting the moment -– feeling it.

To allow for Affective Loop experiences with or through a computer system, the user need to be allowed to express herself in rich personal ways involving our many ways of expressing and sensing emotions – muscles tensions, facial expressions and more. For the user to become further engaged in interaction, the computer system needs the capability to return relevant, either diminishing, enforcing or disruptive feedback to those emotions expressed by the user so that the she wants to continue express herself by either strengthening, changing or keeping her expression." (p. 10)

The other strand, lead by myself, focused on mirroring emotions to oneself, also one kind of more personal Affective Loop experience. The main research question for me has been, how to design for users to become empowered in interaction, a matter which will be further framed in the next section.

1.2.2 Interactional Empowerment Design – Emotional Experiences

As outlined by Redström (Redström 2001), design research benefits from setting up a program with a set of values, a set of aims, an exploration of a possible design space, starting from the aesthetic properties of the material being explored – be it electricity, emotion or sustainability. By framing specific design explorations within such a program, they can together map out a range of insights and bring out innovations. In our work, we quickly came to realize that when designing for emotional experience, it was, for many reasons, important to provide an alternative to the idea that human emotion can be isolated, automatically recognized by the system, and used to make the system automatically adapt – as that kind of framing excluded a whole range of applications we saw as possible and desirable. Step-by-step, we formulated a program we called Interactional Empowerment, which tried to capture this alternative view on design for emotion: allowing users to be expressive, to reflect and to leave the meaning making to users.

In this thesis, I describe how I identified, shaped and tested the relevance of one experiential quality, evocative balance, and two desirable qualities, blending experience and harmonizing modalities in design for digital embodied emotional expressivity and experiences. These desirable qualities capture and frame properties of an interaction that promote emotional expressivity,

making users feel as "one" with the system, where the expressions and interactions are familiar to them in a bodily sense. These qualities first occurred as an outcome of our first project. Through using a multi-grounded, explorative, design process applied to several design processes, we came to see, step-by-step, how we can create for empowerment. By multi-grounded design, we refer to a process of both involving users in various stages of the process as well as being inspired by theory, by aesthetic explorations, and from the actual sketching that rapidly goes between creation and evaluation based on what has been referred to as designers' skills and judgments (Schön 1983, Nelson and Stolterman 2003, Cross 2007). The actual design processes behind each of the systems we built are described in enough detail to show both which design decisions were successful, and which ones we had to leave behind. Describing the design process in this detail serves not only as a validation for the choices made for the design knowledge I bring forth in this thesis, but also as inspiration for other designers aiming at designing in the same or similar domains (Ståhl et al., 2005, Ståhl and Höök 2008, Ståhl et al, 2011).

In total, I took part in designing three different systems that were taken all the way to full implementation and tests in "the wild" with users. In this process I was able to test and refine the qualities repeatedly and finally articulate one of them in depth, as the experiential quality, evocative balance (in paper G). The other qualities discussed in this thesis can be seen as embryonic qualities, which have not yet gone through a process of reflection and articulation or been put into relation to other concepts as required in a design research exploration.

I refer to these qualities as being desirable rather than having the power to determine a user experience. There are two reasons for this distinction. First, there is no way we can guarantee that a user will have a certain experience of interacting with a system. All we can do is to set the scene for certain experiences to be more likely to occur. Second, designers will pick up on bits and pieces of others' designs, alter them, and mould them into unique forms that may resemble, but rarely be exact, copies of what has been done before. The same holds for designing for certain experiential qualities – they always have to be slightly changed to fit with the requirements at hand.

The research process that allowed me to arrive at the qualities described in this thesis can be divided into four parts, which all inform the qualities and in turn also interactional empowerment, see Figure 1.3.

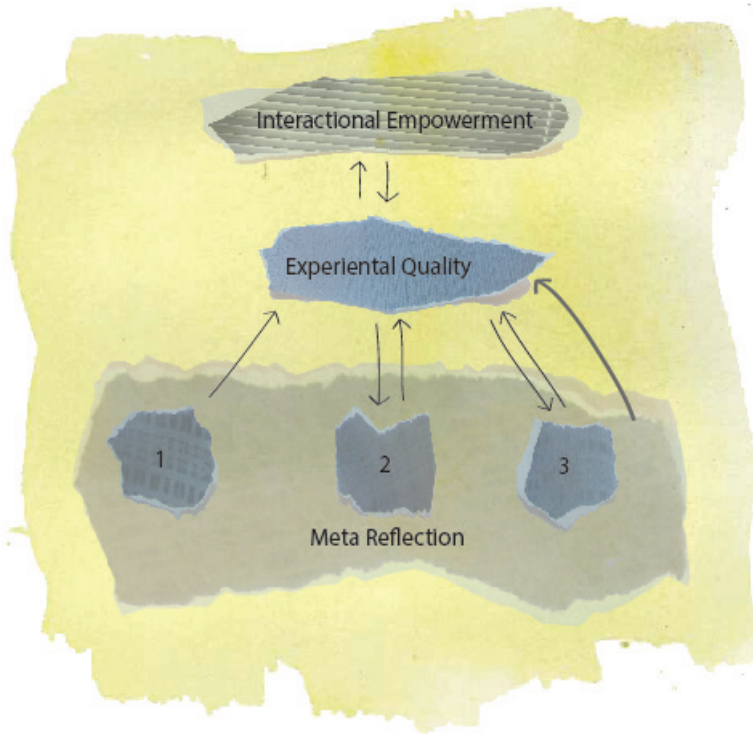


Figure 1.3: The research process, how the three applications together with the meta reflection develop an experiential quality.

1. The first part in this process constitutes of the prototype eMoto (paper A and B), which was designed, tested in use and the result analysed. The outcomes of this process were four qualities that were useful in designing the system and desirable in the experience of it: media specific qualities, cues of familiarity, awareness of contradictory modalities, and openness to personal expressivity.
2. The second part in the research process was the Affective Diary (papers D and E). This work was among many different things guided by the qualities that came out of the eMoto project. This work helped in the development and validation of the qualities. We ended up with three fairly similar desirable qualities to those developed in the first project, but with a deeper and more reflective understanding. For example, the quality concerning media-specific qualities was not perceived as being relevant; it was too general and did not treat design for emotional expressivity in particular.
3. The design of the third application, Affective Health (paper F), was again guided by these desirable qualities amongst many other things. The design process including user encounters and analysis of these further

developed and validated the desirable qualities. In the outcome of this part the qualities were; co-construction of emotional experiences and harmonizing modalities.

4. The fourth part of this research process is a meta-reflection of the three first steps. Here the interdependence of two of the qualities became apparant. These were merged into one quality, evocative balance (paper E), which was thoroughly examined, analysed, articulated, and compared to the works of other designers. This work also informed formulating the program of interactional empowerment. The other two remaining qualities can be seen as embryos of experiential qualities that have not yet gone through the scrutiny of a proper design research validation.

In an interactional empowerment design, users contribute their interpretation and co-construct the meaning of what the system portrays of them over time (Höök et al., 2008, Boehner et al., 2007), and it is through the interaction over time that the system starts making sense, mirroring behaviour data or users' experiences back to them. An interactional view sees meaning/emotions/dialogue as constructed in and through the interaction.

The interactional empowerment design stance aims to support people in understanding and experiencing their own expressions subjectively – be it bodily data or other kinds of data. An interactional perspective on design will not aim to detect a singular account of the "right" or "true" interpretation of the user and tell them about it but rather make experiences available for reflection. It requires a representation that portrays people's everyday experiences in a form that they feel familiar with and that they can later reflect on. Users' own, richer interpretation guarantees that it will be a truer account of what they are experiencing. This perspective on how to design puts users' own interpretation of their own lives, bodily processes or sociality at the core. It empowers them to make their own choices rather than being told by a system what they are experiencing, when they should stop stressing about a decision or when they need to take a break.

By using an application over time, users start to make more sense of the emotional experiences mirrored back to them and deepen their interpretation of both the system and themselves. In our work, we chose to focus on empowering users in affective interaction between users, but also through mirroring data from biosensors interacting with and reflecting on themselves.

In short, to reach this empowerment of the user through a digital system,

we chose to work with abstract expression forms that provide resonance and feel familiar in our everyday experiences of emotional processes, such as bodily reactions, facial expression, and body language. This method placed an emphasis on the bodily experience of the emotional processes. For these expression forms to resonate with users' experiences, they have to balance evocativeness for interpretation to take place. For these expressions to work out they have to be designed with a delicate aesthetic touch and feel.

1.3 Method

Back in 2003 when the work behind this thesis started, the academic field of interaction design was less established, in particular the strand with roots in industrial design. During the years since 2003, the community has grown but is still in many ways trying to find its own format for validation, articulation, venues and knowledge transfer that can capture the essence of design.

Just to make it clear, when I talk about design, it is from the perspective of an industrial designer. By a designer, I mean someone who went to a design school and was trained in that way of thinking, problem solving and (not least) in aesthetic form-giving processes. In the beginning of the millennium, the part of industrial design that dealt with interaction design turned to HCI, as this was the community closest to their interests. Although these fields have a great deal in common in the outcome of a project, as it turned out, when trying to publish within that field, the research method, design process, grounding, validation and what counted as a result partly differed from what is in focus in design research (see chapter 2).

Trying to capture the essence of an industrial design approach in the research could be tackled in many different ways. In my research, I have chosen to create designs and make the design process part of my research method. This approach is obviously not uncontroversial. All industrial designers will create novel, innovative design, that is, at the core of their identity; so what is the difference between a design practitioner innovating novel ways of interacting and a design research practitioner doing the same thing? When does the latter count as research? The research method that I have developed and used in this work was not a previously-existing, well-established or commonly-used research method (see Figure 1.4), even if there were several inspirational examples arriving at the time (Redström 2001, Nelson and Stolterman 2002, Ilstedt 2004, Krippendorff 2006, Zimmerman and Forlizzi 2007, Mazé 2007, Cross 2007, Westerlund 2009, Koskinen et al., 2011).

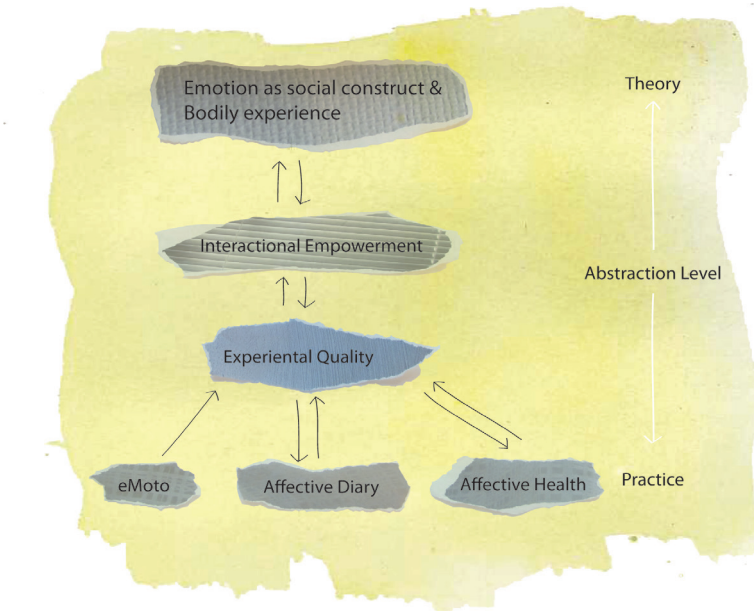


Figure 1.4: The research method showing how the actual research prototypes and their deign processes is connected to abstracted knowledge, such as, experiental qualities, programs and higher theories.

During the work, I have been trying to relate the method I have been using to the developing, ongoing debate in the design research community on how to perform design research. One of the many questions that had to be answered is whether this method could produce validated knowledge fulfilling epistemological criteria? I will devote a whole chapter (chapter 2) to this problem.

Since the design community did not have high-quality academic venues where I could publish when this work started, the content in this thesis has to a large extent been published and also reviewed from an HCI perspective. At the time, HCI was changing and more and more designers came to influence the field. But the field is still struggling to see more publications that wholeheartedly describe their research in a designerly manner. Many publications still have the obligatory final user study as the main criterion of success of a particular design. I have put a lot of effort into trying to keep the character-

istics of design when describing design processes and results. Sometimes I have exerted more effort on trying to explain and convince the HCI-audience that design conducted in this way can also be viable research, instead of putting my efforts into articulating the contribution to the design research community. This is a natural process, however, since all new research methods have to be articulated and motivated.

1.4 Contributions

My contributions can be divided into two main parts: first, the design insights for Interactional Empowerment and how to design for emotional experiences, and, second, it may serve as an example of how to do research from a design practitioner's perspective.

For the first part, I see the following achievements as my main contributions:

1. The applications we designed and implemented: eMoto, Affective Diary and Affective Health
2. The articulation of one desirable experiential quality (and two embryos to experiential qualities), capturing some of the lessons learnt on how to design for empowerment and emotional experience.

Together with my colleagues, I have created three fully-implemented applications, eMoto, Affective Diary and Affective Health. These three systems flesh out our Interactional Empowerment program, filling it with content. They are, at the same time, tangible proofs of our design stance.

The first application, eMoto, is a mobile system for sending and receiving text messages enhanced with emotional expressions. eMoto was elaborated in close co-operation with Petra Sundström under the direction of professor Kristina Höök. In this co-operation I was responsible for developing and designing and evaluating the graphical emotional expressions. Sundström was responsible for the implementation and the final evaluation. The hardware device used in eMoto was put together by Martin Nilsson at the Swedish Institute of Computer Science (SICS). The product design of the hardware device was carried out by a company called About Design.

Affective Diary is an extended diary or life log, utilizing biosensors logging movement and Galvanic Skin Response (GSR) to provide users with bits and pieces of their emotional arousal processes for reflection, recalling and meaning-making. The system also logs activities on the mobile phone, such as photos, text messages and Bluetooth activity. This is downloaded to a tab-

let PC where one can see the data visualized over time. This project consisted of Martin Svensson, an engineer and professor Kristina Höök as a supervisor, Alex Taylor and Richard Harper from Microsoft Research, and myself. In this project, I was responsible for the graphical visualizations of the data, supervising an interaction designer, Madlene Lindström, who sketched the early conceptualizations of the interface, the explorations of the mapping of sensor data to graphical representations. I also conducted and analyzed a final user evaluation of the system. Martin Svensson at SICS implemented the system.

Affective Health also logs bio data (movement, GSR and pulse) and visualizes it in real time on a mobile phone, but the data is also visualized over time, so one can view events in the past. This project has been running since 2008 and is still ongoing, so there have been many different people involved. I will try to sort out my contributions and also declare the most important contributions by other team members. The overall idea of the project is a joint effort of the team members with Professor Kristina Höök as supervisor. Pedro Sanchez (SICS, KTH) and Pedro Ferreira, a PhD student at KTH, have mainly worked with the more technical sensor part of the project (Sanchez 2008), Ferreira 2008), (Ferreira et al., 2008). Claus Weymann (SICS) implemented the graphical interface. Together with Elsa Kosmack-Vaara, an industrial designer and researcher at SICS, in a joint effort with me, we designed the graphical visualizations of the data. We took turns working on the graphical material, mainly due to parental leave. The idea of representing time in cycles is Elsa Kosmack-Vaara's contribution (Kosmack-Vaara et al., 2010), while the modalities on how to represent bio-data builds from my previous experiences. The final evaluation of the system was conducted by a master's student, Johanna Mercurio, under the supervision of Marie Sjölinder, SICS and Professor Kristina Höök. I also contributed with supervision during the analysis of the user study material. I later reanalyzed the study material with a specific focus on how users responded to the desirable qualities used to guide the design and to see how they came through in the design.

The formulation of the experiential quality named evocative balance was done by myself with the help of my two supervisors, Löwgren and Höök.

From the design processes of these three projects, I have struggled with how to maintain an industrial design research approach to the problems, work process and outcome, but still make it acceptable as a contribution to the HCI community. As a result of this, I wanted to open up the design pro-

cess, to show the complexity and how decisions were made to become visible to others. That they were not random is exemplified in chapter 4. To declare this fact, I have given a reflective account for each of these three design processes, so it is more visible where and how decisions were made and how they were grounded as well as what input theories we have been using (see paper A, D and F). These three reflective accounts serve as both a validation of the research in line with Zimmermann's criteria for judging design research contributions (Zimmermann et al., 2007) and as an inspiration for other designers regarding how to go about it when designing for something in the same area. The level of details in these descriptions is such that another designer should be able to almost copy the design process, but this is just to show how decisions are grounded. The intention of knowledge extension is that it should not be copied but rather work as an inspiration. The aim is not to come up with a new method of how to go about it when designing for something in this area but to show how different methods, theories and inspiration were put together and used. This contribution is my own.

1.5 Outline

This thesis is composed of seven papers and a cover paper. The purpose of the cover paper is to present a coherent story and show the progression between the seven papers included in the second part of the thesis.

Part 1 – The Introduction

Chapter 1 – presents and frames the research problem at a high level. It motivates the research and provides a short introduction to the research method by describing my design journey in designing for emotional experiences and expressivity. Section one also briefly presents the program to which this thesis belongs – designing from an Interactional Empowerment stance.

Chapter 2 – motivates and frames why and how actual design work and a designerly approach to exploration of a design space can also be used as a research method. It frames the methods used in this thesis in an industrial design tradition. It provides a brief historical background to interaction design from an industrial design perspective. It then contrasts this against other interaction design traditions, originating from informatics and HCI. It discusses similarities and differences in these three strands in terms of their respective epistemological claims, their research methods, and their groundings in theory: how they can be judged, validated and extended to make a

contribution to knowledge. It also states where my research belongs in this rapidly changing and developing research tradition.

Chapter 3 – presents the emotion theories that were inspirational in our design processes. In this section, I discuss our theoretical backgrounds. This section provides the theoretical underpinnings to affective interaction and the interactional view presented in this thesis. It also presents the multi-grounding in many different theories and other inspirations motivating my design work. It also shows the wide range of theories that have been used as input for the gestalt in the design processes and how these were selected.

Chapter 4 – provides three excerpts from the reflective accounts of each of the three design processes that led to the three systems, eMoto, Affective Diary and Affective Health. In this, an example is given from each of the three processes to illustrate how the theories, methods and inspiration are used and how design decisions are made and validated – sometimes in cycles of sketching and judging the outcomes myself, sometimes in longer cycles, involving end users or through performing major redesigns based on technical or social insights.

Chapter 5 – presents the experiential quality that is the outcome of these three processes and the process of arriving at it and thereby some other desirable qualities, which are not yet worked through to the extent to be called experiential qualities. It also gives a background to experiential qualities and discusses what makes a quality experiential

Chapter 6 – summarizes and discusses the work presented in this thesis and how the knowledge gained from the three applications, eMoto, Affective Diary and Affective Health can be extended and become accessible for others. This section also outlines potential future work on how to find methods for bringing in Interactional Empowerment and a view on the users as whole, alive and social beings.

Part 2 - The Papers

Paper A – Published as Anna Ståhl, Petra Sundström, and Kristina Höök (2005) A Foundation for Emotional Expressivity, in the Proceedings of Designing for User Experience (DUX'05), San Francisco, CA, USA.

This paper is my first reflective account of a design process, the process that resulted in the system eMoto. It gives a brief background to our view on emotions and the inspirational theories used in the process. The paper explains that expressing emotions to others in mobile text messaging requires designs

that can capture some of the complexity and subtlety that characterizes emotional interaction and keeps the media specific qualities. Through the use of a body movement analysis and a dimensional model of emotion experiences, we arrived at a design for a mobile messaging service, eMoto. The service makes use of the sub-symbolic expressions: colours, shapes and animations, for expressing emotions in an open-ended way. In this we present the design process and a user study of those expressions, where the results show that the use of these sub-symbolic expressions can serve as a foundation to use as a creative tool, while still allowing for the communication to be situated. The inspiration taken from body movements proved to be very useful as a design input. It was also reflected in the way our subjects described the expressions, and it further worked as the base for the initial formulation of the desirable design qualities.

In this paper the graphical design that I had made was studied. I was main responsible for the study set up and performance me with assistance by Petra Sundström. The analysis was done by me and discussed with my supervisor Kristina Höök. I was main responsible for writing the paper. My two colleagues Petra Sundström and Kristina Höök read and commented.

Paper B – Published as Petra Sundström 1, Anna Ståhl 1 and Kristina Höök 2 (2007) In Situ Informants Exploring an Emotional Mobile Messaging System in Their Everyday Practice, in a special issue of IJHCS on Evaluating Affective Interfaces, vol. 65, issue 4, pp. 388403,April 2007.

This paper presents the final "in the wild" evaluation of the eMoto system. It also presents the idea behind eMoto and how it works. We describe the user-centred design process that led to the eMoto system but focus mainly on the final study in which we let five friends use eMoto for two weeks. The study method, which we call in situ informants, helped us enter and explore the subjective and distributed experiences of use as well as how emotional communication unfolds in everyday practice when channelled through a system such as eMoto. The in situ informants are on the one hand users of eMoto, but also spectators, who are close friends observing and documenting our participants' use. Design conclusions include the need to support the sometimes fragile communication rhythm that friendships require – expressing memories of the past, sharing the present and planning for the future. We saw that emotions are not singular state that exist within one person alone

but permeate the total situation, changing and drifting as a process between the two friends communicating. We also gained insights into the underestimated but still important physical and sensual aspects of emotional communication. Experiences of the in situ informants' method include the need to involve participants in the interpretation of the data obtained as well as establishing a closer connection with the spectators.

In this paper the system eMoto was tested, where I was part of the overall idea and mainly the graphical design. Petra Sundström was main responsible for the set up of the study and the performance of it. I was part of doing a test pilot and as a discussion partner around the study. I also discussed the analysis and wrote parts of the paper, but mostly read and commented the paper.

Paper C – Published as Kristina Höök, Anna Ståhl, Petra Sundström, Jarmo Laaksolahti (2008) Interactional Empowerment, in the Proceedings of the International Conference on Human Factors in Computing Systems (CHI'08), April 5–10, 2008, Florence, Italy.

In this paper the idea of Interactional Empowerment is defined and exemplified. The paper gives two design examples that are built from the idea of Interactional Empowerment, eMoto and Affective Diary. Interactional Empowerment builds from an interactional perspective on how emotion is constructed, shared and experienced. This is a good basis for designing affective interactional systems that do not infringe on privacy or autonomy but instead empower users. The paper summarizes the lessons learnt from designing for Interactional Empowerment and exemplifies how to translate this experience into the actual designed systems. These guiding design elements include: designing open familiar surfaces that can be appropriated by users, leaving the interpretation to the user through balanced ambiguous design elements and involving users in affective loop experiences. These elements used in the design can work as a basis for users to make sense of their own emotions and their communication with one another. With such tools, users are provided with control over their own data and the interpretation of it.

These elements are tightly connected to the desirable design qualities mentioned above, but they are on slightly higher level; the desirable qualities together with a reflective account of the design process gives a more detailed example of how the qualities can be translated practically into design.

In this paper I was part of designing two of the systems the paper builds

from, eMoto and Affective Diary. I wrote parts of the paper, commented and discussed, especially the parts where the design element are discussed. Kristina Höök was responsible for the paper and wrote the main part of it.

Paper D – Published as Anna Ståhl and Kristina Höök (2008) Reflecting on the Design Process of Affective Diary, in the Proceedings of the 5th Nordic Conference on Human-Computer Interaction: Building Bridges (NordiCHI'08), 18-22 October, Lund, Sweden.

This paper is the second reflective account of a design process, the process that culminated in the system, the Affective Diary. The Affective Diary is a digital diary that makes use of biosensors to add some recall of bodily experiences. The design process behind Affective Diary aimed at being "sensitive" to three design qualities extracted from a previous project (eMoto), providing cues of emotional expressivity building on familiarity, making the design open for personal expressivity and being aware of contradictions between modalities. Through the design process of Affective Diary, with frequent user involvements during the process, these design qualities became further tested, developed and refined. By providing a fairly detailed and reflective description of the design process behind Affective Diary, we aim to provide other designers with inspiration on several levels, both in terms of methods used and also in regard to why these three design qualities are important and how to realize them. Our aim is also to provide designers with knowledge in the form that makes sense to designers: the practical link between design qualities and final results.

In this paper I was responsible for the design of the Affective Diary. I set up the study in discussions with Kristina Höök and Martin Svensson. I performed most of the interview discussions with the users, analysed the material, which was discussed with Kristina Höök. The paper was written by me and read and commented by Kristina Höök.

Paper E – Published as Anna Ståhl, Kristina Höök, Martin Svensson, Alex S. Taylor, Marco Combetto (2009) Experiencing the Affective Diary in Journal of Personal and Ubiquitous Computing Volume 13 Issue 5, June 2009, Springer-Verlag London, UK.

This paper gives an overall presentation of the Affective Diary system, a final user evaluation of the system and the analysis of the data.

A diary is generally considered to be a book in which one keeps a regu-

lar record of events and experiences that have some personal significance. As such, it provides a useful means to express inner thoughts privately or to reflect on daily experiences, helping in either case to put them into perspective. Taking conventional diary-keeping as our starting point, we designed and built a digital diary called Affective Diary, in which users can scribble their notes, but which also allows for bodily memorabilia to be recorded from body sensors and mobile media to be collected from users' mobile phones. A premise that underlies the presented work is one that views our bodily experiences as integral to how we come to interpret and thus make sense of the world. We present our investigations into this design space in three related lines of inquiry: (1) a theoretical grounding for affect and bodily experiences; (2) a user-centred design process, arriving at the Affective Diary system; and (3) an exploratory final evaluation study of the Affective Diary with four users during several weeks of use. Through these three inquiries, our overall aim was to explore the potential of a system that interleaves the physical and cultural features of our embodied experiences and to further examine what media-specific qualities such a design might incorporate. Concerning the desirable design qualities used as guidance, the key appears to be to find a suitable balance in which a system does not dictate what should be interpreted and, at the same time, lends itself to enabling the user to participate in the interpretive act. In the exploratory end-user evaluation, users, for the most part, were able to identify with the body memorabilia and, together with the mobile data, it enabled them to remember and reflect on their pasts. Two of our subjects went even further and found patterns in their own bodily reactions that caused them to learn something about themselves and even attempt to alter their own behaviours.

This paper builds from the same study as the previous paper but does not treat the design qualities specifically. I set up the study in discussions with Kristina Höök and Martin Svensson. I performed most of the interview discussions with the users, and me and Martin Svensson analysed the material together. I was main responsible for the paper, both Kristina Höök, Martin Svensson and Alex Taylor wrote parts of the paper and Marco Combetto commented.

Paper F – Published as Anna Ståhl, Kristna Höök and Elsa Kosmack-Vaara (2011) Reflecting on the Design Process of Affective Health in the Proceedings

of International Association of Societies of Design Research (IASDR2011), 31 October - 4 November 2011, Delft, The Netherlands.

This paper describes the third reflective account of a design process and also puts the desirable qualities through yet another design loop. The findings and insights from the Affective Diary system and the fact that there is a growing market of applications that relate to our bodily wellbeing or ways of expressing ourselves through bodily acts, such as monitoring our sleep, dealing with stress and creating life logs or diaries that included bodily data led to the design of yet another system called the Affective Health system, which is described in this paper. The applications mentioned above interact with our bodily, physical, selves through biosensors or body movement/gesture recognition. The question is how we best design these to allow us to be empowered, recognize ourselves in the interaction and be expressive. In this paper we uncover the design process behind the bio-sensor-based, wellness-system, called Affective Health, aimed at helping users to get into biofeedback loops as well as find patterns in their bodily reactions over time. By describing and discussing details of the design process, we provide a reflective account of the particular design we arrived at. This paper gives a reflective account of the design process of the Affective Health system, the theories used as input, the methods and the user encounters and how these were puzzled together. The three design qualities are also used here to guide both the generation and evaluation of different design sketches. They are, in short, (1) that the design should build on elements that feel familiar to users, mirroring their experience of themselves; (2) that it create designs that leave room for users' own interpretation of their body data; and (3) that the modalities used in the design do not contradict one another, but instead harmonize, helping users to make sense of the representation. The final user encounter of the Affective Health system shows that those design qualities were indeed both useful and important to users' experience of the interaction. We believe that this is a fruitful form of design knowledge that can be shared between design researchers and practitioners.

In this I was responsible for the analysis of the study. Johanna Mercurio performed the study. Elsa Kosmack-Vaara was main responsible for the design used in the study. I was responsible writing the paper and Kristina Höök read and commented.

Paper G – Published as Anna Ståhl, Jonas Löwgren and Kristina Höök (2014) Evocative Balance - Designing for Interactional Empowerment in International Journal of Design , Vol. 8(1) April 2014.

This paper describes the one desirable experiential quality, evocative balance, which we repeatedly found important to carefully consider in the design processes of eMoto, Affective Diary and Affective Health.

In short, to make sure that our design is experienced in a way that is evocative to people, we need to base it on emotional, bodily, social everyday experiences that are known to people – they have to resonate with their lived experiences. But the experience must be balanced so that it does not become too suggestive and thereby over determined, singling out one specific emotion, labelled as if there was only one possible way of being, say, happy. Instead, it has to give leeway for the uniqueness of experience, as our everyday lives and emotional processes have endless variety. At the same time, experiences have to be balanced in the other way so that they do not become underdetermined – that is, to be experienced as so abstract and open to many different interpretations that users cannot make sense of them at all or will start reading everything into them, like in a horoscope. When we have achieved a balance in here, the likelihood increases that an evocative balance is experienced.

This experiential quality is the outcome of three affective interactive systems. All three mirroring and enriching one's own or others' understanding and interaction with our bodily-emotional experiences was a key functionality. Two focused partly on understanding one's own somatic arousal reactions – allowing one to reflect on them and interact with them thus creating a diary of past everyday, emotional experiences. The third system was an extension of a mobile text messaging system, allowing users to express themselves through gestures relating to or even spurring emotional experiences that they wanted to communicate to a friend.

From the design process behind these three systems, we learnt that for the evocative balance to be experienced it had to be crafted with an aesthetic touch and feel.

In this paper I was main responsible for the writing, Jonas Löwgren read and gave feedback throughout the whole process. In the end both Jonas Löwgren and Kristina Höök read through and wrote parts of the text.

research method

2 Research Method

In this chapter I will discuss three different traditions (HCI, Informatics and industrial design) within the field of interaction design research and reflect upon how they influence the approach, actual design process and final research result, and both how the work is conducted practically and the way that it is viewed augmented for and reflected upon afterwards. This procedure leads us to a discussion of what design research is, what knowledge construction in design research is and how can we judge whether a result is valid. Validity in a sense that can be accepted in the interaction design/HCI research community and examples of how to communicate this are Höök and Löwgren's proposal of strong concepts (Höök and Löwgren 2012), Bowers and Gaver's annotated portfolios (Bowers 2012, Gaver 2012, Gaver and Bowers 2012) and Forlizzi and colleagues' criteria for Research through Design (Forlizzi et al., 2008). Design research is an immature part of the community, and there is not yet a common ground for knowledge contribution in the community.

First of all, I need to clarify what I mean by design here. In his book (Norman 2004), Norman states that we are all designers. That observation might be true, but some people are more skilled in design than others; they have been trained to think and approach problems in a certain way (Cross 2007), which may be through education and through practising design professionally. Buxton (Buxton 2007) defines design "as someone who went to art college and studied industrial design would recognise it", which is simply another way of paraphrasing Cross' definition. In his earlier work, Löwgren (Löwgren 1995) divides design into creative design and engineering design, according to their different perspectives on design. This division is crude and simplified, but it captures the historical background of each field, for the most part still present to some extent and evident in their respective ways of approaching problems, practice and their view on what constitutes a research result and what they consider to be a valid piece of design knowledge. Since I have an educational background in industrial design and interaction design, my view on design belongs to the field of creative design. The area of design research and its aims are also divided: there are design researchers and design research practitioners and design practitioners. Design researchers often study designers, designers' work or products designed by others, although they may not have a creative design education themselves. Design

research practitioners are practicing design researchers doing design work aimed at producing knowledge (this is where I belong) described as constructive design research by Koskinen et al. (2011). Then we have design practitioners, whose aim is to produce products, not knowledge in the first place. The result I produce first hand which was aimed at practicing design researchers and design practitioners might be inspired by the knowledge if it reaches them, but I think results have to be presented in a more accessible form to be assimilated by design practitioners. Of course, designers and design work can drift between these three categories, but often most of the work has its home in one of them.

In addition, my design research work has been carried out in an environment focused on HCI. While HCI today includes design to a larger extent than when I started my doctoral studies, there are still differences between the core HCI-strand and a more design-oriented research approach to HCI. Both these tensions, between creative design and engineering design as well as between the mainstream HCI and a design, will be further elaborated below.

If a design process that results in new knowledge aims to count as research, it has to fulfil the criteria we normally set for any research endeavour. For example, according to Löwgren (2007), an academic knowledge contribution must be new, relevant, grounded and criticizable. "New" means that the contribution proposes a position that not everyone in the academic community already believes – that it is novel. "Relevant" means that it is interesting and makes sense to the research community, that it is one worth the time and effort of the researcher conducting it and community members engaging with it. A contribution must be grounded in something the community accepts. Lastly, the contribution has to be criticizable by other researchers in the community: it should be possible to form an opinion of the contribution by identifying and criticizing every step that the contribution builds on. Apart from these generic criteria of what constitutes a knowledge contribution, however, we also need to consider what we mean by design research knowledge and what research methods a design researcher can use: can the design process itself, that is the sketching, prototyping, testing of different ideas, inspiration from theories, work by others, blind alleys, successful routes, and opening of the design space for a novel area be part of the research method? Below I will provide a brief historical background to the

area of interaction design, which here will be divided into HCI, informatics, and industrial design, since these are the fields I ground my experiences on. Many of the differences between these areas seem to have their explanation in their respective founding traditions. I will go through the differences within knowledge construction for these fields. These sometimes strong intuitive beliefs in approaching things are something that we might not be aware of or reflect much upon on a daily basis. It is simply there, because we were taught to approach our work in a certain way; the shifting of worldviews first becomes evident when working in an interdisciplinary setting. My own research work together with researchers from other backgrounds forced me to articulate more strongly regarding what a design researcher brings to the table, which methods from a design research practice may also be used as research methods, how to validate the knowledge a design research practitioner brings forth, and what constitutes a piece of validated design knowledge beyond the user-centred design perspective

This thesis includes research activities that go from usability and user-centred design towards a more experience-oriented perspective. This perspective also follows an emerging trend of HCI research (Harrison et al., 2007, Bødker 2006).

The role of HCI in systems design has traditionally been to "*enhance the quality of the interaction between humans and computer systems"* with the goal to produce usable, safe and functional systems (Preece et al., 1994, p.43). It has also been described as an interdisciplinary field *"concerned with the design, evaluation, and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them*" (Preece et al., 2002, p.8). The process of designing such artefacts can broadly be referred to as interaction design (Löwgren and Stolterman 2004).

2.1 Brief Background to Interaction Design

The field of interaction design is fairly young, dating from the early 1980s, and has sprung out of three main traditions: HCI, informatics and industrial design (Löwgren 2008). This means that people calling themselves interaction designers have shifting educational backgrounds. They have in recent years developed and shifted focus, moving in and out of one another's practice, with, for example, industrial designers specializing in interaction

design, HCI-researchers and practitioners moving towards the area of user experience and researchers and practitioners in informatics focusing on interaction design. HCI, informatics and industrial design have different founding traditions, which result in different views on problem formulation and different foci on rigour in the design process, the final result and ways of validating the result. On a higher level, it also brings a difference of opinion on knowledge construction, what knowledge might be and extensibility and transferability of this knowledge.

2.1.1 Background to HCI

HCI as a field has its roots in software engineering and cognitive science, each with strong scientific traditions (Bödker 2006, Harrison et al., 2007). Cognitive science researchers often work in a positivist tradition, looking for the truth. The software engineers constructed new technology but had to validate their results through user studies oftentimes in the same positivist tradition. Traditional HCI researchers and practitioners focused on usability, in which efficiency, ease of use, ease of learning and effectiveness were the cornerstones. Their work shared a common terminology, with shared methods. The rigour came from these shared techniques and methods and the results were measured through usability tests, all aiming at a high level of usability according to more or less well-defined standards. The services and prototypes developed and tested were, in the beginning, for the most part, work-related, as this was where computers were used at the time. There was an obvious practical value in evaluating these systems against usability metrics, as the work environment required those kinds of goals – efficiency in particular.

Later developments and the spread of digital technology, such as mobile computing, games and context aware systems, moves us from work-related HCI into use of interactive systems as part of our everyday lives. This move in turn brought a different view and focus into HCI, shifting away from seeing users as focusing solely on completing tasks through their computer tools. Instead, a more complex human being became the target, someone living in shifting situations and contexts, enjoying herself with and through technology, being creative, playing games and bringing her technology with her everywhere. This change called for new ways of studying and understanding human practice, bringing in new disciplines, such as ethnometh-

odology, ethnography, phenomenology and design, to better capture the richness of human experience.

To broaden the scope of HCI to include more than work-related issues, this turn to other disciplines was necessary, but that also meant bringing in different traditions with other backgrounds and ways of validating results, and thereby novel tensions in the field. The HCI is still grappling with these tensions between traditional, academic ways of evaluating the result in some form of user study and social sciences studies and design-oriented ways of bringing out knowledge (Bödker 2006, Antti Oulasvirttas[1]).

2.1.2 Background to Informatics

Informatics is the science of information and has, just as HCI does, a strong positivist tradition (Carroll 2003). The research focus is on studies of information processing, including social and biological mechanisms. With the shift towards digital systems, informatics started dealing with the structure and behaviour around information systems. It has treated questions concerning how to design systems that give the right information to the right person in the right place and at the right time. The field has studied work flow and brought out standards. This means that informatics is also closely related to design research, and those with an educational background in informatics may also count as interaction designers.

Their view on science, however, lies more strongly in the positivist tradition, focusing on bringing out hypotheses capturing generic knowledge that can be validated through end-user studies and evaluation sessions, across people, cultures and domains.

In informatics, there are of course other views on knowledge, and how to approach design. One strand within informatics is the Scandinavian Participatory Design (PD). Originally PD focused on work processes but had two important distinguishing features: a political focus on democracy and power to the workers over their work tools in their workplace, and, second, that participation of skilled users in the design process, which would render successful designs as an outcome. This approach grew from the dissatisfaction with how traditional theories and methods for system designs were applied when introducing new technology-based systems into industry. It also involves a theoretical critique of the scientific rationality that comes with this traditional view of system design. Instead, the PD-researchers felt an affinity

1 http://notesonresearch.tumblr.com/post/22650772011/hci-in-crisis-two-sciences

with phenomenology and a constructivist position on knowledge and work culture (Ehn, 1992).

One characteristic trait of the PD-movement was the tool perspective (Ehn and Kyng 1984), implying that the design process must involve both experienced users and design professionals. Their design process was characterized by a design-by-doing approach, creating, for example, mock-ups that would allow the skilled users to become actively involved in the design process.

By bringing in skilled users, the researchers hoped to get hold of the tacit knowledge they posses: what is it that the users know that they can express in action but not explicitly put into words and explanations? Equally as important as the participation of skilled users in the design process was the participation of designers to bring out the mock-ups and tool designs.

Today, many of the methods and ideas from the PD-movement have been picked up by industry, often called user-centred design. Those methods are often taught at Swedish industrial design schools, such as the one I attended, Umeå Institute of Design. The knowledge construction through such user-centred methods is semi-abstract and closer to the knowledge view in design research.

2.1.3 Background to Industrial Design

Industrial design has its roots in design practice and does not yet have its own established research tradition. Design research on the other hand is a fairly new research area with no specified or commonly-agreed-on research tradition. This situation has also evolved out of design practice and has to a great extent brought the design thinking and working methods from design practice with it.

Two influential traditions can be identified in industrial design, "*natural functionalism*" and "*styling*" or "*consumer appeal*" (Kuutti 2009). Natural functionalism or "*modernistic*" thinking has its roots in the Bauhaus School of Design in Germany (1919-1933). The Bauhaus ideas built on functionalism, in which form follows function. Their intention was to develop a new aesthetics for industrial products, working from the functionality, material and production process, the result of which was well-functioning products, economical to produce and with an added aesthetic value to their users.

The second influential tradition in industrial design is a bit vaguer than

the Bauhaus ideology, but it has its roots in the same time-period in the US, This tradition is commercial and its aim is to sell more by styling.

The Bauhaus ideas have been influential and are present in most design education today. For example, the Ulm School of Design (1953-1968), built on many of the ideas of the Bauhaus ideology, relying heavily on the functionalistic logic and tradition in which "form follows function". Ulm also brought in semiotics theory as a way of understanding the signs and meanings in design. Semiotics came from linguistics and dealt with meaning-making from symbolic systems. This view has later been developed and extended by Krippendorff (Krippendorff 2006). In his book *The Semantic Turn* he discusses how to design for meaning in artefacts but distant from semiotics and functionalism. These ideas developed by Krippendorff are very close to what is taught in Swedish industrial design schools today.

It is important to remember that design is not only to create the function of the product but also to consider the aesthetics. In Swedish design schools, there is a strong focus on practices to achieve aesthetic skills, which is refined through practical training, from laborations and design crits. The aesthetic skill is probably the most distinguishing trait of an industrial designer compared to that of designers from HCI or informatics. Although the identified traditions within industrial design differ in many areas, they have one thing in common, and that is the designer's approach to the problem at hand. This approach always builds on the designer's own previous experience of creating similar products or of the domain. This experience may come from being taught in design education, trained in professional practice or also studying other designer's designs and processes. This experience, or design knowledge, has many names. Schön refers to it as a design repertoire (Schön 1983), Nelson and Stolterman describe it as design judgments (Nelson and Stolterman 2003), and Cross (Cross 2007) frames it as being "designerly" in opposition to being scientific or artistic, that is, being concerned with the appropriateness of the form to the domain and situation. The validity of this design knowledge does not necessarily have to come from user studies or other empirical evaluations. It is instead justified by the skills and judgment of the individual designer – a good, experienced designer will draw on her skills and prior experiences of what works in a particular domain to bring out a novel, functional solution. Design practitioners will take inspiration, combine, and innovate from this basis – not only from

a dialogue with the prospective users. If this is how a practicing designer works, however, the question of what a design research practitioner needs to do to validate this knowledge remains.

2.2 Merging into Interaction Design

As the brief background to the three respective traditions explains, the main bulk of research done by HCI and informatics researchers has its roots in the positivist tradition, even if social science and other traditions have been making their way into this field as well. Design, on the other hand, has its roots in design practice and design thinking. Given the advent of digital technologies, these three groups of interaction design researchers have all moved towards the same design area often called interaction design. Preece (Preece et al. 2011) defines interaction design as:
"designing interactive products to support the way people communicate and interact in their everyday and working lives" (p.9)

Hence, this includes even more disciplines than I have described and makes interaction design today an even more broad and shifting field. One common trait within the field of interaction design is the desire to capture the richness of designing for user experience. Arvola (2014) describes interaction design as human and technology acting together towards a common goal. He resembles it with a dialog, which has a flow over time.

Design researchers have also turned to the HCI-field in search of rigour in their research contributions. When starting to work together on a common problem, the differences stemming from the knowledge views in the founding traditions have become more and more evident, sometimes leading to tensions and problems.

To make the differences in worldviews by a practical tradition meeting the more academic ones more distinct and clear to the reader, the points might here and there seem crude and simplified. In reality, there is, of course, HCI- and informatics research that is closer to design thinking and vice versa. By this work I also hope to create an understanding of the underlying differences that sometimes cause problems when researchers from these different disciplines try to collaborate.

2.2.1 Respective Worldview

As the three disciplines have different views on what constitutes knowledge,

their approach to a design problem, practical work, the design process and the final outcome are different.

In his book from 2007, Cross contrasts science with design by pointing to some of the traits that are particular to design. First, in terms of practical work (method), the science-focused tradition searches for (more or less) controlled experiments, classification and analysis, while design focuses on modelling, pattern-formation and synthesis. Second, the values in the two worldviews differ: where science is concerned with objectivity, rationality, neutrality and the truth, design talks about practicality, ingenuity, empathy and a concern for appropriateness. Third, the ultimate aim in the two traditions differs: the aim in science-based work is to find the generic, universal rules, while in design the aim is a desired solution to the problem at hand.

Nelson and Stolterman (2003) also touch on the contrast between a scientific and design view of knowledge. They discuss this difference in terms of what is true and what is real. When something is true, it has to be true in all situations, a tenet which implies that science deals with what is general and universal. Design on the other hand deals with what is real or ideal aiming at the particular. Design is a process moving from the particular, general and universal into the ultimate particular. Nelson and Stolterman (ibid) also claim that we can never achieve absolute perfection in design; rather we are trying to find that which is adequate, which is by no means the same as mediocre. Cross (2007) describes this: the aim is not to find the best, but a quickly satisfactory solution. Buxton (2007) puts it more directly: "*The role of design is to get the right design. The role of usability engineering is to get the design right*" (p.389).

Nelson and Stolterman (ibid) point out that scientific disciplines study that which already exists, not what should be brought into existence, while design is about creating something that does not yet exist. This might be one explanation of why the design process in HCI often is black boxed by tradition. Fällman (2003) points this out by saying: "*The design process tends to remain implicit as researchers are embarrassed by not being able to show evidence of the same kind of control, structure, predictability an, rigourness in doing design as they are able to show in other parts of their research*" (p.230). Since HCI has moved into the field of creating and studying user experience, which brings with it a complexity in terms of shifting situations and contexts, it can no longer focus on studying a finished proto-

type through a final user evaluation and not argue for or declare the design decisions made. In reality, HCI moves between the different worldviews of design and science. In the actual design process, HCI deals with what is real and what is ideal, using what is particular, general and universal, while in the final stage, with the final user evaluation, HCI seems to stick to the scientific view resulting in claims of what is true, generalizing beyond the specific. This complexity makes it very difficult to find the scientific rigour when it comes to describing the design process as has been based on design judgments rather than generalized rules. This fact also puts the final user evaluation into question – if the aim was to study the ultimate particular, then should the findings be formulated in terms that make them relevant to the real and ideal rather than the true?

The consequences of respective worldviews are also pointed out by Kuuti (2009), writing about HCI and design as being uncomfortable bedfellows, he concludes that no one can argue against the premise that usability is needed, but he also addresses the view of the designer, who is aesthetically trained. When HCI and design started to touch the same work area, the designers' experiences are expressed in the following way:

"Thus from the viewpoint of a designer HCI people were not designers but „"barbarians", uneducated technicians lacking any understanding of the aesthetics and complexity of the cultural filtration involved in a design. This suspicion was strengthened by the HCI people's obsession on methods instead of a personal judgement." (Kuuti 2009, p. 54)

Furthermore, he points out that the designer is trained with good design examples and the way the magazine and book industries build on this, while in HCI the designer lacks something similar, but instead often builds from bad examples (don'ts) (ibid).

When it comes to what is considered a problem worth addressing, and how to frame it, Cross suggests that research-based work is more problem-focused while design practice is more solution-focused. This difference stems from the educational backgrounds of the two groups. Designers are taught to co-evolve problem definition and solution. Problem framing in design often attempts to address problems that are ill-defined (Cross 2007), under-specified, or wicked (Frayling 1993).

2.2.2 Knowledge View and Extension of Knowledge

Using the terminology of Nelson and Stolterman (ibid) presented above, design deals with what is real and ideal and not what is true. That which is true concerns the universal or general, while the real is particular. In the case of design, we strive towards the ultimate particular, which is simply what it says, the ultimate particular to that design situation. Something that claims to be general needs to be reusable in more than one context. In situations with fixed contexts, this approach is much easier than the kinds of contexts a designer typically faces with its characteristic shifting borders.

In an ongoing discussion on transferability of design research result, the idea of extensibility is discussed (Zimmerman et al., 2007, Forlizzi et al., 2008, Vetting Wolf 2006, Höök and Löwgren 2012, Löwgren 2013, Gaver 2012, Bowers 2012). If the results of a design process cannot be generalized, as the solution is particular to that situation, it can be extended. This extension could be accomplished in different ways; designers may study and make use of already-existing artefacts from the design domain they are addressing (Cross 2007), the designer can herself provide the extension through extracting qualities from a series of design cases in the same area (Löwgren 2009), programs can be set up (Binder and Redström 2006, Mazé and Redström 2007), an ecology of designs can be made (Forlizzi 2009), design cases with common traits can be abstracted into strong concepts (Höök and Löwgren 2012) or an annotated portfolio can be constructed (Bowers and Gaver 2012).

Cross sees design knowledge as embodied in the products as well as in the design process (Cross 2007, Cross 1999). This knowledge is retrieved through simply looking at existing objects and thereby learning from the past. Knowledge resides in the designed objects themselves, sometimes referred to as "metaphoric appreciation" (Douglas and Isherwood 1979). This view captures the designers' ability "*to reading the world of goods, in translating back from concrete objects to abstract requirements, through their design codes*" (Cross 2007, p.27). This is what design practitioners do all the time. In fact, almost the first thing that is usually done in a design project is to create an overview of existing products in the same area; these are often put together in an image board, from which the design team can gain inspiration, view and discuss. This board becomes, as Cross (ibid) points out, a wealth of information that can be built from. These existing

products can also be used as references pointing out design directions the design team does not want follow. This approach is not so common within the more academic design research approaches, a fact which might have to do with the followers of the disciplines not being trained in design thinking aimed at finding solutions, while designers see this more as a springboard in the design process with ideas of where to head. Design crits are closely related to this practice. A crit is used in a group setting, where a design is examined from perspectives other than the one of the specific designer. It can be by other designers or experts within the domain of the design. This process extends the knowledge around an artefact within that group of people. (Löwgren 2007)

Krippendorff also refers to the knowledge that resides in products, but in a more extensive way. He refers to whole ecologies of artefacts (Krippendorff 2006). He divides those ecologies into diachronic and synchronic ones. The diachronic deals with the evolution of one artefact over time, focusing on its changing role and interaction with other artefacts, such as in the evolution of the phone. The synchronic account describes the network of concurrent connections between artefacts, in part determining their use. Designers need to take such relationships into consideration as otherwise their design will most likely fail as users will not be able to use it. A diachronic product ecology account also deals with reflection on the development of existing products in a similar manner that Cross proposes, although with a wider scope. Extensions of this knowledge can, for example, be in forms of transferring knowledge from one artefact species to another through metaphorical use. The most famous example is perhaps the horse head that was put on early car designs to make it blend in. After a while, such metaphors become obsolete; the metaphor goes through a metaphorical blend and comes to have its own meaning.

Another way of opening up for extension of design work is to extract experiential qualities. These qualities can be seen as a reflection on the practical work and the resulting artefact. These qualities can be extracted from one single design, but they might become even more accurate if they are used and refined in several designs in the same domain of designs. These qualities are not the same as general findings, such as guidelines, but are extracted from the particular design work and are often tied to a design domain. It is important to remember that there is no sense in even trying

to make a "recipe" for design within a certain area, first because the other design case will not be exactly the same and, second, if the same design problem is given to a different designer that person will probably end up with a different solution as it will be built from her design repertoire knowledge including aesthetic preferences and skills (Forlizzi et al., 2008). Just as the knowledge obtained from one product always has to be reformulated and changed for a new design to fit with the specifics, so too the qualities in one product must be reformulated and changed when used in another in a discursive manner. If we set up design requirements in terms of a set of design qualities that does not mean that by ticking them off, one by one, we are guaranteed to arrive at a better design. Qualities are something that the specific design holds and for experiential qualities in the use experience of the product. To achieve these qualities the design process might vary. It should be treated in the same way as Ehn (1992) writes about knowledge: "*To know does not mean explicitly knowing the rules you have learned, but rather recognising if something is done in a correct or incorrect way*" (p. 64).

Patterns are another way of extending knowledge (Christopher Alexander et al., 1977, Löwgren 2005). These patterns are extracted from several designs, taken to a semi-abstract description level, and can then be re-used in new design situations. The idea behind the patterns builds on Schön's (1983) design repertoire focusing on a specific design domain.

One example of this knowledge extension is inspirational patterns or i-patterns (Löwgren 2005). From a series of design cases in a specific domain, i-patterns are extracted and are formulated in a somewhat abstracted and purified way. The aim of the patterns is to provide generative knowledge to other designers so that it can be assimilated into their design repertoire and be used in new design situations.

Following what Redström has called a programmatic design approach (Binder and Redström 2006), design research benefits from setting up a program with a set of values, a set of aims and an exploration of a possible design space starting from the aesthetic properties of the "material" being explored – be it electricity, emotion or sustainability. By framing specific design explorations within such a program, they can together map out a range of insights and bring out innovations.

In creating strong concepts (Höök and Löwgren 2012) propose an intermediate design knowledge form. A strong concept is generative and carries a

core design idea not tied to particular use situations or application domains. A strong concept captures interactive behaviour and is a design element and a part of an artefact. But at the same time it holds use practice and behaviour over time. It aims for discursive knowledge construction of abstracted knowledge.

As much as knowledge resides in the designed artefacts themselves, the academic world is struggling to find ways to articulate, share and archive this embodied knowledge. This issue becomes extra problematic with digital materials, where the product does not come to life until it is used and its "dynamic gestalt" is revealed. In a recent initiative move by Löwgren, archival video publications have been made possible (http://cie.acm.org/video-journal/). This does not only rely on the traditional written form of communicating research results. The video format is in many ways even more suitable when it comes to interaction design research for capturing the knowledge that resides in the product, since it relies on the visual presentation, which is a bit closer to the actual design than the written. It can also capture temporal aspects in a way that is not possible in the written format.

Bowers and Gaver (Bowers 2012, Gaver and Bowers 2012, Gaver 2012) recently proposed annotated portfolios as a way of knowledge extension in which design cases are proposed to be annotated with their core design decisions in a portfolio-like format. These portfolios can have different forms depending on their audience. It could, for example, be an exhibition of the artefacts together with explanatory information for the general public or with more reflective text going into details for an academic audience.

These extensions are examples of knowledge production grounded in how design is created, starting from the design practice itself and extracting common traits that can be used in design research practice. This extraction has always been carried out in design practice through the study of previous designs, but when extracted, articulated and reflected upon, and a bit generalized into, e.g., qualities of relevance to certain domains, it becomes extendable. From there we can then build a body of design knowledge that fulfills the criteria of a research discipline outlined at the very beginning of this section: new, relevant, grounded and criticizable. It will still be different to science-based traditions such as HCI or informatics in that design knowledge of this form is not general, true, or applicable in a one-to-one manner when creating a new product. Bringing out a new product will always be a

delicate and well-balanced process of picking up on some of these extensions, getting inspiration, changing, and reformulating against the specifics of the domain. It will always require skill and training in design judgments. This process follows the significant traits of design work described, in which the designer herself has much influence in how these extensions are treated.

2.2.3 Design Process Layout – Exploration of a Design Space

Interaction design researchers with Informatics, HCI and design backgrounds all use iterative design processes in some sense and often use the same methods, but when we examine the particulars of these processes up closer, there are many differences. The focus here will be the differences between design and HCI, as this is where my own work can be placed.
In HCI practice, the work is mainly structured in a single-tracked iterative process, putting a prototype through different user encounters and thereby changing and refining the design – in many ways following the waterfall model. Buxton has described this as a spiral shape that becomes narrower the closer it gets to the final result (Buxton 2007). He describes this prototyping as: "*like a spiral closing in on along a single trajectory. Each prototype is a refinement of the previous one, and takes you one step closer to the final prototype*" (p.388). The final prototype is often just one way of describing what has been going on, but sometimes it seems as though it is seen as the one possible solution to a fixed problem. An exploration of different ideas to find the most suitable in order to bring out and visualize a space of possibilities is often lacking or at least not argued for (see Figure 2.1).

A design-driven process has a more exploratory character, in which a bigger design space is mapped out and explored, and many tracks are worked on simultaneously (Westerlund 2009). The aim is not to refine a single concept that is honed from a set of design requirements as the one-and-only possibility but to explore the design space and pick bits and pieces from different sources ending up with the ultimate particular. Buxton (Buxton 2007) illustrates this as a branching exploration and comparison, showing that in design there is more than just one path and also many alternative solutions to each question. The final result is often a mixture of pieces from different branches, and the development of this is often not linear in time (see Figure 2.1).

Others have also described design processes as non-linear, although of

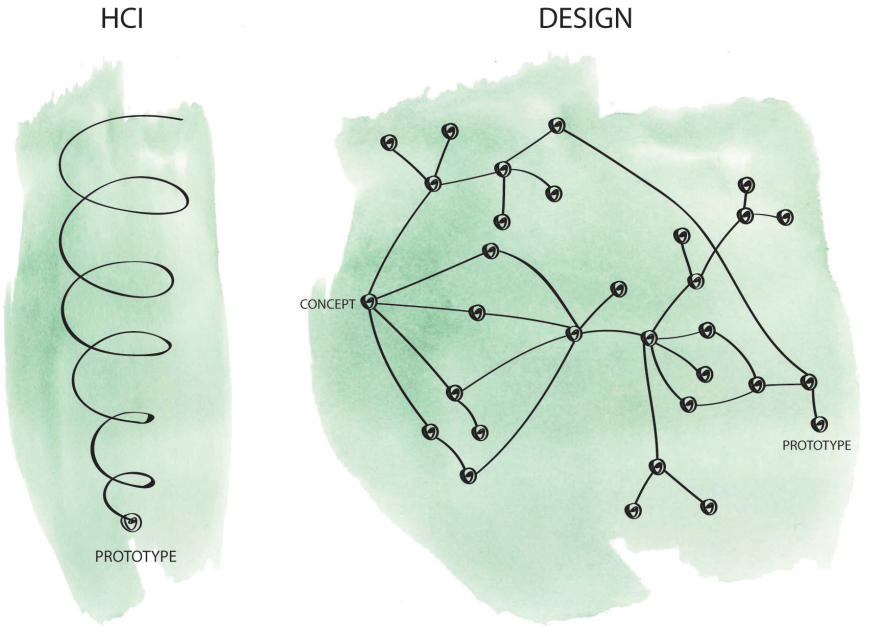


Figure 2.1: Design process layouts, simplified. The left illustrates a single-tracked iterative process used in HCI (Buxton 2007), the right the more exploratory character used in design practice research.

course happening over time (Vetting Wolf et al., 2006, Cross 2207). Cross (2007) states “design is exploratory”. This way of working in design practice is also used in design research, but when meeting the requirements on rigour in HCI, it might seem as if the choices made in a design research practice process are arbitrary and lack grounding. This view is often a misconception: to work designerly requires a highly-disciplined and rigorous process (Vetting Wolf et al., 2006). As I aim to show next, however, with a better process for documenting and articulating the design process, and in some cases, more structured methods, the design process may well be used to validate a design.

2.2.4 Grounding – Multi-grounding

Programmatic framing implies a view on foundations to work from as discursive and, thereby, when reaching a certain level of maturity within the program, it needs to be reformulated and can drift in its foundation and

thereby have a different aim. This shows multi-grounding in its foundations. As mentioned above, in a design-driven process, the design decisions are multi-grounded in a way that may seem arbitrary and lacking rigour. In a design process, decisions can be made based on many different groundings: from theory, inspirational material, analytic discussion and/or empirical work such as sketching. In HCI, the empirical user testing is the dominant explanation of where practical design decisions came from. Background theory and analysis are often used as some kind of value base on which the design stands. Often, methods are used without entering any personal values or skills. The design is portrayed as coming from an objective consideration of the facts, rules and knowledge in HCI (see Figure 2.2).

In design research practice, judgments and appraisals have the same value as other input and do not have to be empirically tested in end-user studies to be validated.

The design decisions can be grounded in experience. The process is a reflective process, going back and forth between creation and evaluation in cycles. This is referred to in the literature as design judgments (Nelson and Stolterman 2003), reflection in action (Schön 1983) or a search for appropriateness (Cross 2007). Here we will use the term design judgments.

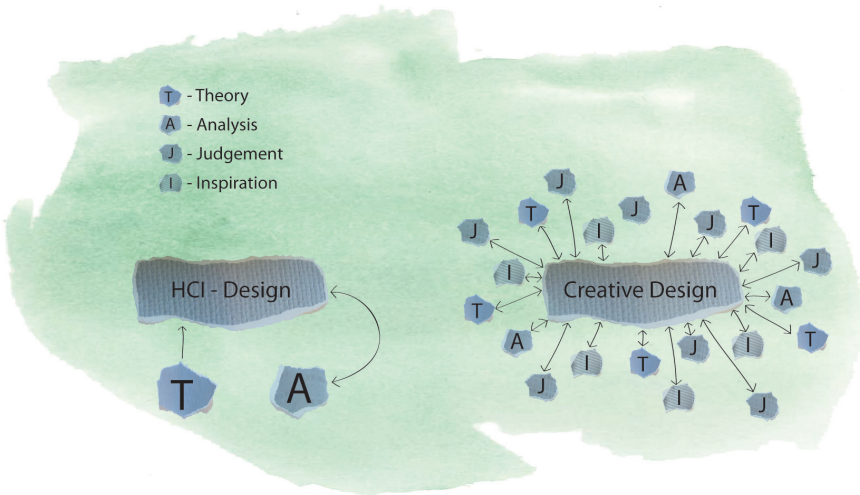


Figure 2.2: Illustration of the grounding within HCI and design research practice, in which HCI is often grounded in theory and deign research practice uses a multigroundedness.

The ability to make solid design judgments is what distinguishes a skilled designer from a novice. Nelson and Stolterman define judgments as the means, and wisdom as the outcome. Wisdom is good judgment. Judgment is not something that can be learnt as a method to follow; *"judgment is knowing based on knowledge inseparable from the knower"* (Nelson Stolterman 2003, p.185). In addition, as discussed above, this knowledge is connected to the particular and the ultimate particular and cannot be generalized. This interpretation does not mean that judgments cannot be important to describe to other designers. The judgments cannot be separated from the designer, but they can still be reflected upon and made accessible to others. Learning how to apply such knowledge, however, is the same as learning a skill – not learning an abstracted rule. Another characteristic of judgment is that judgments are dynamic and adaptive to the situation at hand; changed conditions will change the judgments.

Nelson and Stolterman (ibid) also emphasize the importance of good adequate judgments and not true judgments, following their argument for the ultimate particular. Rather than using Schön's term design repertoire, Nelson and Stolterman refer to this as a design palette, which is a more suitable metaphor, since the designer can mix the bits and pieces needed in a palette-like manner to find the adequate judgment. In design work these judgments are on the same level as empiricism and theory. In design this counts as grounded knowledge as well and shows that there are more ways to advance arguments for a statement than the empirical work.

Nelson and Stolterman (ibid) visualize this multi-grounding in an illustrative way, showing that the true, the real and the ideal form design (see Figure 2.3). The true coming from research theories, the real can come from studies of users and ideal is something we aim for, an ideal goal.

Through these examples of grounding, I want to show that design research is multi-grounded and that this differs from grounding many of the decisions in empiricism or theory, but it is still not arbitrary. Nonetheless, how can research built from personal judgments become a research contribution of knowledge?

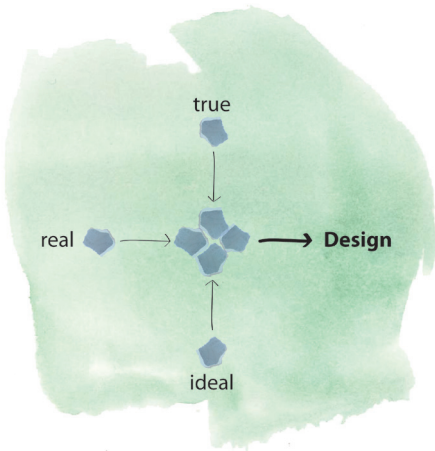


Figure 2.3: Illustration of how the true, the real and the ideal form design from Nelson and Stolterman (Nelson & Stolterman 2003).

2.2.5 Rigour built from Judgments

Löwgren (Löwgren 2007) summarized what a contribution has to contain to become research knowledge: it has to be new, relevant, well-grounded and criticizable. The questions that become evident from reading the characteristics in worldview, knowledge construction, design process and grounding in these traditions is, how can this design practice become design research? How can the outcome show rigour and be a valid knowledge contribution in a design research community, since many of the differences point towards knowledge residing in the designer herself? This implies that there have to be other, new ways of knowledge construction than those traditionally relied upon in adjacent fields with stronger academic traditions. Several researchers have lately touched upon the topic (Cross 2007, Zimmerman et al., 2007, Forlizzi 2008, Vetting Wolf et al., 2006, Löwgren 2013, Krippendorff 2006, Höök & Löwgren 2013, Fällman 2008, Stolterman 2008, Fällman and Stolterman 2011, Gaver 2012 and Bowers 2012).

For something to become design research, it has to be reflected in an abstracted way, a step away from the artefact or the designer herself. Cross (2007) states that the whole point of research is to extract reliable knowledge and to make this reusable to others. The difference between design practice and design research practice partly resides in a reflection on the design. Through not only showing the final design but also articulating the design process, the knowledge conveyed can be examined and understood.

This must then be communicated in a form that invites design research practitioners to reuse it – it must be relevant to them (Stolterman 2008), and it must be articulated in a form that allows other design researcher practitioners to scrutinize it as well.

In his book, The Semantic Turn, Krippendorff (2006) emphasizes the importance of a science for design in contrast to a science of design. A science of design uses the natural science for theory construction and aims at generalizations, while a science for design introduces desirable changes in the world generating practical knowledge. Krippendorff concludes that, for a science for design, it is important "*to provide ways for designers to substantiate the claims made for their design*" (p.212).

To validate these, he discusses more explicit claims for the design in the form of multiple descriptions of artefacts, semantic claims. These semantic claims explain what "*proposed artefacts are likely to mean and do in particular communities*" (p.262). He proposes five ways of validating these semantic claims: demonstrative validity, experimental validity, interpretative validity, methodological validity and pragmatic validity. Demonstrative validity entails showing an artefact in a concrete form, for example, a prototype to stakeholders. Experimental validity means that users or stakeholders actually get to test the prototype. Interpretative validity means justifying the design by theory, such as findings about perception, cognition, ergonomics etc. Theory is reframed and reinterpreted for use in the specific design, since the whole is different from the sum of its parts. Methodological validity can be proved by the number of version of approaches tried before coming to the proposed design, number of feasible paths a design can take in the future and the numbers and kinds of stakeholders involved in the development of a design. Pragmatic validity deals with the fact that stakeholders must be willing to support, use and realize the product. Krippendorff also emphasizes the need for documentation to prevent reinventions and repetitions of mistakes, to extract recommendations and to identify important exemplars.

In a paper from 2006 Vetting Wolf et al. (2006) addresses the question, how designers can communicate their intellectual rigour to the HCI community. They illustrate their point by presenting a system built on design judgments and interpretation. They outline four professional qualities that that is inherent in design rigour. It is a nonlinear process, design judgments, making of artefacts and the design crit. If a design process has all these qual-

ities, they argue that it is a proof of design rigour.

Folizzi et al. (Forlizzi et al., 2008) have set up four criteria for evaluating a high-quality research contribution within design. These are: process, invention, relevance and extensibility. The design process must be documented with enough detail so that a particular design process can be replicated and a rationale for selected method should be provided. That a process can be replicated is not the same as the intention for it to be replicated; it is to create an understanding for selection of methods and the rigour in the use of these methods. Invention deals with communicating technical opportunities to computer scientists and the HCI-community and should be supported by an extensive literature review. In their argument, relevance replaces validity. Relevance is articulated through describing why the outcome of the work is a preferred state, described in a form that helps the HCI-community to understand. The aim behind this articulation must be to inform the research community and not just discuss a personal exploration. Extensibility, as has been discussed above, deals with making sure that others can use and build on the outcome of the research. This extensibility can take many forms, such as reusing design process or leveraging knowledge from an artefact. This aspect, in turn, requires a thorough description and documentation of the research so that knowledge can be derived from it.

The different criteria above, all aim more-or-less at what Löwgren summarizes as research knowledge in a community. The knowledge contribution or extensibility is often articulated in some semi-abstracted way. Characteristic of these criteria are that they are domain specific and will typically have come out of a generative, evolutionary process. Extensibility can, for example, be in the form of strong concepts (Höök and Löwgren 2012), experiential qualities (Löwgren 2007, 2009), ecologies (Forlizzi 2009) or annotated portfolios (Gaver 2012). The difference from design examples is that these are somewhat abstracted and purified – they capture the core ideas. A design crit also extends knowledge when a proposed design is questioned and explained in a group setting. That a result is criticisable or as Forlizzi et al. (2008) choose to call it, process. This can be achieved in the manner that is suggested above – either in textual form that describes the design, in a video submission or as a design crit. A design process that is reflected on and described in this much detail also answers the question of how well-grounded a design is. The newness can, as suggested above, be proved by an extensive

literature review (Forlizzi et al.), and this review should not limit itself to academic publications, since design research also contains parts of design practice, while consumer product and concepts should also be reviewed (Krippendorf 2006).

Relevance can be both academic in that the research contributions are of relevance to other researchers; this criterion can be communicated through an articulation of design process, qualities etc. It can also be relevant in the way that Krippendorff (Krippendorff 2006) discusses pragmatic validity, in which stakeholders must be willing to support, use and realize the result.

From describing a design process in all this detail – process, invention, relevance and extensibility – Forlizzi and her colleagues claim that it will be accessible and inspirational to other designers.

Looking at Fällman's (Fällman 2008) triangular model of design, in which different kinds of interaction design research are mapped out – design practice, design studies and explorative design – Fällman and Stolterman (2011) conclude that each research activity has its own purpose and intended outcome. Following this, they also have different intention and outcome, and this consideration has an impact on how the rigour and relevance should be measured. Their proposal is to state in which of these three divisions the contribution belongs, but they also address the problem that a designer dynamically moves between these forms of research. The result would then be that different contributions would have to be mapped to their own form of research, even though they come from the same design process. Another view of knowledge contribution without classifying the type of research, which sometimes can be hard, could be to view this from the point of abstraction levels of the knowledge contribution. Here design research result close to practice cannot and should not be judged in the same way as something that is more abstracted from practice and thereby more general, although both may be equally valuable to a design research practitioner depending on the aim of her research. Since a lot of knowledge in design lies in the product or artefact (Cross 1999) and its design process, non-abstracted results that describe the process are equally as important as the abstracted ones (Löwgren 2013).

Seeing the rigour in research contribution in this light allows for having criteria for both rigour and relevance, in the form that Zimmerman and Forlizzi discuss, and very practice-based close to the design evidence, such

as Bowers and Gaver propose in their annotated portfolios, (Gaver 2012, Bowers 2012, Gaver and Bowers 2012 and Löwgren 2013). Deciding on what is a proper way to aims in terms of validation of a specific design could be to map them out in abstraction level (Löwgren 2013).

The background to interaction design as described in the beginning of this chapter is very diverse, and as design research has been described to be multi-grounded, I think the right way to proceed would be to embrace this multi-groundedness both in background and in the rigour of the outcome.

2.3 Judgmental Rigour within Interactional Empowerment for Affective Experiences

In this section I will discuss how my work responds to the academic criteria for contributions to the research considered above.

First, I want to discuss the articulation of my results: the form they are presented in. When conducting research in the area of design practice, as mentioned above, there should be other ways of articulating one's results for validation than the traditional academic publication, describing the designs in words and a few pictures. Given my educational background, it would, in some cases, be more suitable with, for example, an exhibition of a product/system combined with the more analytical, written documentation. Taken together, those means would allow for reflection and abstraction as discussed above. The main reasons I chose not to do this was because the research was conducted in an HCI-environment with a strong, academic culture. For several years, I was the only industrial designer in the research lab; this fact made it hard for me to understand how to break the "rules". When I started this work in 2003, the design community was also immature, almost non-existent in Sweden, and there were only a few role models to gain inspiration from, but I hope in the future that there will be alternative forms of presenting a PhD that better capture the unique characteristics of design research practice. Since that time, our group has worked more towards creating video (ACM CiE) and started to explore alternative ways of articulating design research.

Second, concerning the criteria for design research, let me briefly touch upon how my work fulfils the requirements of novelty, relevance, groundedness and exposure to being criticizable.

Concerning the novelty of my work, extensive literature reviews have

been conducted initially in each of the three projects, in line with what Forlizzi et al. (2008, Löwgren 2007 and Krippendorf 2006) suggest. Parts of these reviews are documented in the published articles and also in my licentiate thesis (Ståhl 2006). Also turn to chapter 5, in which the experiential quality, evocative balance, has been placed in relation to work by others.

As I see it, the relevance of the work here is how it can be extended upon, and how other design research practitioners can pick up on the knowledge I brought forth, use it and become inspired by it in their work. In my work, there are two major forms of design knowledge of relevance. The first is through picking up on and extending the experiential quality, evocative balance, outlined in paper G, and through the other, more embryonic experiential qualities, which are described in more detail in Chapter 5: other designers can improve their design processes towards systems that fall in the same domain as mine. The second form is through the lengthy and rich descriptions of design processes that I provide (in papers A, D and F), aimed to be a source of inspiration for other designers working with a design problem in the same domain. A possible third contribution that these detailed descriptions offer is to act as practical examples of how to fill the gap between criteria for validation and the actual design.

In my research I have placed great emphasis on making the design process as transparent as possible and also augmented and reflected on the choices made concerning methods, theory input and analysis in the process. I have tried to describe the dead ends in the process, because much knowledge resides in the things that were rejected. I have described the processes leading up to the three research prototypes in the articles; this description is done much in line with what Forlizzi et al. (2008) refer to as process. These accounts also show the multigrounding as Löwgren discusses (2007). These descriptions of the design and its level of details also make them open for critique.

theoretical background

3 Theoretical Background

The aim of this section is to go through some of the theoretical underpinnings for our design program Interactional Empowerment. Our design stance comes from some of the theories of emotion processes as well as a set of values regarding what the being human is about.

Emotion theory is very complex and draws upon research in many areas, all the way from neurology to sociology and the arts. I will only provide a brief background to some of the theories and focus on those that dealt with emotion experiences, as we wanted to design for a strong and interesting involvement with the interaction. Our design philosophy was particularly informed by those theories that describe emotion as actively constructed in interactions with others, our environments and ourselves.

In short, we came to see emotion processes as inseparable both from our everyday encounters with the world and from our bodily experiences. These processes cannot be isolated to exist only in our brains, but instead reside in our whole bodies (Sheetes-Johnstone 1999). We also noted that emotional expressions and experiences are intertwined, co-evolving with and dependent on who we are, our history, culture and context.

In the past, emotion has been seen as getting in the way of rational decision-making in, for example, stressful situations. In our western society, emotion has belonged to the less valued pair of male-female, rational-irrational, mind-body (Grosz 1994). This difference can be contrasted with some of the eastern philosophies, in which body and mind are considered to be one. The existing western view of emotions is starting to be re-evaluated, but we still have a long way to go (Höök 2012).

The aim of this section is to review some of the emotion theories briefly, focusing in particular on the search for modalities that we could use in our designs. We wanted to move a bit closer to designing for emotion in ways that care about their full complexity – including body, mind, sociality, expressivity and culture.

As we were aiming to design for everyday use of technology for communication purposes and for dialogues with oneself, it was important to find theories that supported and allowed for emotional experiences and expressivity that could be integrated with our everyday lives, in other words, with our communication needs that allowed for rich, varied, complex emotional experiences and did not separate mind from body, but intimately coupled

the two. The intention behind my work is to provide users with digital material based on some of their partly bodily data expressed (through pressure, biosensors and/or context) in a way that does not categorise their emotions in narrow ways, reducing emotion experiences to a few, well-defined, limiting emotion expressions. Nor did I want to create a system that would attempt to draw conclusions on behalf of the user of what they were subjectively experiencing or trying to communicate. The design challenge that intrigued me was how to allow for rather than reduce the enormous complexity and range of possible experiences.

While we have a strong design program through the Interactional Empowerment program, it is not a model that can be used to simply generate designs. It needs to be interpreted vis-à-vis the design situation at hand, exploring, testing and slowly bringing out the solutions that will work. To take theories underpinning our design stance into practical design requires an understanding of how to design for emotional experiences and expressions using whatever modalities fit the use context. It was important to us that our designs would mirror how ordinary people understand, talk about and experience emotions, in a sense addressing "folk theories" of emotion (Astington et al 1988). By looking for theories addressing how we experience emotional processes in a bodily sense and then looking for combinations of colour, form, animation and mirroring body postures, we hoped to find expressions that would resonate with our bodily ways of being in the world.

The important value that runs like a thread through all the work presented in this thesis is the idea of users' empowerment in and through interaction (Höök et al., 2008 Boehner et al., 2007, Boehner 2006). This notion requires dealing with how to empower users in their interaction with digital systems and, in particular, how to practically portray the feedback from the digital system of an Affective Loop experience for users to get into this loop with themselves or others.

Let us now, however, turn to the emotion models that addressed the kinds of experiences we were interested in before explaining the idea of affective interaction and interactional empowerment in some more detail.

3.1 Emotion Theories

Emotions used to be regarded as unimportant and even disturbing when it came to rationality, decision-making and problem solving. Emotions

have been viewed as something that are uncontrollable and do not contribute to cognitive aspects of rational thinking. Research has altered this belief. Emotions are now seen as closely connected and intermingled with rational thinking and rational decision-making (Damasio 1994). Emotions are closely linked to both our rational reasoning processes and our physical, bodily, reactions. The old separation of mind and body, going back to the works of Descartes (ibid), turns out to be unfortunate to our understanding of how human decision-making, reasoning and behaviour are initiated, controlled and enacted. Body and mind are intimately connected. Emotional experiences can originate not only from external stimuli, but also from one's imagination and sometimes even from bodily processes. For example, by smiling, dancing and jumping around, we can (to some extent) alter our emotional experience from sadness to happiness, which in turn may influence hormonal processes and affect our brain processes.

In the literature, we can crudely divide emotion theories into those with a biological approach, in which emotion is viewed as biologically determined and inherited, with those of a constructivist view, in which emotions are seen as socially and culturally grounded, dependent on learning, prior experiences and culture.

Our view when designing for emotional experiences in our prototypes is closer to the constructivist position while not discarding the biological influences on emotion. Our actual corporeal bodies are constituted in certain ways, even if they are "completed" by training, culture and context (Grosz 1994).

The way we use emotion theory in our work is mainly as a value standpoint to enable Interactional Empowerment interactions. We want this take on emotion to be visible, embodied and experienced in the prototypes we design. We do not aim at measuring emotions and visualising them in a one-to-one manner as if there was only a limited set each pinpointing a singular possible state. The aim of our work is instead to enhance and empower users to reflect on their lives through some indications of what is going on with and in their bodies, which of course include emotional experience in relation to the situation and context around them. Another aim is to provide the area of design with a complementary view on how emotions can be designed for and also some practical examples of how to get there, partly inspired by emotional theory.

3.1.1 Emotion Models

Emotion theory has had an explosive growth during the end of the last century (Scherer 2002). Emotion theory includes various areas such as neuroscience, psychophysiology, cognitive psychology and genetics. This is a large area and describing all parts of emotion theory is not of interest here. Here the focus is on using emotion theory as background in the design process, to provide users with representations reflecting their experience of being in the world. In the practical work, I was looking for a model that could capture the view of emotions as processes, with an onset, increase, and decrease, and as highly personal experiences.

The use of emotion theory in computer systems consists mainly of inspiration from different emotion models to be able to model and interpret data. Scherer (Scherer 2002) has structured and summarized the most common emotional models according to their components and phases in the emotion process. Answers to questions such as how many emotions there are and what they are have varying answers depending on the theoretical stance taken.

When reviewing the literature on emotional models, we were looking for a model that could capture the way people experience emotions and how this could be translated into different representation modalities. Psychologist Russell's Circumplex Model of Affect (Russell 1980) builds on a study of how people (in the western world) typically talk about emotions. His model distributes emotion words in a circular space made up of two different dimensions: arousal and valence (positive to negative) (see Figure 3.1). In his study, people he interviewed would typically place emotion words in the same parts of the circle. This means that the model mirrors our everyday, subjective, folk theories of emotions. We were especially intrigued by how these emotion words were mapped on a circular space as we could see how that could be translated into a design. As the sphere captures two experiential dimensions, valence and arousal level, it also captured, in some ways, how these emotions are experienced.

Russell's circumplex model of affect belongs to the category Dimensional Models in Scherer's classification (Scherer 2002). In dimensional models, emotions are described along two or several dimensions that reveal different qualities of emotions. For example, the dimensions can be their valence (positive versus negative) and their activation or arousal level. In a sense,

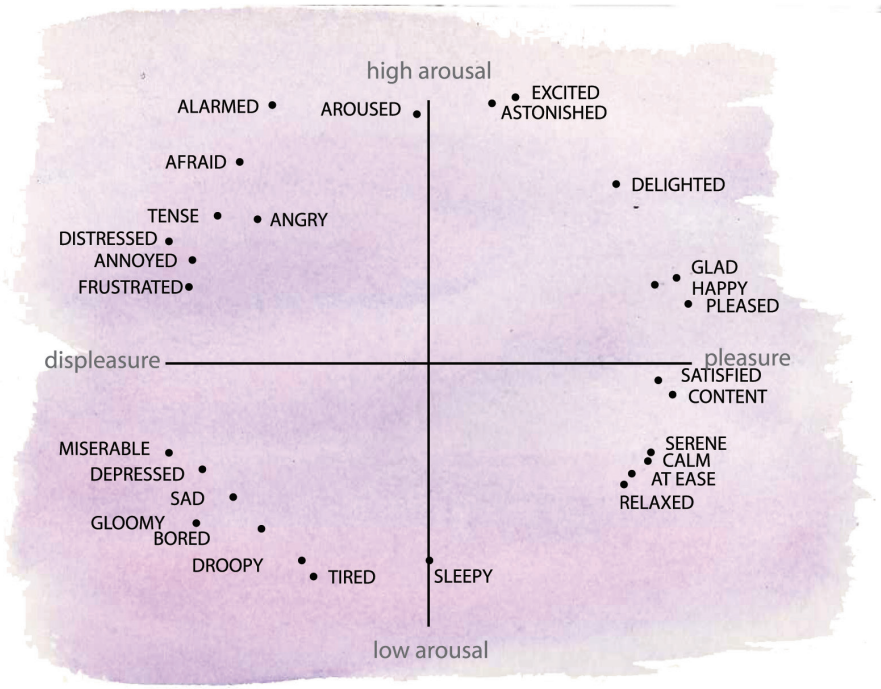


Figure 3.1: Circumplex Model of Affect (Russell 1980).

dimensional models attempt to describe the experience of emotions. These models aim to capture what is in common in emotional experiences as expressed by people when they talk about them. Admittedly, this means that the model is not grounded in some biological facts about how emotions are spurred by stimuli, processed and created in our brains, hormone systems or acted out in facial expressions, body movements, or acts towards the world or other people. Nor do they explain the function of emotion: why we have them or what behaviors they support. They simply describe how people typically will group emotion experiences and reveal some aspects of how they are experienced.

Apart from Russell's model, we were also inspired by cultural studies' accounts of emotions and their role in our interpersonal relations, societies, and culture. For example, Katz (Katz 1999) describes emotions as embodied processes, imbued with our personal experience, our political views, the

situation at hand, and as a means to perform social acts. For example, when describing anger, he turned to driving in Los Angeles and the kinds of anger experiences that may show up there. From his studies, he convincingly argues that we become angry when our car (our embodiment) gets cut off, not only because it might be dangerous, but also because we might have ideas about other drivers, who they are, their intentions, their political views, their race and so on. Anger becomes a social act that helps us to regain balance when we have been thrown off course. In his book, in similar ways, he describes, e.g., happiness and laughter at the fair ground as a social production aiming at connectedness, or kids crying in kindergarten as means of getting attention and bonding. In this view, emotion is not simply a stimulus-response activity, even if that may also be the case sometimes, but instead an active, constructed process in which we are not simply experiencing emotions passively but instead actively producing them, as social and mental acts. This means that if we are going to design for communication between people, we cannot simply recognize emotion from, e.g., facial expression but instead allow users to actively construct the expressions they want to convey. In any social interaction, we always walk carefully on the borderline between honesty and transparency to our thoughts and emotional experiences, and social, constructed acts aimed at being attentive to the other or even actively "lying" to save face (Aoki and Woodruff 2005).

In fact, in our first major "in the wild" study, done on the eMoto-system (see paper A), we saw this process in action. Our five friends who used the eMoto system appropriated it for their own purposes but more importantly, their emotional communication was purposeful, a means to create certain experiences in one another. They would set up expectations for the next joint party, or they would provide sympathy for one another's issues, all part of the social fabric of being friends. This is not to say that they did not experience those emotional processes; oftentimes they did, but what it means is that we are actively taking part in our emotion experiences; they are not just given stimulus-response reactions.

In the area of Affective Computing (Picard 1997), the importance of emotions to our everyday experiences and interactions is advanced as an argument to design computer artefacts in such a way that they take our emotional states into account. In Affective Computing, the aim is, in short, to capture users' emotional states through the use of bio-sensors, readings

of facial data or body movements and from that build computational models that interpret the input data and represent it back to the user in order to create better interaction.

One example of a proposed Affective Computing application is to measure students' emotions through sensor readings during a lecture to give the teacher feedback on how the students are following the lecture (Picard 1997). The questions that follow this are how should these measurements be interpreted? And what actions should be taken? And is it really the best way to mediate what is happening in the classroom? Given a socially-situated, cultural perspective such as that of Katz above, we might instead see the classroom as an arena where emotion, attention and experience are a co-construction between the teacher and the students. It is not an emotion to be detected and dealt with but on an on-going improvisation, actively created, and if there is a skilled teacher, it will be an artful performance aimed at creating a good climate for learning (Cooper et al., 2000).

While Affective Computing inspired us, we turned to other strands in the area to find a complementary view that would lie closer to our design goals.

3.2 Affective Interaction

In considering the design of Affective Computing applications, Boehner and her colleagues (Boehner et al., 2005) have drawn on what might be called a socially situated perspective of emotion. They suggest that affective computing systems have typically tried to identify users' emotions as information. Seeing emotional experience as information means seeing it as consisting of well-defined, discrete units that can be transferred from human to the computer repeatedly, without changing the content of the emotions. In an effort to counter this trend, they provide an alternative perspective for systems that engage users in embodied emotional processes. They call their approach the interactional view. Let us first explain the concept embodiment, taken from phenomenological theories.

3.2.1 Embodiment

In our designs, measurements of the body (through accelerometers and bio-sensors) play an important role, requiring us to take a stance on how we understand the body. When Merleau-Ponty writes about the body, he begins by stating that the body is not an object (Merleau-Ponty 1962). It is instead the condition and context through which I am in the world. Our bodily

experiences are integral to how we come to interpret and thus make sense of the world. This premise draws heavily on the notion of embodiment (see also Dourish 2001). Playing a central role in phenomenology, embodiment offers a way of explaining how we create meaning from our interactions with the everyday world we inhabit. Our experience of the world depends on our human bodies, not only in a strict physical, biological way, through our experiential body, but also through our cultural bodies. This concept of embodiment can be similarly applied to emotion. From such a perspective, it becomes apparent that the experience of emotion depends both on our experiential (physical) and cultural bodies. Thus, emotions are partly experienced through the constitution of our experiential body. The way we make ¬sense of emotions is a combination of the experiential processes in our bodies and how emotions arise and are expressed in specific situations in the world, in interaction with others, coloured by cultural practices that we have learnt.

3.2.2 Affective Interaction – The Interactional View

To achieve an interactional approach, Boehner and colleagues provide a set of requirements for systems that engage users in embodied emotional processes with an emphasis mainly on the cultural body (Boehner et al., 2007). These requirements are called, the interactional view. This perspective does not endeavour to detect the "right" or "true" emotion of the user but rather make emotional experiences available for reflection. Their ontological view on emotion is that it is "*culturally grounded, dynamically experienced, and to some degree constructed in action and interaction*". With an interactional approach, affect is created in co-construction and active interpretation of one's emotions. From this perspective, affective communication becomes an ambiguous, complex and ill-defined process. The target here is to make the design open up for interpretation, experience and for the production of emotions. The emotions build and extend on already-existing socially communicative relationships between people. Boehner et al. (2005, 2007) lists these six design requirements from their experience of designing for affect as interaction. The principles discussed are the following:

The interactional approach recognizes affect as a social and cultural product

This builds on emotions being something that relates to the context and

social situation we are in, that we need to have grounds in the real world for meaning making with the system.

The interactional approach relies on and supports interpretive flexibility
To leave the definition of emotions and its interpretation for the user to decide upon, emotional meaning emerge between users in situated way.

The interactional approach avoids trying to formalize the unformalizable
Here, in the interactional approach the emotions should not be formalized by the system; instead the users should supply the emotional meaning in the system.

The interactional approach supports an expanded range of communication acts
Emotion can, in this way, be communicated in a richer way than clearly defined signs allow. Instead of labelling the emotional expressions, the users can mirror their emotions in the affective expression and find something that suits them. This should, according to Boehner et al., be achieved through the designer not putting in meaning within the system, for example, that a fast-moving dot should be interpreted as high energy.

The interactional approach focuses on people using systems to experience and understand emotions
In the design, open up for the complex, ambiguous nature of emotions by designing for the experience of emotions; through use it can make people more aware of their emotions. Hence the systems do not have to read or label users' emotions.

The interactional approach focuses on designing systems that stimulate reflection and awareness of affect.
The aim is not to make systems more aware of users' emotions but to make people more aware of emotions through system use and design.

The view of affect as interaction allows for Interactional Empowerment, in which the user can be in charge of what emotions are expressed or interpreted and also open up for emotional expressions that users can create through their own interpretations and reflect on. This view opens up for interaction as a process in which we actively contribute to and construct the

emotional experience. (Quoted from Boehner et al., 2007, pp.65-66)

In our take on this and in an attempt to address the bodily parts of this experience more explicitly, we envision a user-centred affective loop. (Sundström et al., 2005).

Hence, in designing for affective interaction, Boehner et al. contend the focus should be moved "f*rom helping computers to better understand human emotion to helping people to understand and experience their own emotions*" (Boehner, et al., 2005); we would like to add the constructive part to that focus, not only understanding and experiencing, but actively constructing experiences. Obviously, there are design situations in which affective interaction and reflection on emotional processes are not the aim, and in those cases other approaches might be more suitable. For example, a pilot getting too scared to actually make proper decisions of how to fly the plane would not benefit from getting her emotions mirrored back to her in that particular real-time situation. Then, an affective computing approach might be more suitable to take control of the situation. In persuasive technology, the goal is topersuade people and not to make them reflect over their emotional processes.

3.3.3 Interactional Empowerment and Expanded Interactional Approach

In our own related research, we have attempted to expand on the interactional design approach by directly addressing everyday, physical, bodily experiences, capturing aspects of the experiential as well as cultural bodily influences on emotion (e.g., Sundström et al., 2007). Our efforts have in essence been to build systems that re-unite the corporeal and cultural aspects of our embodied experiences. We see that it is not only problematic to reduce emotions to their physical, corporeal processes. It is similarly problematic to separate emotion from corporeal physical experience. Our design research, as we will go on to present, has therefore aimed at mirroring some of the aspects of physical everyday bodily experiences while, at the same time, leaving room for users to interpret them actively.

Our position has been that bodily data, be it gestures users actively produce or signs and signals we emit based on our autonomous nervous system, should be represented in ways that feel familiar to end-users, but still be open-ended and ambiguous in such a way that they can recognise them, make sense of them and appropriate them for their own purposes (Höök

2006). We will come back to exactly what we mean by familiar below.

Furthermore, we did not want to avoid a subjective stance towards interpretation. The interactional empowerment design stance intends to support people in understanding and experiencing their own expressions subjectively – be it bodily, social or other kinds of data. A subjective design stance requires a representation that portrays people's everyday experiences in a form that they feel bodily familiar with and that they can later reflect on and imbue with their own meaning. Users' own, richer interpretation guarantees that it will be a truer account of what they are experiencing. This perspective on how to design puts users' own interpretation of their own lives, bodily processes or sociality at the core. It empowers them to make their own choices rather than to be told by a system what they are experiencing, for example, when they should stop stressing out or when they need to take a break.

According to Boehner et al., the design principle "The interactional approach supports an expanded range of communication acts" can be achieved through not putting the meaning-making process in the system itself but letting it rest with the user.

My own view here is that if we want users to appropriate the design and make it part of their own meaning-making processes, then the designer has to design precursors upon which those meaning-making processes can be based. One way of creating such precursors is to try and resonate with what is bodily familiar to us in our everyday lives. For example, we may decide to represent heartbeats through pulsating animations. As the system can, however, never grasp the full complexity of users' emotional bodily experience, we cannot over-define or over-determine the meaning for the user; we can only hint or indicate. The heartbeat may be mirrored in a pulsating animation, but we will not tell the user "your hearbeat is now increased; therefore we infer that you are stressed". This means that we avoid explicitly labelling the expression with a set of pre-defined categories. Instead, we provide enough leeway in the design to let users decide what these expressions mean to them. On the other hand, if we do not provide any familiar cues but let the users create their own expressions freely, we will not really be providing anything. The distinction between too many cues of meaning and too few is very subtle, and the view of what amount of meaning that should be built into the application by the designer differs by the aim of the application.

In examples such as emoticons, the expressions are explicitly labelled, not leaving much room for the users to interpret and create their own meaning around the expression. The view on smilies has changed over time; in the beginning when first used, smilies were thought of as being quite open for interpretation in their expression form. With more advanced techniques for expressing emotions, smilies have become narrower in their appearance, pointing to one singular emotion expression. Users still appropriate them as best they can to open their meaning to allow for different meanings in different settings.

While Boehner et al. often leaned towards quite abstract representations, leaving the interpretation and meaning making totally in the hands of the user, my approach and design would be placed somewhere in between theirs and the over-determined designs. My aim has been to empower users through providing a foundation, i.e., some guidance, building on patterns and cues that are bodily familiar to them in their own realities, but without explicitly labelling them. I have wanted to provide cues that can help users get started in interaction and meaning-making building on similarities with our physical, corporeal bodies, which can be modified over time and interpreted differently depending on context and situation.

If we aim to build systems for communication between people, emotions are a natural part of any communications and need to be catered for. In those settings, however, we see the same need in the design. For emotions to be communicated through digital techniques, it is important that they build on socially, already-existing communicative relationships and are situated and context-dependent. When implementing this feature into a design as discussed above, the cues that are apparent to us in our bodies when expressing or interpreting in real life have to be included. Therefore, the foundation for expressions in my design cases are built from an emotional model, emotional body language, bio-signals that are familiar indicators of emotional reactions. It also builds on theories on colour, form, animation and body posture, which are used in the design of the expressions of meaning making (Figure 3.2). The aim of providing some measurements from our bodies is to empower users in the emotional interaction, providing a link back to their own bodies.

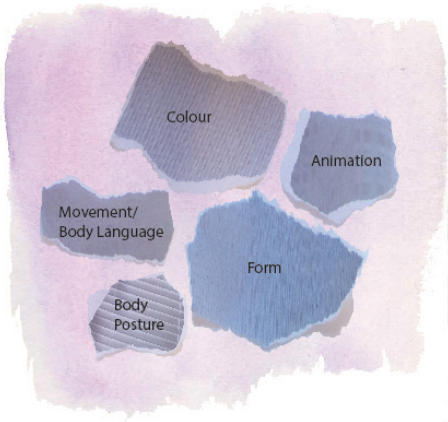


Figure 3.2: The theoretical areas that will be presented next, which all aim to convey bodily representatons.

3.4 Representation Modalities to Achieve Emotional Interactional Empowerment

To achieve Interactional Empowerment in this area of emotions through the designs of eMoto (paper A and paper B), Affective Diary (paper D and paper C) Affective Health (paper D and paper E), we have extracted one experiential quality, evocative balance (paper G), and some embryos to experiential qualities; these we found to be key ingredients in the design. These qualities did not come out of thin air but were built from theories on how to use expressive representations to mirror experiences.

As we shall see in the designs we have created, we wanted to explore the relationship between bodily movement and emotion, so that we could pick up on aspects of them through, for example, sensor technology and how to influence users' emotion through mirroring them in modalities speaking to our bodily emotional experiences.

To address (I) we did a literature review and found some interesting links between bodily movement and emotional experiences. In fact, Darwin (1872) had already explored the intimate coupling between bodily movement and emotions. The tight coupling between emotion and movement has been explored in other areas as well, such as computer game design (Höök et al., 2003, Isbister 2011), philosophy (Sheets-Johnstone 1999, Shusterman 2008), arts (Khut 2006) and dance (Davies 2001, Lawrence and Laban 1974). The theory we found most helpful in our design process when we started out in 2003 was, however, Laban's Theory of Movement. Below I provide a brief introduction to his work.

To address (II), we looked for modalities that had an ability to link to what was already bodily familiar to us, such as body language, body posture, colours and the perceptions of shapes and movements. Another reason for this choice was my training and interest in working with these modalities. One could, for example, have used sound, music or haptics, but for me, at the time, that would have meant learning something from scratch. As discussed by others (Isbister and Höök 2009), it is important that a designer cultivates a deep relationship to the materials used in her design practice, developing a design repertoire. In my case, that design repertoire was focusing on colours, shapes and animations. Below I will briefly present the theories behind the modalities that were inspirational to me in the design.

3.4.1 Laban's Theory of Movement

Laban (Davies 2001, Laban and Lawrence 1974) was a famous choreographer who provided a framework for analysis of movement in terms of the inner experience. His theories correspond nicely with the view of emotions, such as inner, bodily processes on the one hand, and the basis for communication on the other.

Laban's theory (oftentimes referred to as LMA [Davies 2001]) helps articulate the characteristics and essence of emotional body movement. Laban defined five underlying dimensions in movement: body, space, effort, shape and relationship. In our analysis, we mainly focused on effort and shape, as these directly address bodily emotion expressions. Here we will only provide a superficial account of these, enough to explain our design inspirations.

Shape describes the changing forms that the body makes in space, while effort involves the "dynamic" qualities of the movement and the inner attitude towards the use of energy (Zhao 2001).

Shape can be described in terms of movement on three different planes: the table plane (horizontal), the door plane (vertical) and the wheel plane, which describes sagittal movements. Horizontal movements can be somewhere in-between spreading and enclosing, vertical movements are presented on a scale from rising to descending, and sagittal movements go between advancing and retiring (Figure 3.3).

Effort comprises four motions factors: space, weight, time and flow. Each motion factor is a continuum between two extremes (Table 3.1).

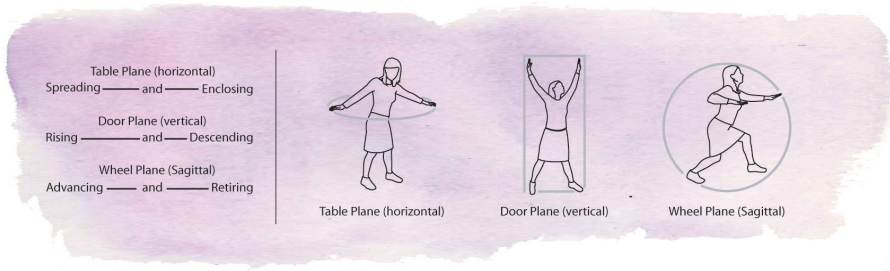


Figure 3.3: The three different planes of shape, adapted from Davies (Davies 2001).

Table 3.1 The dimensions of effort according to Laban as described by Zhao (Zhao 2001).

Motion factor	Dimensions	Examples
Space attention to the surroundings	Indirect (flexible): spiralling, deviating, flexible, wandering, multiple focus	Waving away bugs, surveying a crowd of people, scanning a room for misplaced keys
	Direct: straight, undeviating, channelled, single focus	Threading a needle, pointing to a particular spot, describing the exact outline of an object
Weight attitude to the movement impact	Light: buoyant, weightless, easily overcoming gravity, marked by decreasing pressure	Dabbing paint on a canvas, pulling out a splinter, describing the movement of a feather
	Strong: powerful, forceful, vigorous, having an impact, increasing pressure into the movement	Punching, pushing a heavy object, wringing a towel, expressing a firmly held opinion
Time lack or sense of urgency	Sustained: leisurely, lingering, indulging in time	Stretching to yawn, striking a pet
	Sudden (quick): hurried, urgent, quick, fleeting	Swatting a fly, lunging to catch a ball, grabbing a child from the path of danger, making a snap move
Flow amount of control and bodily tension	Free (fluent): uncontrolled, abandoned, unable to stop in the course of the movement	Waving wildly, shaking off water, flinging a rock into a pond
	Bound: controlled, restrained, rigid	Moving in slow motion, tai chi, fighting back tears, carrying a cup of hot tea

Table 3.1 The dimensions of effort according to Laban as described by Zhao (Zhao 2001).

In Figure 3.4a we depict the graphs Laban uses to express effort. As an example, Figure 3.4b presents an effort graph of the movement of inserting a light bulb, in which the movement is direct in space, light in weight, sustained in time and bound in control.

Laban's notations on how to describe the characteristics in emotional body language give us a way to articulate and describe similarities and differences between different expressions. This description in turn allows for conveying these characteristics in the design of the emotional expressivity and through testing the designs see if these characteristics came through to the users.

LMA was used in analysing a study of emotional body language conducted in the design process of eMoto (Ståhl et al., 2005), see article I, and these characteristics of emotional body language have also inspired the design of Affective Diary and Affective Health.

3.4.2 Colour, Form, Animation and Body Posture

As mentioned above, we were also inspired by theories of colour, form, animation and body posture in 2D. In the design, it can be the combination of all modalities or separated visualisation channels that lay the ground for emotional experiences. In here we have separated them as an attempt to understand the contribution from each one of them.

I would like to make clear that I am fully aware of the debate on the cultural dependence of colours, form, movement, and body posture and to what

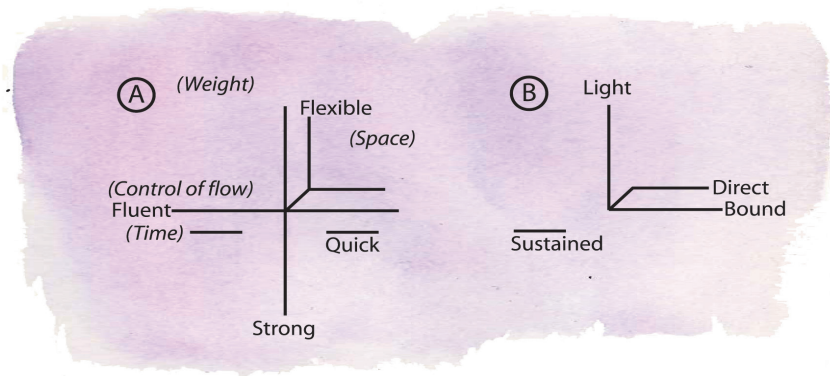


Figure 3.4: (a) Laban's effort graph, (b) an example effort graph of inserting a light bulb (Laban and Lawrence, 1974).

extent it is universally valid. In my view, these modalities are culturally-dependent and context-dependent; they bear different meanings in different cultures. But we can draw upon them and their cultural connotations, and, with time, using one of the systems we have designed, they will also take on their own meaning, derived from how users appropriate them and use them. In addition, while the theories of colours, shape, and animation presented below are the result of work done within a specific culture and might not be valid all over the world, some parts might be of a more universal sort, linking to biologically determined perceptions.

Colour Theory

Colours have been studied for many different purposes; for example, in physics, where their physical properties are explored (Newton 1704), or in cultural studies, where our understanding of colour is shown to be linked to which habitat and culture we have grown up in (Cole 1996), by psychologists looking for emotional effects of different colours (Sivik 1997, Ryberg, Stahre et al., 2004) and by their potential to carry meaning through various artists (Ittens 1971 and 1973, Sällström 1976, Steiner 1995, Albers 1975).

Pythagoras, Aristotle and Plato had already examined colour mixtures and created colour systems. In the eighteenth century, Newton was the first to arrange colours in a circular system; Newton's approach to colours was in the area of physics only (http://www.colorsystem.com, 14-Feb-2014). (Figure 3.5)

About 100 years after Newton, the German poet Goethe (Sällström 1976) studied the nature of colours with a different approach. His interests were in the psychological effects of colour. He attempted to bring order to what in his opinion were the chaotic and aesthetic aspects of colour. In Goethe's

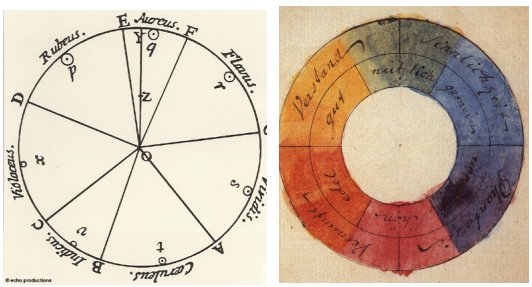


Figure 3.5: Newton's and da Vinci's colour systems from http://www.colorsystem.com.

colour-circle (Figure 3.6), the basic pair of yellow and blue were not placed opposite one another but placed together with red in a colour triangle. Goethe writes about colours as having negative and positive qualities. He refers to the part of his circle from yellow to red as the plus-side while the opposite side is the minus-side. Goethe discusses colours in terms of yellow being associated with "*effect, light, brightness, force, warmth and closeness*" and blue as "*deprivation, shadow, darkness, weakness, cold, distance*". The colours on the positive side in the system "*induce an exciting, lively, aspiring mood*", whilst the colours on the negative side "*create unsettled, weak and yearning feelings*".

Hårleman conducted a study in which he put subjects in rooms painted in different colours and reported on their semantic experiences. The findings for the three colours that caused the strongest reported experience were:

- green rooms were experienced as open, tranquil, lacking cheerfulness
- blue-green rooms were experienced as the coldest
- pink rooms were experienced as being cheerful and lively (Stahre et al., 2004).

What was interesting to me was that these results followed the same direction as Goethe's account of colours.

Later both Itten (1971, 1973) and Albers (1975) examined colour as a

Figure 3.6: Goethe's colour circle

means of interaction. Itten (1973) discusses how the perceived cold-warm qualities of colours can be verbalized in numbers of other dichotomies, such as, shadow-sun, airy-earthy, light-heavy, or wet-dry. These impressions illustrate the experienced powers of the cold-warm contrast, which can be used in expressions creating depth and perspective effects within a picture.

In his book *Interaction of Colour*, Albers has empirically examined the interaction of colours. He states: "*In visual perception colour is almost never seen as it really is – as it physically is. This fact makes colour the most relative medium in art*" (p.1).

This opinion concurs nicely with the interactional view of emotion described above, in which the meaning is often relative to how it is being used in a particular context. Although relative, a specific colour can be said to belong to a category e.g., red. Albers studied the interplay between different colours, so-called colour illusions. But he also deals with colour harmony and pairs of contrast in colour. In contrasting colours against each other, he suggests that colours invoke a distinct meaning such as gay-sad, major-minor, active-passive. He also states that together with form a colour can be given a more distinct meaning. This last insight became very important to me in my design work.

Colour Psychology

In the area of colour psychology, the effect on humans' perception of colours is in focus. According to this field, different colours are said to influence us in different directions (Stahre et al., 2004, Sivik 1997, Ryberg1991). For example, a room with the exact same temperature was experienced differently depending on the colour of the walls. A room painted in orange was experienced as warmer than a room painted in blue-green colours (Ryberg 1991). Colour creates automatical responses or leads to abstract associations. Ryberg describes the amount of energy in different colours, in which red represents the most powerful and strong emotions, moving along a colour scale ending with blue, thereby moving towards less energy. He also describes the qualities of each specific colour (Figure 3.7).

Here we can start to see how colours could be used as an emotional mirroring modality¬, both in the sense of their meaning, and also in how open they are to interpretation – many will find some of the interpretations in figure 3.7 quite dubious. To strengthen their meaning and not make an interface

that requires users to try and remember which colour means what, colours can be placed in form, or juxtaposition against one another in forms, or used in animations to allow for a stronger, more meaningful expression. Let us therefore turn to some of the theories on the semantics of forms.

Form Theory: Product Semantics

When discussing the execution of form in products, its' meaning and how this is perceived by users, industrial design oftentimes refers to product semantics.

Product semantics was first mentioned in 1984 (Krippendorff and Butter 1984). It is an inquiry into the symbolic qualities of objects as well as a tool to improve these cultural qualities. Product semantics is defined as:
"*A systematic inquiry into how people attribute meaning to artefacts and interact with them accordingly*."
"*A vocabulary and methodology for designing artefacts in view of their meanings they could acquire for their users and the communities of their stakeholders.*" (Krippendorff 2006 p 2)

Monö (Monö 1997) has a semiotic approach to form in which he discusses the study of sign and sign systems and their structure and role in socio-cultural behaviour and relates it to product design. In industrial design, a product's different qualities are often expressed in the design: in its physical form, the choice of material and the sounds it produces (for example when closing a car door or turning a knob). The meaning that we arrive at, when

Red: instinct, heat, sexuality, strength, courage, fight preparedness, impulsiveness

Orange: lively, joy, friendship, generosity, abundance

Yellow: intellect, hastiness, clarity, precision, logic, communication

Green: dream, hope, tenderness, sensitivity, youth, artistic

Blue: intuition, idealism, truth, authority, calm, concentration

Violet: will, power, religion, mystery, genial, artistic

Figure 3.7: Examples of the qualities of each colour (translated from Swedish) (Ryberg 1991).

our senses perceive these different qualities, should make it easy for us to understand the product's message.

Using semiotics and semantics as a way of discussing form factors is one way of assigning words to the sometimes quite subtle messages hidden in a product design. The approach that Monö takes can be problematic, since there is not any conventionalised way of doing or seeing form; instead it is in its nature vague and arbitrary. Applying Monö's view of meaning in form, you would almost have to have a library of curves, form elements, structures, and sounds to pick from. Putting these together in a certain way would create certain qualities, for example "heavy" and "fast". Monö grounds his discussions in semiotics and semantics, and his findings are important to the area of form and design, although they can also be discussed without the underpinnings of the semiotic theory. Norman (Norman 1990, 2004) discusses the same issues and arrives at similar conclusions, but with a different theoretical perspective, somewhat influenced perhaps by his background in psychology rather than form and aesthetics.

Kansei engineering (Nagamachi 1995) is a Japanese method concerned with translating feelings (kansei) into the design of products. The method relies on Kansei words, which are used to report emotional responses. Briefly, the aim is to generalise emotional association to different products in a quantitative way. But since Kansei engineering relies on a particular vocabulary, it has been criticised for predicting only what can be expressed by those Kansei words, not really addressing, at a deep level, the feelings or emotional experiences people may have as those cannot be reduced to a specific vocabulary. As we shall see later, I had to face this challenge when designing for self-reflection. Such a system cannot confine users to a small set of ready-made experiences but must open up for an indefinite range of simple and complex experiences.

Where does the meaning of form and colour reside?

The different parts of a product, for example its colour and form, are not isolated factors that simply can be stapled on top of one another to achieve the experience sought, but must be seen as a whole, influencing one other in complex ways. Hesselgren (Hesselgren 1967) presents factors that help us discern this influence. Examples of factors he introduces are: *proximity, similarity, area, common movement* and *experience* (Figure 3.8).

The ways formal elements are arranged and related create meaning

through the way they dynamically either harmonize or contrast with one another. Depending on what the aim is with the product's expression, the different formal elements can be put together to form a coherent whole or be contradictory and thereby cause confusion or suspicion for the user. Take for example a car that gives the impression of being a robust, cross-country car, but when the engine starts it sounds as though it has a very tiny motor. You would probably not believe in the car's cross-country qualities.

The physical form that a product possesses creates expectations from the user of other qualities that it holds. A static form can be perceived as heavy or slow and a sleek, graceful form could be perceived as light (Figure 3.9). A form can also express two or more different qualities, which also may seem contradictory in their appearance. The picture below shows interplay between two different expressions that could be regarded as counteractive (Figure 3.9). Another example is products with the same functions, for example a mobile phone, can, in its form, express status, youth, "techiness" or other properties.

In addition to describing the properties, the form in itself can also describe how it should be used, for example, how to manage different light switches. The form of the light switch indicates that it should be flipped, while the second light switch does not have the same properties but instead describes itself as to be pushed (Figure 3.10). This concept is applicable to digital products as well, in which the form can describe the function, buttons to be pressed or slide bars to be moved in a certain direction, make informa-

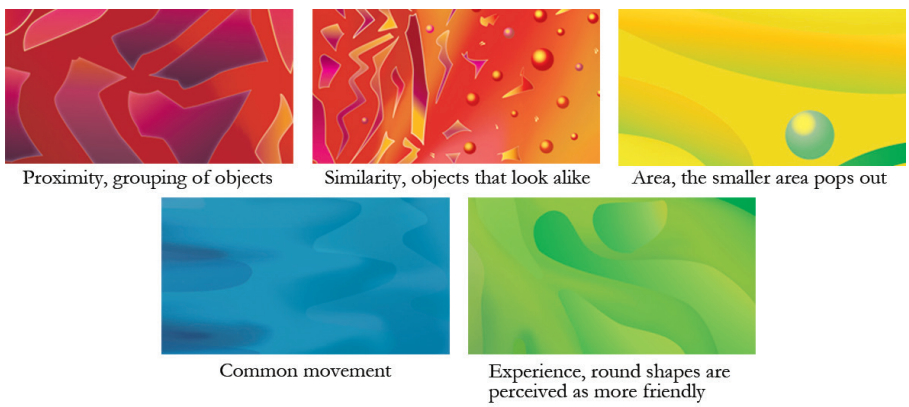


Figure 3.8: Showing examples of the different factors from the eMoto-design.

Figure 3.9: The two tea pots to the left, static resp. graceful. Counteractive expressions in a ski boot, to the left, expressing both speed and robustness

tion look active or passive etc. (Figure 3.10). In HCI this phenomenon has often been referred to as its affordance (Norman 2004).

Monö also discusses our current cultural habits and conceptions of how a product's principal function should be expressed in a particular form. These cultural notions of an object's appearance can be a strong bearer of meaning to us, so, even when presented in a very abstract way, we interpret them as the product itself (Figure 3.11). If the principal function is not expressed, it is difficult to interpret. This difficulty explains why a shape of random proportions becomes ambiguous and is open to many different interpretations.

In addition, people often try to read symbolic meaning into abstract patterns of shapes and try to construct a story around it (Heider and Simmel 1944).

Often, when we design, we have visions of what we want to convey in our design, expressed in words and spoken language. To convert these into form elements is something we unconsciously do daily, by speaking of strong and weak, warm and cold colours. In the same manner, we perceive round shapes as more friendly and positive, while an angular, spiky shape is per-

Figure 3.10: To the left, light swithes expressing to be flipped, to be pushed and turned. To the right, button expressing to be pushed and a bar indicating sliding.

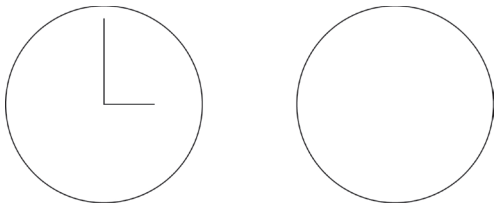


Figure 3.11: An abstract representation in which the principal function is expressed, building on what is already known in the culture at hand.

ceived as more negative (Itten 1973, Bang 1991).

Rudolf Arnheim worked with gestalt laws in perceptual psychology, arguing that we have an innate capacity to perceive and comprehend visual abstractions. He argued that this ability to understand visual abstraction already happens in the perception of the object but must be understood together with the context in which the object is presented (Arnheim 1969).

In her book (Bang 1991) on perception and composition, Bang adds yet another layer to this interplay between different objects and colour. She states that shapes and colours are always seen in context, so the person viewing an abstract shape adds the meaning dependent on the story around it (see Figure 3.12). Her thesis is that it is not the color or shape in itself that determines our experience of it but the meaning of the words we associate with them. According to Bang, different colour of the same shapes can completely change the associations arising around a particular shape (see Figure 3.12). She even goes as far as stating that colour cannot exist without human perception and meaning-making.

Similarly to Mönö, Bang has found certain principles to convey meaning and emotions in form and colour:

- Smooth, flat, horizontal shapes give us a sense of stability and calm.
- Vertical shapes are more exiting and active. They imply energy, reaching towards heaven.
- Diagonal shapes are dynamic because they imply motion or tension.
- The upper half of a picture is a place of freedom, happiness and triumph, whilst the bottom half is more threatening, heavier, constrained and grounded.
- White or light background makes us feel more secure.
- We feel more scared looking at pointed shapes; we feel more secure looking at rounded shapes or curves.
- The larger an object is the stronger it feels.

Figure 3.12: To the left, in a story this shape can represent a shark fin, a sail or a pyramid. To the right we can see how the red soft shape becomes prominent when red, chang ing it to a paler color makes the two different shapes more equal in the picture.

- We associate the same or similar colours much more strongly than we associate the same or similar shapes.
- Contrast enables us to see.

These principles go hand-in-hand with Itten's explorations of the interplay between design and form (Itten 1971).

Animation

There has been much work done in practical animation in film and games but not so much in the area of how to convey emotion in abstract forms, without providing a whole story around them. We were curious to see how to capture the subtle characteristics that make an animated expression create affect or what makes an animated character appear to have human emotions in a believable way. Thomas and Johnston (Thomas and Johnston, 1981) of Disney animation talk about harmony and disharmony in animation as a way of conveying emotions. Movements that harmonize can be perceived as positive. As an example, imagine the billowing waves of a sea where all the waves move in the same direction, slowly, together (Figure 3.13). In contrast, movements of objects that are not harmonizing, looking as though they might be close to colliding, can be perceived as negative. Imagine, for example, the same sea but now in full storm where the waves are moving in all directions in the wind, breaking against the cliffs (Figure 3.13).

Another important source of inspiration according to Thomas and Johnston is using patterns of movement that we are already familiar with and by experience connect with a certain emotion. Examples of this connection can be the pattern of movement in nature, like the motion of lightening or billowing waves on a calm sea. Body movements and posture is another example of familiar patterns that can be used in animation to convey emotions.

As mentioned above, Darwin had already addressed certain movements and expressions as strongly connected to certain emotions – something we recognize both in others and ourselves. Overlays, creating depth in the picture by the way the objects are laid out, can create a feeling of emotional expression; using overlays and a dramatic layout is only useful when creating negative emotions (Figure 3.13). Lasseter (1987) discusses the importance of timing in animations: the speed of an object may give emotional meaning to the movement. It can be used to portray the weight and size of an object. Itten has explored the effects of rhythm in form-giving and compares it to music. He states that great strength is associated with things that are rhythmic (Itten, 1973). Regular and irregular rhythms can be applied in animations and movement to strengthen emotional expressions.

Body Posture

To convey emotions or activity through abstracted visualisations of human body postures has been investigated in a few studies (Walters and Walk 1986, Walk and Homan 1984) but, in fact, surprisingly few compared to studies of vocal or facial expressions. Coulson's (2004) study on body posture had the highest correlation for emotion pairing with Ekman's six basic emotions (except for disgust). In Thomas and Johnston's work on Disney animation, they show how animals in the wild clearly communicate their feelings in bodily attitudes (Thomas and Johnston 1981). They explain how to use and exaggerate these bodily characteristics to create evocative character behaviours in cartoons.

Another example in which body posture was used as a human representation form in design is in Breakaway sculpture (Jafarinaimi 2005). In a very subtle way, the sculpture is used on the desk in order to portray the body's

Figure 3.13: From left to right: movements that harmonize, movements that disharmonize and creation of depth in the picture, example from the eMoto design.

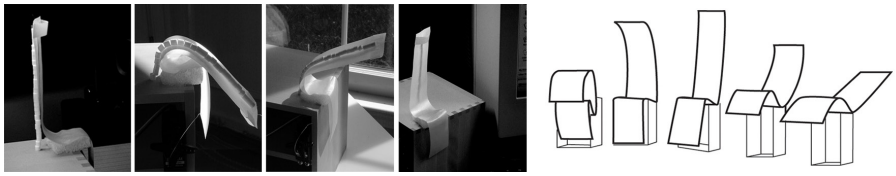


Figure 3.14: Breakaway

fatigue from the time a person is sitting in an office chair (see Figure 3.14).

3.5 Summary

I used the theories described in this chapter as a backdrop and inspiration in my designs of the three systems presented in this thesis. We started from the circumplex model of affect by Russell, as it promised to address the everyday, folk theories we all have of emotion and experience. Later, the work by Boehner at al., as well as our own work, became the foundation for understanding emotion as a product of the social fabric of everyday life, making emotion situated and context-dependent.

The inspiration for the choices of colors, shapes and animations came from a combination of our study of body postures using Laban's notation, together with the colour theories and product semantics discussed above.

Given this background, we can now turn to the design cases and excerpts of the design processes, which in turn will show how some of these theories were applied in the design.

design cases

4 The Design Cases – Reflective Excerpts of Design Processes

In here the three design cases eMoto, Affective Diary and Affective Health are briefly presented For more in-depth information go to paper A, B, D, E, and F Observe that these applications were never seen as potential products. These prototypes further define and exemplify the values in Interactional Empowerment. They worked as probes in an unknown design space, where, at the time, few had explored the relationship between emotion, movement and mirroring these. Today there are existing products for this on the market, such as, Wii, Kinect and sports equipment with different bio-sensors. In addition, I will also present detailed excerpts from each of the design processes, in which I will go into such details of judgements made, which is not possible when describing the whole process. The reason for doing this is that reflected design decisions made in the design processes can work as a proof of validity (Forlizzi et al., 2007, Nelson and Stolterman 2003, Krippendorf 2006). It also presents the judgements made, i.e., the framing of the judgements (Nelson and Stolterman 2003), so that decisions made do not seem to be random or arbitrary. The aim of these descriptions is not to present novel methods for how to go about designing; it is to present the constitution of user-encounters, methods, theory and inspiration. These descriptions together with the whole design processes described in the papers can also be used as inspiration for other practicing design researchers in coming design processes.

4.1 eMoto

eMoto was the first prototype building on and illustrating the idea of Interactional Empowerment in my work.

In eMoto, users send text messages between mobile phones, but, in addition to text, the messages also have colourful and animated shapes in the background. The user writes the text message and then chooses which expression to use as background from a large palette of expressions mapped on a circle. The expressions are designed to convey emotional content along two axes: arousal and valence (Russel, 1980). For example, aggressive expressions have high arousal and negative valence and are portrayed as sharp, edgy shapes, in strong red colours with quick sharp animated movements. Calm expressions have low arousal and positive valence, which is portrayed as slow, billowing movements of big, connected shapes in calm

Figure 4.1: A user sends a messages with eMoto, expressing her emotions with the extended stylus, which renders a background with an emotional expression to her message.

blue-green colours. To navigate around the circle, the user has to perform gestures using pressure and movement with the stylus pen (that comes with some mobile phones), which we have extended with sensors. Users are not limited to any specific set of gestures but are free to adapt their gesturing style according to their personal preferences. (See Figure 4.1)

By having users express their emotions in interacting with the system, they see their emotions mirrored and are either influenced or increased in intensity, both by the input modality in which emotions are expressed and as a response to output. This interaction builds on the idea of the affective loop and is described more in detail in the thesis, Defining the Affective Loop. (Sundström 2010). The design of the system eMoto is based on the theories described in the chapter 3.

4.1.2 Reflective Excerpt from the eMoto Design Process

Here I will try to describe the judgements I have made in designing one piece of the graphical background circle. We will see how hard it is to filter out pieces of the design, since everything is designed in relation to something else, but to get the details I will, nonetheless, try to reflect on the design judgements made in designing the shapes in one part of the circle.

The design of the graphical background was based on theories presented in the previous chapter, which inferred some boundaries around the design space. In mirroring emotional expressions, we used the Circumplex Model of Affect (Russel 1980) as a base mapping of the modalities of shape, colour and animation.

Figure 4.2: The part whose reflections are going to be retold here

The picture of the design below shows the part of the circle, whose reflections are going to be retold here (see Figure 4.2). I will use an interview form for describing these reflections to get it told in a way that captures my thought, as is done by Schön (1983) describing reflection in action.

What are you thinking?
I am trying to capture some qualities with the happiness and joy I want to convey, like that it contains high energy…that is why I am trying to get this bubbly, confetti like character in the expression, without making it look as it is those things. I try to abstract it a bit. (see Figure 4.3)

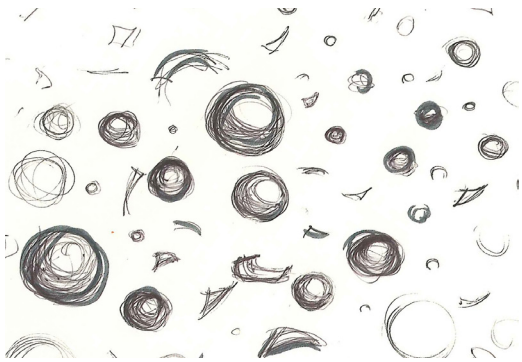


Figure 4.3: Sketch of the expression representing happiness and joy, bubbly, high energy character

What did you do now?
I am comparing all the time, thinking of the counter expression, and how the forms are going to blend into the expression next to them. Trying to balance the expression. (see Figure 4.4)

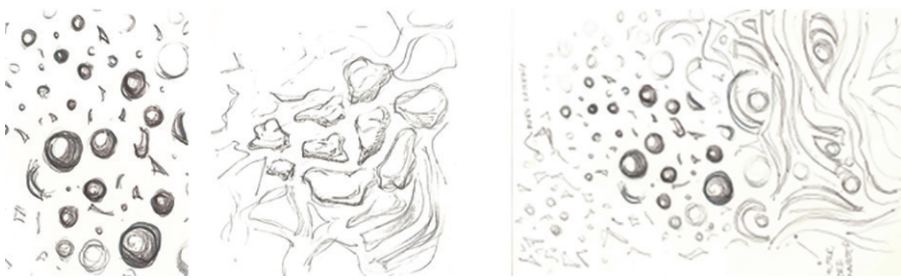


Figure 4.4: Sketch of the expression representing happiness and joy, bubbly, high energy character.

How?
The counter expression to joy would be sadness, how does sadness feel? I am thinking dark sea, dark clouded sky, depth and slow movements almost bouncing into each other, which in turn means that joy should feel like the opposite. Movements that are quick and rising, rounded forms that can

follow these animations. Bright and vivid colours, saturated, high energy in the colours. (see Figure 4.5). *The forms next to them have to smoothly, gradually blend into the next expression, making it feel like there are not any separate expressions in colour, shape or animation. Like starting to make objects smaller when going into an angry expression, making them sharper, more edgy, but still small to allow for the fast animations. The animations conveying anger should also move, as they would collide. More contrast should also be added on the negative expressions to create a sensation of depth, threatening, a deep cave. On the contrary the positive side, like joy should also contain small object allowing for fast movements, but should not be colliding*. (See Figure 4.6)

Figure 4.5: The expression with colours.

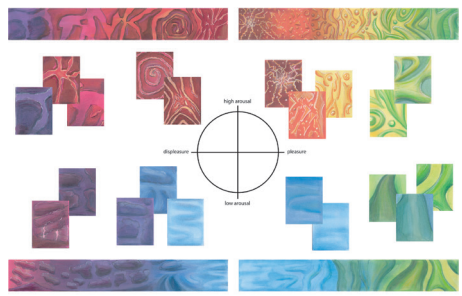


Figure 4.6: Sketch of all expressions in relation to each other.

This excerpt of the design process gives a brief insight into the way design judgements in the eMoto design process were made. What becomes obvious is how design judgements are not decisions that can be separated; they are always interdependent, balanced and working together as a whole with the rest of the design. Changing something in one part of the design might mean that other parts of the designed expression take on another meaning.

4.2 The Affective Diary

The Affective Diary was the second prototype building on and illustrating the idea of Interactional Empowerment in my work.

The Affective Diary consists of a mobile phone (with camera), body sensors placed in a bracelet that users wear on their upper arm, and a Tablet PC (see Figure 4.7). As a person starts her day, she puts on the body sensor. During the day, the bracelet collects sensor data on movement (by accelerometer data) and emotional arousal (from galvanic skin response readings)

of the user. Activities on the mobile phone are logged, such as text messages, photographs and Bluetooth presence. Once the user is back at home, she can transfer the logged data into her Affective Diary system on the Tablet PC. The collected sensor data are presented as somewhat ambiguously shaped and coloured "characters" placed along a timeline. The materials from the mobile phone are placed above the characters (see Figure 4.7). To support reflection on the day, the user can interpret and alter the representation: changing the posture or colour of the characters or scribbling diary-notes onto the diary.

4.2.2 Reflective Excerpt from the Affective Diary Design Process

In the design process of the Affective Diary we became aware of the need for more characters representing the bio-sensor data, as described in paper D. In this section I will give the reflective account of how one of these characters was formed. The design of the Affective Diary used the outcome of the eMoto design process as input into the graphical design. For representing the bio-sensor data, colours and body posture was used.

What are you doing right now?
I am trying to find the shape of the character in body posture that expresses even more movement than this one (points at the character to the right, Figure 4.8). *Movement in the sense that it still has the characteristics of this, that is the same person.*

Figure 4.8 The characters' postures used representing movement, the one to the right expressing the most movement.

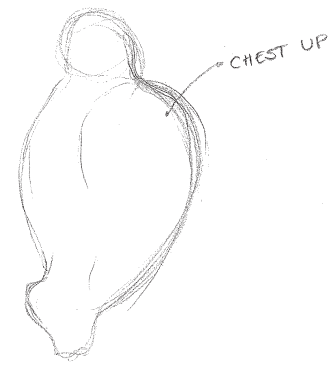
How do you do that, what are you thinking?
I am thinking of how you start running, what happens to you body, what are the characteristics in the posture. The directions in posture. So I start by leaning the "head" slightly backwards as if you were doing a run-up.
See Figure 4.9.

Figure 4.7: Sensor data is collected during a day and then downloaded into the Affective Diary application. The biodata is represented through colorful characters together with other data captured by the mobile phone.

Figure 4.9: Sketch of character with the head slightly backwards.

What are you doing?
I actually try the position (standing up), *what happens to my posture when I do a run-up. My chest is higher up, I lean slightly backwards.* (Now back sketching, see Figure 4.10).

Figure 4.10: Sketch of character with chest up.



And now?
I am thinking how you get up on your toes right before you start running, the whole character expresses movement through shifting the weight to be higher up, and is slimmer, not so heavy. (Figure 4.11)

Figure 4.11: Sketch of the weight shift in the character, to express preparation of movement.

This excerpt of the design process gives a small insight into the way design judgements in the Affective Diary design process were made. Here we can see the strong connection to familiar bodily expression, in which the designer actually tries the different postures and tries to find the characteristics in interplay with sketching.

4.3 Affective Health

Affective Health was the third prototype built from and illustrating the idea of Interactional Empowerment in my work.

Similar to the Affective Diary, the Affective Health system monitors users' skin conductance (GSR) related to emotional arousal, pulse (ECG) and movement (accelerometer). But instead of downloading the data to a computer once in a while, the data are transferred in real time to users' mobile phones (via Bluetooth), where users can engage in two kinds of activities. First, they can get into a so-called biofeedback loop in which the effects of trying to relax, breathing deeply or meditating are immediately visible – as are the effects of thinking about something stressful. Secondly, the system offers a history of prior states, and users can find patterns in their own bodily reactions relating to their everyday behaviour. The system is supposed to be used daily over a longer time period so that users gradually can reflect and start to act on their everyday choices. The interface on the mobile uses colour and animations in a shell-shaped figure to portray how skin conductance, pulse and movement change over time. The real time is visualised in the centre growing out becoming history in three time circles. The three

circles can represent either three minutes, three hours or three days. (see Figure 4.12)

4.3.1 Reflective Excerpt from the Affective Health Design Process

In the design process of the Affective Health the mapping of the colours to the bio- sensor data was a challenge. In this section I will give an excerpt of the reflective account of how the colours were chosen and how some of the mapping to GSR was made. The knowledge gained about colour representation in the two previous design processes were used as input.

What are you doing here?
*I am starting with the colours used in Affective Diary, there is a difference here because the colors are not supposed to be visualised separately, but blending into each other (*see Figure 4.13).

Figure 4.13: The separated colours from the Affective Diary design, and the same colours blended.

And blending colours is complicated. It is easy to think that there is simply to blend the colours, you actually get new colours when blending them. To get a smooth blend you have to alter the hue and saturation of original colours to make them become a family. Then I pick out even more fixed colours to get the transitions less sharp (see Figure 4.14).

Figure 4.14: Top, the colours slightly altered to belong to the same family. Bottom picture, more colours added to make the transitions smoother..

Figure 4.12: Biosensors capture data in users ' everyday lives. This is visulised back to them in real time on their mobile phones, building a cyclic history of data over time

What is the next step?
Now you can think of each colour occupying a certain length, which should be filled and blended into the next one. Now I have equal length on the blending, but different colours have different strength, even though having the same hue and saturation, so I am trying to make some of the colours last longer, cover longer distances. (Figure 4.15)

Figure 4.15: Top, the colours are occupying equal distance. Bottom, the distances of the colours modified.

How do you mean?
The proposal should make the impression of the colours be equal, that they have the same value. That means that I also might have to change the saturation and hue again to reach what I am aiming for. This with colours and how they are perceived is complicated. (see Figure 4.16)

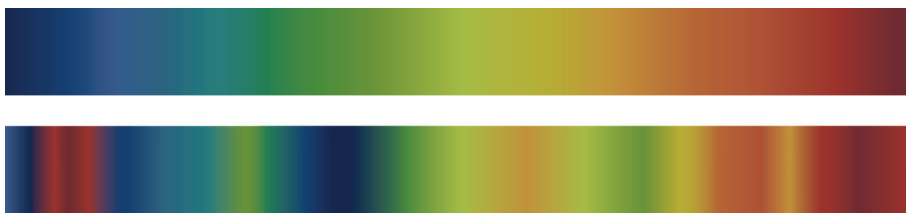


Figure 4.16:Top, final distance, hue and saturation. Bottom, final proposal with the colours in mixed order.

Is this the end proposal?
No, this is a colour sketch, where I build on what we know worked in the previous systems and how I can imagining that the representations would feel like in different situations. So this is only a first sketch, the big work remains with mapping the colours to the sensor data, where we have to try using the sensors to get our own lived experiences and then try to map this to the colours. Especially for GSR it is complicated.

This excerpt of the design process gives a small insight into the way design judgements in the Affective Health design process were made. Here we can see the strong connection to colour theory and perception of colour. Where the designer actually tries the different colours and tries to give the colours equal strength so when mapping the colours to bio-data, the colours will be perceived quite equally.

4.4 Summary

Above we have seen detailed excerpts from each of the design processes, which are supposed to visualise examples of judgements made in small details. This level of detail is not possible when describing the whole process. The reason for doing this is twofold. First the reflective design decisions made in the design processes can work as a proof of validity (Forlizzi et al., 2007, Nelson and Stolterman 2003, Krippendorf 2006). Secondly, it also presents the judgements made, the framing of the judgements (Nelson and Stolterman 2003), so that decisions made do not seem to be random.

The aim of these dialogs is also to exemplify how these judgements can be made when designing. These descriptions together with the whole design processes described in the papers can also be used as inspiration for other practicing design researchers in their future design processes.


evocative
balance

5 Evocative Balance

One of the results from this work is in the area of experiential qualities (Löwgren 2009). I have articulated one experiential quality "evocative balance" within Interactional Empowermant (presented in more detail in paper G) and two embryos of experiential qualities, which have not yet gone through the full articulation to become experiential qualities for other design researchers to use.

In this section I will briefly present what makes an experiential quality, the notion of evocative balance, and. the two embryos to experiential qualities blending experience and harmonizing modalities. I will also explain how this is an addition to design research knowledge.

5.1 Experiential Qualities

Experiential qualities (previously known as use qualities) are characterizations of interaction experiences, how an interaction feels, how it is experienced in use (Löwgren 2009). Experiential qualities are primarily discussed as analytical concepts, emerging from erudite criticism or other forms of systematic reflection and abstraction combined with various sorts of empirical data. They are typically presented as indications of key concerns in certain genres of interaction design. In communicating an experiential quality for the appropriation by peers, it is essential to combine carefully chosen examples with reasoning and articulation.

Experiential qualities are relational in the sense that they reside in the interaction, neither being properties of the artefact itself nor of the user. This means that a designer can never know for sure that an artefact will render a specific experiential quality when it is actually used. However, what the designer can do is to set the scene, to create conditions under which the experiential quality is likely to manifest itself in use.

Even though experiential qualities are predominantly analytical concepts, manifesting themselves only in actual use, they are not without value in practical, generative design. They serve as sensitizing devices for the designer, drawing attention to core qualities of the users' experience and, in a sense, of ideal use. If the designer accepts and appreciates that insight, it is then quite feasible to proclaim a particular experiential quality as a desirable one in a new design project and to arrange the work such that the new artefact is likely to exhibit that quality when used.

Finally, from the point of view of design research, experiential qualities form a useful abstraction level for articulating emerging insights over a range of experiments performed within a program. The experiential quality of evocative balance serves as a center of gravity to draw together insights from the three design experiments, presented in the previous chapter, within our emerging program of Interactional Empowerment.

5.2 Arriving at Evocative Balance for Interactional Empowerment

As described above, an experiential quality is articulated in a process-like manner. The quality, evocative balance, has been developed over three design experiments, and therefore the way of articulating it has changed along the way, which becomes evident in the papers (paper A, Ståhl 2006, paper F, and paper G), where this quality has been discussed in its different incarnations.

After the first design case, eMoto, the quality, evocative balance, was presented as two different qualities "open for personal expressivity" and to "provide cues of emotional expressivity built from familiarity" (Ståhl 2006). These qualities went through yet another design case, Affective Diary, and were thereby developed and refined. The outcome of that design process slightly renamed the qualities to "co-construction of emotional experiences" and "harmonizing modalities" (paper D), but the experiential intention of them was the same. The last design case, Affective Health, aimed at the same qualities in the design, but when analysed once more I became aware of the strong interdependence of these two qualities. They actually balance each other and the qualities were merged into what I now name evocative balance. This process of, step by step, articulating and refining our understanding of an experiential quality, constitutes the empirical part of my design research journey. The evocative balance quality may of course be further refined through design and use – by myself but also by other designers.

5.2.1 Evocative Balance for Interactional Empowerment

Evocative balance starts to unpack a space of interaction experience within affective interaction in which recognition of the familiar is in simultaneous play with the suggestive openness to interpret and to express in new ways. I claim that, when these two sides are balanced, the resulting interaction experience is characterized by the quality we call evocative balance (paper G).

Striking this balance is a considerable challenge. There are examples of

affective interaction that fail to evoke the familiar, leaving a completely open playing field without grounding in lived bodily experience. In those cases, we would argue, the resulting interaction might be perceived as rather random and meaningless. Similarly, affective interaction designs that place too much emphasis on the literal and depictive would tend to be perceived as closed, matter-of-fact and not conducive to reflection and meaning-making.

Our work here is informed by the program of Interactional Empowerment (paper C), approaching affective interaction from the standpoint that users are expressive and autonomous, that they will interpret, reflect and engage in meaning-making – if empowered by appropriate tools and media. We have found evocative balance to be a key factor in interaction experiences furthering these aims.

When we express ourselves emotionally to others or when we experience emotion, the experience is composed of many different processes: processes in our brains affecting our thinking, hormone levels in our blood, or attention direction; muscles tensing or relaxing leading to facial expressions, body postures, movements; our interpretations of what is going on; our perceptual coding and decoding of what we see in others, hear, or experience in our environment; our cultural belongings and prior experiences, etc. (Davidson et al., 2003). If we want to design for interactions that express emotion experiences that users can understand, identify with, use to express themselves and which will evoke lived emotion experiences, we need to find expressive modalities and mould them into interactions that resemble and touch the bodily emotion experiences we want to evoke.

It might be tempting to think that the easiest solution is to create some anthropomorphic character in the interface that mirrors human emotional expression. However, it is well known that such treatments have a detrimental side effect of raising expectations of (human) intelligence (Tinwell et al., 2011). The examples above illustrate ways of treating familiarity in non-anthropomorphic ways. It is also worth noting how contextual information (such as phone calls, text messages, photographs and location data) was used in Affective Diary as a way to enhance familiarity and aid recollection (paper E).

To find expressions that are suggestive and open to interpretation, it is important to identify and translate some of the underlying dimensions in our emotional processes – be it arousal, valence, movement or some other

factor. As mentioned in chapter 3, our inspirations came from the choreographer Laban's way of understanding movements in terms of effort and shape, Russel's account of how different people map out emotions on arousal-valence scales, and our understanding of the timing and rhythm of emotion processes. We can all feel our hearts beating in a certain rhythm; we experience the energy of a thunderstorm or the billowing movement of an almost calm sea, etc. Our design work has explored the underlying experience of energy levels, movement and sometimes even shapes and colours that evoke connotations to us beyond the layers of literal mapping. The aim has been to avoid crude simplifications of emotion experiences in order to allow users to recognize their own complex, shifting, ever-changing emotional variations, without over-determining the experience.

In my opinion, striking an evocative balance between familiarity and openness paves the way for a co-constructive interaction experience. As mentioned above, I take a constructivist perspective on emotion, one in which we assume that emotion experiences are created together with other people, when talking, laughing, joking, confiding or quarrelling, or through elaborately setting the scene for an experience, such as when attending an opera event, going to a party, relaxing on the couch or watching a movie. Therefore, if we want users not only to be influenced by the expressions in our designs, but also actively take part in constructing their experience in and through the interaction with the system, we have to make the user an active co-constructor of expressions without evoking overly strong connotations in the design that exclude the users' own interpretation, experience and expression. Evocatively balanced designs thus become empowering.

I propose the experiential quality of evocative balance to be a key aspect in designing for interactional empowerment in affective interaction. Evocative balance draws on the dual meaning of the word "evoke" in characterizing the user's sense that data and actions evoke familiar recollections of lived experience, yet are open enough to evoke multiple interpretations in an ongoing process of co-constructive making of meaning.

The concept of evocative balance is constructed through reflective analysis and empirical studies of our own design work as well as the work of others. Furthermore, evocative balance can serve as an analytical lens for untangling the perceived shortcomings of less successful designs in the same genre and for suggesting possible directions for improvement.

5.3 The Two Embryonic Experiential Qualities

Throughout the three design experiments there were other promising qualities that could be articulated as experiential qualities, "blending experiences" and "be aware of contradictions between modalities" (Ståhl 2006). The latter was, after the design case Affective Diary, called "harmonizing modalities" (paper D). I have chosen to refer to these as 'embryos' since they have not been properly worked through and articulated, but I think they have potential and should therefore be worth mentioning. Below I will briefly present the two embryonic qualities.

5.3.1 Blending Experiences

Like our bodily experiences, our movements, pulse, emotions etc. blend seamlessly into each other, and the designed expressions need to mirror this in order to feel familiar. The representation modalities, be it colour, shapes or music, should blend into each other in their expression form to achieve that experience. We live a continuous life, and, if we want to represent this in another form, the experience of this representation should blend into each other without sharp transitions. Russell (1980) has mirrored this in his study in which people have mapped out their emotions in a two-dimensional model. In the model, it became visible that people's experience of emotions blend into other nearby emotions. This merging became a source of inspiration in our representations of emotions. If blending is not used in the designed expression, the experience in use becomes like snapshots of our lives. If these snapshots do not capture an important or significant moment for us, it is likely that we do not recognize the mirrored expression. For example, if movement is represented during one hour and our experience is that we have mostly been sitting at the computer working, but we went to get a cup of coffee and to the printer one time. If let us say five snapshots are used, it would be represented as little movement, more movement, little movement, more movement, little movement to try to capture the experience. This would probably not mirror our true experience; it would look as though we had been changing our movement very frequently. Adding the quality of blending over time in the expression would mean smoother transitions, showing long periods of inactivity, sitting by the computer, interrupted by short bursts of movement, going to the printer and getting coffee – all continuously portrayed.

In Affective Diary (paper D and paper E), the bodily data was represented as a maximum of five characters per hour, next to each other over time, capturing the most significant changes in that hour. This lack of blending over time became obvious when people tried to make sense of their bodily reactions. On one occasion, one user recalled a vivid dream she had, where she awoke with her heart pounding in a cold sweat, but she could not find strong evidence for this in the Affective Diary:

"*But the result was not more than this* [referring to the representation]. *I think it is strange, because it was really dramatic. And I woke up totally exhausted, I had palpitations when I woke up.*"

If the representation had been continuousover time, this might have captured the changes better and thereby mirroring her experience.

From the eMoto design, we have an example in which the blending of the emotions in the representation worked. The colours, shapes and animations used to represent the emotions blend seamlessly into each other. One example is when a user is trying to find the exact representation for her emotional experience:

"*It is almost like this [referring to the representation], but a bit warmer, a bit more actio*n [while she moves around in the representation to find what she is looking for]."

Here the blending helps the user in finding a suitable representation for the experience she wants to convey. If there had been separated expressions, it would not have been possible to affect this explorative search, and we would have had to move between, for example, happy, happier and happiest. It would be harder to express an emotional experience that, for example, was at the border of happiness, almost excited.

When representing emotional and bodily experiences, it is important to mirror this in a blending representation in the way we live our lives as continuousor experience our emotions as ongoing and shifting. If the representation is cut up into pieces of experiences, it becomes harder to understand and might not capture the parts that we found important. By blending experiences we can empower the users to find out themselves what is important or suitable in an experience.

5.3.2 Being Aware of Contradictions in the Modalities or Harmonizing Modalities

A very simple example of being aware of contradictions in modalities when designing can be expressed as this: the experience of our own pulse, reflected back to us in a pulsating animated surface using a color scale to show changes in pulse, needs to follow the actual pulse we have as well as our experience of our pulse as portrayed by the energy level in the color chosen. The modalities: animation and color choice, need to work together, not contradicting one another; otherwise, we become distanced from the representation, unable to identify and empathically recognise ourselves reflected in the interface. If the user has a really high pulse and this is represented by a fast pulsating animation, but the color supposed to harmonize with it portrays a color with low energy, for example, green. The user will most likely not identify with the expression at all because of the contradiction, although the animation is in line with the experience.

If a contradiction is used, the designer needs to be doing it purposefully and very carefully. This might be with the aim of, for example, creating subtle or dynamic expressions mirroring how bodily emotional processes can be subtle, complex, and combined. (It can also be used to portray irony, quirkiness or provoke the user – but the designer then needs to be aware that this is what they are doing and that this might alienate users and be seen as irrelevant to their experience).

In the eMoto example, the area of the colourful circle that aimed to portray frustrated experiences, described in more detail in paper A, had, as did all of the designs, a combination of three different modalities: colour, shape and animation. In the frustrated-expression, the colour of the background was perceived as contradictory to the shapes and the movements, which led to participants in our studies to describe the area in terms of the words thorny, sharp, angular shapes and stressful, but in the same sentences as artistic, creativity, cool, love, modern, passion, and a rose. As one subject in the study put it:

"*You would want the sparkling, that you're angry, but at the same time the colours are a bit too happy to…*"

If there had been harmony between the different modalities of expression, these shifting experiences could to have been avoided.

In the design experiment of Affective Health, two of the bio-sensor readings used the same output modality, colour. Since GSR-measured arousal vs. pulse-measured arousal behave quite differently (where the GSR-measured arousal is fast-changing and pulse is slower in its variations), we were happy to see that this was never experienced as a contradiction to our users: "*and then there was a stressful walk to the commuter train, and then I relaxed when I got there. So the pulse is up [pointing to color of pulse], but I have become this calm and cool [pointing to color of arousal]*" (Figure 5.1)

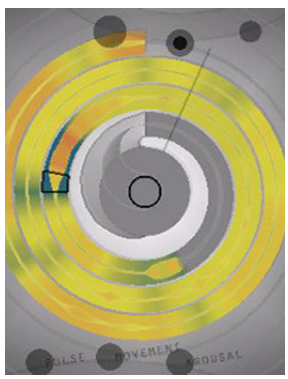


Figure 5.1: A screen shot representing a stressful walk to the commuter train, represented by an orange color and the blue in background representing the arousal.

Turning to another example, "the Influencing Machine", (Höök et al., 2003) presented in more detail in chapter 1, the output modalities colour, shape, animation and music were used. The system expressed different emotions through childlike drawings together with music. The music in the system did not seem to be in harmony with the rest of the expressions. The music was a form of improvisational jazz, while the animations looked like children's drawings. This made it harder for the users to fully understand what the system expressed.

As designers, we need to be aware of contradictions between modalities as in many cases, a design will be a combination of several different modalities. In eMoto, we used colours, shapes and animations, but we can easily imagine using all sorts of modalities – physical, visual, auditory and so on. When designing the various cues in each of these modalities, it is important that they harmonize and strengthen one another rather than be contradictory. And when a contradiction is used, the designer should be doing it purposefully with the aim of, for example, creating subtle or dynamic expressions

that mirror how emotion processes can be subtle, complex, and combined.

5.4 Summary

In this chapter I have first presented the experiential quality called evocative balance, in which users in affective interaction find indications evoking actual lived experience, but are still free to interpret them in new ways to engage in ongoing meaning-making and, secondly, the embryonic qualities called harmonizing modalities and blending.

Experiential qualities, in general, represent abstractions or intermediate-level knowledge, and as such inhabit an epistemological realm similar to other kinds of interpretative qualitative knowledge forms. For instance, the concept of grounding is generally crucial when it comes to the results of qualitative research. A typical taxonomy would be to speak of empirical, analytical and theoretical grounding, and in paper G an account that provides some concrete illustrations of what this means is given. The concept of evocative balance is empirically grounded through our reports of user interaction experiences with the eMoto, Affective Diary and Affective Health systems I have created and our analysis of these reports. It is analytically grounded mainly through the way I am using it as a lens for discussing other examples of affective interaction experiences, in which I hope to have shown how evocative balance is a way to capture the essence of ideal interaction as well as to explain some of the discomforts apparent in non-ideal interaction experiences. Finally, it is theoretically grounded to some degree by referring to the general theories informing our design work and conceptual development. Relating evocative balance to other concepts addressing similar interaction experiences or design aspirations can also be seen as theoretical grounding.

This kind of multi-grounding is characteristic of interpretive qualitative research in general, and, when it comes to experiential qualities in the context of interaction design, it provides a fruitful way to make the reported knowledge contributions criticizable and thus amenable to academic assessment and appropriation.

The way of arriving at these experiential qualities also mirrors the research method used, as described in Figure 1.3. This exploratory research method captures the essence of practical design work and turns it into a valid knowledge contribution. I find this method applicable on other de-

sign research problems. The backdrop with the way I have been using this method is that it has required three fully-fledged working prototypes, which is time consuming to arrive at. But I can see this research method work in shorter design cycles as well.

summary & discussion

6 Summary & Discussion

To design for emotions in applications has been an ongoing topic for at least the last ten years. Through this thesis and work with my colleagues, I have taken a certain stance, by designing from the values in Interactional Empowerment and in a certain genre, affective interaction. The design processes that led to the three systems, eMoto, Affective Diary and Affective Health, have helped to clarify what we mean by Interactional Empowerment. It has resulted both in practical examples (exemplars) on how to go about to reach Interactional Empowerment but also abstracted design knowledge in the form of experiential qualities. Especially important is the experiential quality of evocative balance.

At the same time, this thesis may also serve as an example of how to do research through design. By engaging heavily in practical design work, using that to open a design space, explore possibilities and arrive at knowledge formulations that extend beyond one particular design example, I have been able to both work as a design research practitioner and a design researcher.

Let us now revisit the research questions outlined in the beginning of this thesis to summarize where we stand now.

6.1 Research Questions Revisited

This thesis set out to explore how to design for Interactional Empowerment in greater detail. The main research challenge for me has been how to design for users to become empowered in and through the interaction. Another sub-question has been how to make this a knowledge contribution for the community of design research practitioners. Below I will briefly revisit these two initial questions and see how the work presented in this thesis has contributed to these questions.

6.1.1 Designing for Interactional Empowerment

The question I set out to investigate is how to design for interactional empowerment within affective interaction. This was done through the explorative design processes (including theory, practical design work, implementation, user encounters etc.) of the applications eMoto, Affective Diary and Affective Health.

Just to remind us, in an interactional empowerment design, users contribute their interpretation and co-construct the meaning of what the system

portrays of them over time (Höök et al., 2008, Boehner et al., 2007) – and it is through the interaction over time that the system starts making sense, mirroring behaviour data or users' experiences back to them. An interactional view sees meaning/emotions/dialogue as constructed in and through the interaction.

The interactional empowerment design program aims to support people in understanding and experiencing their own expressions subjectively – be it bodily data or other kinds of data. An interactional perspective on design will not aim to detect a singular account of the "right" or "true" interpretation of the user and tell them about it, but rather make experiences available for reflection. It requires a representation that portrays people's everyday experiences in a form that they feel familiar with and that they can later reflect on. Users' own, richer interpretation guarantees that it will be a truer account of what they are experiencing. This perspective on how to design puts users' own interpretation of their own lives, bodily processes or sociality at the core. It empowers them to make their own choices, rather than being told by a system what they are experiencing, when they should stop stressing, when they need to take a break or what makes them happy.

The desirable experiential quality, evocative balance, presented in chapter 5 and paper G addresses lessons learnt on how to go about designing for interactional empowerment. It shows that striking an evocative balance between familiarity and openness to interpretation paves the way for a co-constructive interaction experience. We show how users not only can be influenced by the expressions in our designs, but also actively take part in constructing their experience in and through the interaction with the system: we have to make the user an active co-constructor of expressions without evoking overly strong connotations in the design that excludes the users' own interpretation, experience and expression. Evocatively balanced designs thus become (potentially) empowering.

A criticism against this quality is that it might seem arbitrary, since we always have to balance the designed expression, and there are not any strict guidelines on how to go about designing. The intention is that, through the examples of my own work and work by others, a designer who is skilled enough can understand the key characteristics in the design and thereby be inspired by this work when addressing questions of balance in their designed expressions. But, in my view, that is equally true for experiential

qualities such as pliability (Löwgren 2007), fluency (Löwgren 2007) or suppleness (Isbister and Höök 2009). As Isbister and Höök points out, a designer has to work on their design skills in relation to the design material at hand. And some designers are bettered skilled to solve one specific design problem and may not be suitable for another design situation.

6.2 Knowledge Contribution from Designing for Interactional Empowerment – Evocative Balance

Let us now turn to how the result of my "research through design"-work can be framed as a knowledge contribution. I will use evocative balance as the example.

When talking about appropriation, an obvious question is that concerning the scope of the contribution. In universalistic research paradigms, there is the more-or-less tacit assumption that a reported finding should always hold a "general truth". Interpretive research yielding intermediate-level knowledge has nothing to do with claims of truth, but rather with scope or usefulness: in what other situations can we reasonably expect this piece of knowledge to be applicable? Or, to return to the topic, in what other interaction situations can we expect evocative balance to be a key concern?

In the previous chapter, I discussed the fact that there are genres or styles in interaction design. Here I am proposing that affective interaction can be viewed as a genre. Interactional Empowerment can be seen as a specific design program within that genre, and evocative balance as an experiential quality emerging from that program.

One admittedly simplified but still quite useful way of talking about experiential qualities and other forms of intermediate-level knowledge is by a dimension of abstraction, ranging from the particular instances of design artefacts, the exemplars, to the general level of (supposedly) universal theory, see Figure 6.1. It should be clear that the concept of evocative balance, along with other experiential qualities, resides somewhere between the particular and the general. Evocative balance is a relevant and useful concept for talking about a whole range of existing and possible artefacts, as shown in paper G, but it is in no way near a general theory that will be applicable to any design situation.

In paper G, I demonstrated how evocative balance is a meaningful concept within the program of Interactional Empowerment, embodied in the

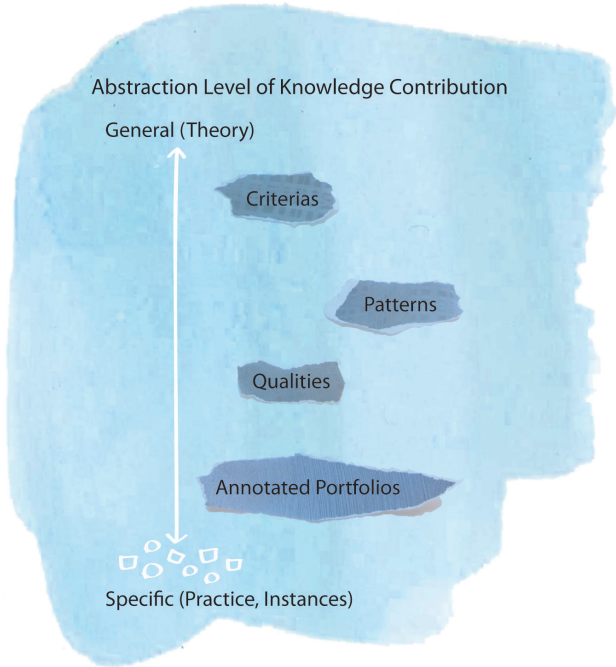


Figure 6.1: Examples of how different ways of validation can be used depending on the level of abstraction of the knowledge contribution.

designed artefacts (eMoto, Affective Diary, Affective Health, and more) as well as a further range of potentially existing artefacts that I or other designers could create. Interactional Empowerment in turn forms a subset of affective interaction, sharing the genre attribution with many other design artefacts that also facilitate affective interaction but which do not necessarily contribute to the aims of Interactional Empowerment. It should be clear that this mono-dimensional characterization is a simplification, but still it turns out to have some useful features. First, it helps make sense of notions of genres and subgenres with affiliated experiential qualities; thinking in terms of a continuous dimension of abstraction can help the analysis of how these interact with each other.

Secondly, it highlights the potentially dynamic nature of experiential qualities as knowledge constructs. Discursive knowledge production entails that concepts are entered into an ongoing academic discussion in which the concepts are developed, elaborated or delimited by other researchers. Here the dimension of abstraction might foster clarity in this discursive work.

In my case, the empirically grounded parts of the analysis are within the Interactional Empowerment program. However, it is demonstrated through a reflective analysis how evocative balance appears to bring clarity to certain issues of design but discomfort in other examples of affective interaction

that were not explicitly related to interactional empowerment. Thus, I would propose that the scope of evocative balance extends beyond interactional empowerment and into other regions within the affective interaction genre. The exact extent of this elaboration, however, would be the topic of further research.

Finally, the simplified dimension of abstraction emphasizes connections between experiential qualities and concrete design artefacts. The reason this connection is significant ties back to our view of experiential qualities: how they are predominantly perceived as analytical concepts, as ways of seeing, but how they can also serve generative roles in design processes by being seen as desirable qualities in the beginning of a design project. The thing about experiential qualities being generative is that they only provide a minor way of guiding specific design moves. If another designer wanted to design an affective interaction application with an interactional empowerment view, they would certainly be able to understand the desirable quality of evocative balance and recognize it (or its absence) in existing examples – but that understanding would not necessarily help them progress through ideation and detailing towards a new artefact exhibiting that quality in use. This is why the dimension of abstraction is important in emphasizing the relation between an experiential quality and a set of carefully analyzed particular artefacts, from which other designers can find generative ideas to appropriate in their unique design situation. Another designer might, for example, shortcut to a good design through picking up on the colour scales as a means to create an open-ended design. Moreover, the way in which I report not only the final designs from our work, but also several iterations of aspects of particular significance for evocative balance, is an intentional attempt to further emphasize the relations between the levels of experiential qualities and concrete artefacts. This is a way of reporting with which I expect to make the contributed knowledge even more useful for design practice.

This proposed dimension of abstraction also fits the current discussion in the design community on valid research contributions for design research practitioners. I have chosen to report my findings partly as an experiential quality, but, by this, I do not intend to say that this is the only or the right way for this community to extend knowledge. As many approaches there are in design research practice, as shifting extension of knowledge this must

allow for. Therefore, in this simple dimension of abstraction, many ways of extension on different levels can fit: some closer to the practical design examples, such as annotated portfolios (Gaver 2013) or more general, such as Zimmerman (Forlizzi et al., 2008), aim for.

A criticism of my way of extending the results and the description of the experiential quality is that it is desirable and thereby not determining of even guiding. There is not any description of how to go about achieving interactional empowerment in a design, but instead use experiences of when it works and not, together with a discussion around what is desirable in use. This approach makes the audience for this quality quite narrow; it has to be taken in use by a skilled designer. Secondly, I have shown the quality's validity within my own work and some related work, but whether it is really going to be picked up by other design research practitioners remains to be seen.

6.3 Future Work

There are surely several interesting areas, which this thesis have not treated, some of them I have deliberately chosen to avoid and others I might not have understood the importance of. The topic aesthetics, in general, and especially as a design research practitioner I have chosen not to discuss in here. This is a difficult and multi-faceted area, which is not easy to grasp and discuss. It is almost like asking the question; what is art? Now afterwards, I understand that aesthetics is something that is very important and might be what is unique for design researchers with a design school background in the interaction design field. First, after several I have come to be aware of that I actually have a vocabulary to talk about aesthetics that was trained and learnt in school. But this vocabulary was only used in discussion with other designers that were in the same situation. Therefore I have not really understood how to discuss with others who are not trained. This is something that would be inteeresting to look into in the future and see what an aesthetic approach adds in term of user experience of a prototype. How we can get the best out of our different competencies in the multidisciplinary work within interaction design. And if I had moved into this area, the design process might have been illustrated and discussed in terms of the aesthetics in a more conscious manner.

Finally my thesis work has been ongoing for almost ten years; there are

both pros and cons with this long-term duration. Some of the work might be seen as old; some of the technology has become out of date. The pros are that this decade has given me time to reflect on what is unique in the old designs, what is not connected to the old technology or use situation, but can be general and universal enough to hold for more than one design.

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PART 2