Beyond Users

Grounding Technology in Experience

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Abstract

This thesis goes beyond a user-centred design approach to explore potential future applications and modes of interaction. With several design cases, we investigate how early technology ideas can be matched with a specific practice to inspire novel design. This involves learning about existing experiences, interests and activities that can be relevant for a potential application, but which are not necessarily found among the intended users. Starting with early technology ideas and then finding a suitable practice to learn from is an alternative perspective of design activities. This can be useful for researchers and designers in Human Computer Interaction (HCI) who are interested in complementing approaches compared to user-centred design. Our approach is also relevant for researchers that face technology-driven starting points, and want to investigate future applications by grounding the design in existing practices.

A set of design cases show how the overall research goes from a usability-oriented perspective towards a more experience-oriented one, in order to accommodate technology-driven design situations. The design cases have involved different technical starting points, including information display technologies, surface-based networking, digital photography, and robot technology for everyday settings. The overall design process evolves towards matching the technology with a practice, and to investigate applications by developing one or more research prototypes. This has resulted knowledge of novel applications and interaction for the technology in question, as well as knowledge on how to employ empirical data to inspire novel design. Finally, we provide an overall reflection of the research process and show how a design approach that goes “beyond users” can benefit the design process.
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\textsuperscript{1}http://eis.comp.lancs.ac.uk/pin&play/ (Accessed Jan 15, 2008)
\textsuperscript{2}http://www.stratresearch.se/ (Accessed Jan 15, 2008)
\textsuperscript{3}http://ecagents.istc.cnr.it/index.php (Accessed Jan 15, 2008)
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Part 1
The Thesis
Introduction

Today, information is literally at our fingertips – we can access, create and attend to relevant and situated data and media almost anywhere and at any time (Vogelstein, 2008). Information technology (IT) is already part of our daily life, and supports different kinds of everyday creative practices. For instance, people find new interests in creating digital media, such as taking pictures, and can share this with friends or the rest of the world in a few seconds (Richardson et al, 2007). Other computer-augmented artefacts previously the realm of science fiction are now products, such as robots that can vacuum floors (Forlizzi & Disalvo, 2006), or entertain in the form of robotic pets (Friedman et al, 2003). Overall, information technology and other computational materials have an amazing capacity that can support many different types of human desires, from more functional needs to supporting different types of creative practices and leisure activities.

In order to understand how to design for different desires and use situations, it can be useful to learn about the design material in combination with the activities that this can support. In Human Computer Interaction (HCI), it is common that the intended users are seen as the most important source of inspiration and guidance for the design of computer artefacts. Users can also contribute in idea generation, and imagine future applications and modes of interaction that support their needs. Another approach is to take the design material as inspiration for design, and for example investigate how early and not yet mature technology ideas can stimulate novel designs. However, with such a starting point it is likely that the technology is unfamiliar for users, and that they will find it challenging to come up with innovative ideas for use. In this thesis, we will describe how our own design approach that has evolved when designing computer artefacts with a technology driven starting point. However, we will first motivate our research by looking into the differences between technology-driven and user-centred design, and introduce how an emerging research trend opens up to invite for a new perspective where we can investigate novel design.
Technology-driven design

A few years ago, information technology that is available anywhere, anytime, was still only part of a vision called ubiquitous computing (ubicomp) (Weiser, 1991, p.94). This vision is now becoming reality in many parts of the world (Bell & Dourish, 2007). However, information technology also supports many practices and desires that were not foreseen in the original ubicomp vision (ibid.).

Today, ubicomp is an active technology-driven research field, but one that has been criticized for contributing to a misleading vision of the future. According to its critics, in ubicomp the technology is taken for granted and scenarios of everyday activities enhanced with ubiquitous computing are grounded on a minimum of trivial use cases or scenarios to justify the existence of the technology (Araya, 1995; Rogers, 2006; Bell & Dourish, 2007). Such critique is reasonable, considering that research in ubicomp often investigates only limited areas of use, and focuses on e.g. technical challenges for positioning (e.g. Kunze & Lukowicz, 2007) sensor technologies for identification (e.g. Hodges & Pollack, 2007) or network technology (e.g. Su et al, 2007). The technology solution that is developed may be novel and have a great potential as a computational material. However, from a more user-centred perspective, the investigated applications are not necessarily novel, or based on practices that people actually do. Furthermore, the original vision focused on making things easier and faster to do, which does not necessarily support a more human-centred perspective of novel applications (Araya, 1995). For example, Rogers (2006) argues that ubicomp should focus more on exploring how to engage people and create exiting, stimulating or even provocative applications. Similarly, Bell and Dourish (2007) stress that ubicomp need to move away from the original vision, and should investigate how to ground technology in the current society and existing human practices. Thus, technology-driven fields such as ubicomp have the potential to investigate novel technologies as potential innovations. However, the lack of understanding for human practices makes it difficult to investigate ideas that are not only novel as technology solutions.

User-centred design

Human Computer Interaction (HCI) is a field that strives to “enhance the quality of the interaction between humans and computer systems” (Preece et al, 1994, p.43). However, here it more established to start a design process with the intended users, than to start with primarily technology-driven ideas.

User-centred design is a well-established design approach in HCI, which can be considered a sort of counter-point to technology-driven research. A user-centred approach focuses the overall design process on the intended users, their needs and characteristics (Preece et al, 2002). Broadly, this involves using
methods and techniques to design services and applications that correspond the
users needs, and are oriented towards usability (Preece et al, 2002; Hackos &
Redish, 1998; Norman & Draper, 1986). For example, inquiry methods, such as
observations and interviews are used to understand the users needs (Beyer &
Holzblatt, 1998). The data can then be used to for instance create fictive users or
so-called Personas, to steer the design process and inform design, based on the
users needs (Pruitt & Grudin, 2003). Users can also be actively engaged in the
actual design activities (Bødker & Buur, 2002; Ehn, 1988). In user-centred
design, the choice of technology is preferably an open question, rising from the
users needs (Kjeldskov & Howard 2004). However, this can also involve a risk
of leading to a design which is very technically challenging to implement or not
feasible (ibid.). Furthermore, user-centred design has been criticised for not
resulting in innovative designs (MacDonald, 2005).

User-centred design challenges
There are several challenges with user-centred design, that relate to investigating
inventive ideas and early technology ideas. For example, user-centred design has
several methods that focus on “understanding” users. MacDonald (2005) argues
that designers in HCI need to learn how to use qualitative methods, such as
ethnography, not only to analyze users and support users, but to also generate
inventive design. Another challenge is that users tend to come up with ideas of
use that are related to what they already are familiar with (Von Hippel, 1986;
Rogers & Belotti, 1997). This can make it difficult to explore novel design ideas,
when they are engaged in design activities (Wilson et al, 1997; Dixon et al,
1997). Thus, whereas technology-driven research can be criticised for exploring
ideas that are not grounded in existing needs or desires, user-centred design can
face challenges to trigger inventive ideas that is “beyond” what the users are
already familiar with.

Starting with an early technology idea and then applying a user-centred
approach could be a potential approach to investigate novel technology ideas,
and to ground these in users needs. This way, the technology could be
investigated at an early stage as a novel idea that the users then provide feedback
on. However, if a technology’s potential use is novel for users, they can not
necessarily imagine how it would appear as a product. This has been pointed out
by Rogers & Belotti (1997) who argue that conducting a requirement analysis for
an early technology concept is challenging. Furthermore, a rigorous evaluation
and user testing of an early technology concept is often not feasible, as such idea
can be difficult to implement as a working prototype, let alone be robust enough
for a reliable use in a realistic setting of users (ibid.). Thus, combining early
technology-driven ideas with a user-centred design approach can be challenging,
especially when this involves use that the users are not already familiar with.
Introduction

Technology-driven innovations

Several radical innovations have actually started out with a technology-driven intention (Rogers & Belotti, 1997). For example, the ideas by Vannevar Bush, Douglas Engelbart and Ivan Sutherland, which laid the foundation for the World Wide Web and the modern graphical user interface, appear to stem from seeing potential in technology, more than being ideas raised from studying users (Bush, 1945; Rheingold, 2000). Furthermore, if their ideas would at the time have been introduced to users, it is very likely that they would be considered unfamiliar and difficult to directly find a use for. For example, the idea of hypertext is likely have been difficult to imagine a direct use for, when it was introduced by Bush in 1945. Other early technology ideas have been demonstrated as implemented prototypes, for example Sutherland’s object-oriented graphics editor implemented in the 1960’s, and Engelbart’s desktop, mouse and graphical interface a few years later (Rheingold, 2000). However, these were not designed as applications that would support specific existing tasks, but instead demonstrated more abstract technical functionality. Thus, they would have been difficult to directly introduce to potential users. Today, through many years of technical and user-centred refinement these early ideas have become part of everyday life. These examples illustrate that early technology ideas are not necessarily a bad starting point, even if they are difficult to directly introduce to users. Instead, early technology ideas could be regarded as “seeds” which can be planted in a design process, where we strive to investigate various kinds of potential innovations.

How can we investigate novel designs?

One approach to investigate novel ideas as potential products and applications is to look beyond the intended users. The consultancy firm IDEO\(^1\) is an example of an established design company that has been acknowledged within HCI to create innovative products and “pioneering new user experiences” (Preece et al, 2002, p.11). IDEO has developed several techniques to support design processes that takes its starting point in an existing product or technology, and strive to reach an inventive design (Spreenberg et al, 1995). For example, such techniques can investigate experiences that are analogous to a specific design, or found among atypical users, in order to come up with inventive ideas (Gilmore & Veláquez, 2000).

Similarly, it is possible that we could stimulate novel design by focusing the design process on experiences instead of users to investigate early technology ideas. The approach above is related to experience-centred design, which is an emerging research direction within HCI, going beyond usability (McCarthy & Wright, 2004). Such research can e.g. investigate peoples’ needs to explore, engage and play, and create design that can intrigue and delight at various levels.

and in various situations of life (Gaver, 2002). As shown by IDEO, experience-centred design open up for inventive designs, that can involve to learn from others than the intended users. This research direction also brings new perspectives of design and evaluation activities in HCI (e.g. Gaver et al, 2003; Wright et al, 2006), for example by providing methods and techniques intended for more exploratory design activities (Gaver et al, 1999). Thus, experience-centred design can support an understanding of how to approach technology concepts, that is beyond usability and a user-centred focus.

**Design-oriented research**

We come from the research tradition at the Viktoria Institute, provided by Dahlbom (1995) who argues that design can be used to investigate and understand the role and use of potential innovations. In our research, several prototypes are designed and evaluated in an iterative process, which is an established research approach in HCI (Fällman, 2003b; Zimmerman et al, 2007; Löwgren & Stolterman, 2004). Furthermore, we as researchers can be considered as designers, when we take an active part in shaping a design (Löwgren & Stolterman, 2004).

Design can be regarded to “take an active stance and to bring about intentional change”, implying a commitment to technology and technological development (Fällman, 2003a, p. 225). However, here design is not considered as an end, but as means to generate knowledge about the future. Thus, we learn from bringing ideas into being, and by studying the design in use (ibid.), even if a design solution is not necessarily optimal (Lawson, 2006). A resulting physical artefact can also stimulate reflection, for instance on similar future designs or on existing technical functionality (Holmquist, 2005). How to conduct design is also dependent upon the goal with the design. For example, a design process can focus on designing and evaluating artefacts to increase their usability, or it can investigate novel applications and modes of interaction from a more experience-oriented perspective.

**Innovative design**

When design-oriented HCI research investigates “novel” designs, this can be regarded to primarily concern inventions to investigate the potential use of e.g. more incremental or radical innovations. Such HCI research is conducted to generate knowledge of for instance their potential interaction, use and role by design and evaluation activities. In this case, an invention can be seen as an occurrence of an idea that may have a potential to become an innovation (Macdonald, 2005). For example, an invention could be an early idea that is implementated as a prototype. Furthermore, an invention could be considered to become an innovation first when it has contributed to a transformation or change
in a community and is widely adopted by users (ibid.).\(^1\) Innovations can also be seen as more incremental if they are smaller continuous improvements, or more radical if they e.g. represent an entirely new paradigm to carry out a task (Rogers, 2003). HCI can investigate inventions that are more towards a radical or incremental innovation. However, this does not necessarily include introducing products that are directly ready to be adopted by users, or to conduct studies about their diffusion.

**Matching technology and experience**

Each design case in this thesis has taken a technology-driven starting point. Here, the “starting point” refers to an early concept or idea of for example some technical properties coupled with a potential use situation that has not yet been investigated as an application. Another example of such a starting point can also be a prototype that is built to exemplify technical functionality, but without being grounded in studies of existing human practices.

The emerging perspective in this thesis goes from usability and user-centred design towards an experience-centred perspective, which also follows an emerging trend in HCI (Harrison et al, 2007; Bødker, 2006). In several of our design cases, an early technology idea is grounded in a practice that “matches” the initial technology concept. In this context, a practice refers to specific interests and activities that several people find it meaningful to engage in. The practice is not necessarily found among the intended users, but should involve experiences that can be studied and interpreted as inspiration for design. This is done in order to understand existing meaningful experiences that can guide early technology-driven ideas to be develop into potential applications or products. The people who are part of the studied practice may or may not communicate with each other, but this is not a primary issue. Thus, this is different from a community of practice perspective, where the central issue is how members learn from and with each other (Wenger, 1998). Another perspective of practices is marginal practices (Spinosa et al, 1997). This refers to practices that are shared, but unfamiliar to, or foreseen by, people in another more general practice. However, a marginal practice might spread in society and become more general, thus contributing to innovation (Denning, 2004). In our work, the practice that is studied for inspiration could be seen as more “marginal”, whereas the intended users could potentially represent the more “general” practice. In that case, the studied “marginal” practice involves activities and experiences that the intended users are not yet familiar with, but potentially could appreciate.

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\(^1\) There are many other definitions and types of innovations that are not further discussed here, e.g. is an idea seen as an innovation in Rogers (2003).
Design cases

This thesis contains a number of design cases that illustrate the design approach that emerges. Informative Art (Chapter 6) are information displays inspired by well-known works of visual art. This represents an early example of a technology-driven design situation, where the process was more oriented towards users and usability than experience. We learned that a different design approach might be needed to investigate more experience-oriented issues. Pin&Play (Chapter 7) is a design case, where a not yet mature ubiquitous computing technology was matched with a practice to investigate a potential application. In the original technology, pushpins become connected to a network when they are attached to a surface. We investigated a practice where the practitioners were working with traditional paper and pins, and learned about possibilities for introducing new technology. Based on this, we built a prototype that revealed challenges and potential applications of the technology. Context Photography (Chapter 8 and 9) took its starting point in the idea of a digital camera that was extended with sensor technology. By studying a photographic practice called Lomography, we found inspiration for experiential qualities that the technology could potentially support. A camera prototype was designed, and then tested with intended users i.e. amateur photographers interested in digital photography. This process provided insights in how studying an existing practice can benefit a technology-driven design and ground a potential application in existing meaningful experiences. Finally, Personal Embodied Agents (Chapter 10 and 11) started out with a concept of exploring agent technology for everyday settings. The initial technology concept of agent technology was matched with experiences found among a specific group of pet owners. Their interests and underlying motivations grounded our initial design of robot and agent applications. In this design case, we also focused on making the experiential qualities more explicit and to “transfer” these into design with the design technique Personas.

Contributions of the thesis

This thesis offers several types of contributions, which we have divided into conceptual, applied and methodological contributions. Conceptual contributions include showing how it is possible to investigate novel designs that are grounded in experiences that the users may not already be familiar with. This is relevant for researchers who want to try a complementary approach to user-centred design. Furthermore, our work shows how early technology ideas that can be difficult to introduce to users, can be grounded in existing practices when exploring potential applications. This can also provide insight in potential challenges and benefits of the technology, which is relevant for researchers that face technology-driven challenges.
Applied contributions include a number of prototypes which have been developed during the course of the thesis, including a Pin&Play scheduling application, a Context Photography camera, and two examples of Personal Embodied Agent applications – Autonomous Wallpaper and GlowBots. In particular, Context Photography, Autonomous Wallpaper and GlowBots are experience-oriented, and their design is grounded in a practice that was deliberately chosen not to represent potential users but to investigate experiential qualities. The resulting design outcomes show that it is possible to match a technology concept with a specific practice to explore novel applications and interaction at an early stage in the design process. The design process for each prototype exemplifies how such a process can be conducted, and the specific knowledge that this has resulted in.

Methodological contributions are a design method and several supporting design cases that illustrate methodological concerns for the design approach that emerges in this thesis. This can support researchers and designers that want to try a similar approach.

Structure of the dissertation

The first part of this thesis, i.e. the cover paper (chapter 1 to 5) motivates the research, outlines the background and positions the work to related areas of research, presents the research approach, describes the contributions and discusses and concludes the general findings. The second part of the thesis (chapter 6 to 11) consists of previously published material, and reports on the design cases that support the contributions stated in the thesis.

Part 1 – the thesis

Chapter 1 – is the introduction that motivates this research by describing how technology-driven design situations can be seen an opportunity for innovation in HCI. It also brings out some challenges that a user-centred design approach may involve when investigating potential innovations. Furthermore, we introduce how experience-centred design opens up for novel perspectives of design, and present our design-oriented research approach.

Chapter 2 – describes the background, which frames this work in the HCI research field and other related areas. This includes how experience-oriented design opens up for new perspectives of design and evaluation of computer artefacts within HCI. Furthermore, we describe design-oriented research and tools, and how to ground early design ideas with a more experience-perspective. This leads into why it can be beneficial to learn from experiences beyond the intended users, when aiming to investigate novel applications and modes of interaction.

Chapter 3 – is the research chapter, where we introduce the design cases Informative Art, Pin&Play, Context Photography and Personal Embodied
Agents. They take their starting point in early technology concepts, but evolve from usability and user-centred design, towards an experience-oriented perspective. The overall research includes fieldwork, workshops, design activities and evaluations of research prototypes. Finally, an overall reflection of the approach in each design case is made.

Chapter 4 – brings out the main contributions of the thesis. These include conceptual contributions, applied contributions and methodological contributions.

Chapter 5 – is the discussion and the conclusion, which summarises the work with a reflective discussion on the gained knowledge and overall concerns. It also provides insight into how this work can be expanded on in future research.

Part 2 – the papers

Chapter 6 - Between Aesthetics and Utility: Designing Ambient Information Visualizations


Informative Art are information displays that take inspiration from visual art to display information. We investigated this technology concept by designing a display of real-time bus departures, inspired by the visual style of the painter Piet Mondrian. Even if more experience-oriented issues such as aesthetics was considered important, this paper describes a usability and user-oriented design process that primarily shed light on usability issues and resulted in guidelines for how to design such display concerning readability and placement issues.

In this project the conceptual work has been a collaborative effort with Tobias Skog who programmed the bus display, and Lars Erik Holmquist who programmed an early version of Informative Art in the style of Mondrian. My empirical contribution was to engage users in the design process, and to plan and conduct the evaluation of the display in the university setting.

Chapter 7 - Ubicomp Challenges in Collaborative Scheduling: Pin&Play at the Göteborg Film Festival


In this design case, we investigated a potential application of the Pin&Play technology. The initial technology concept was that pushpins could hold information when being attached to a board that would serve as a network. We matched this with a collaborative scheduling practice that appeared to appreciate properties that the technology involved. The practice used large-scale notice
boards filled with paper notes to schedule a film festival. Based on our findings, we developed a prototype that also was evaluated by the team. This process helped us to further understand how the Pin&Play technology potentially could benefit or challenge such practices. Overall, this design case provided insight in how an early technology concept can benefit from being matched with a specific practice, in order to learn about realistic potentials and challenges of potential applications.

In this study, Maria Håkansson and I shared the fieldwork, did the analysis and developed the initial design requirements together. We also shared the responsibility to supervise the three students that built the prototype. They assisted us in the final test of the prototype, carried out with the film festival team. Maria Håkansson and I conducted the analysis of this final data.

**Chapter 8 - Designing for New Photographic Experiences: How the Lomographic Practice Informed Context Photography**


This project started out with an idea of that a digital camera combined with sensor technology (such as sound or temperature) could give rise to a new photographic experience, when visually affecting pictures as they are taken. This would potentially involve unpredictable results, and could give rise to particular aesthetics. This paper describes how we matched our initial idea of the camera, with a photographic practice. The practice is called “Lomography” and involves amateur photographers that use obsolete cameras and enjoy unpredictable visual effects. This paper reflects upon how this specific practice supported the design process of the context camera.

I conducted the data analysis for this specific paper, but the conceptual work for the overall project has involved close collaboration with Maria Håkansson and Lalya Gaye. Maria Håkansson and Lalya Gaye and I have shared empirical work such as arranging workshops and conducting user studies. This work has also involved practical expertise and collaboration with the programmers Mattias Rost and Pontus Munck, and the visual artist and programmer Panajotis Mihalatos.

**Chapter 9 - More than Meets the Eye: an Exploratory Study of Context Photography**

This paper describes how the context camera was explored and perceived by various amateur photographers during a six weeks long study. We present their different experiences, and discuss how the context camera gave rise to novel picture taking, new aesthetics, new goals and expectations of digital picture taking.

The conceptual work for this study of Context Photography has primarily involved collaboration with Maria Håkansson and Lalya Gaye. We shared all conceptual and empirical work, such as planning and conducting users studies. Furthermore, we analysed the data together and shared the writing. Mattias Rost made final adjustments of the context camera application, so it would fit two different phone models.

Chapter 10 - Designing Personal Embodied Agents with Personas


This project started with an initial idea of Personal Embodied Agents, and investigated potential designs for agents and robots in everyday settings. This paper describes how we matched the initial technology concept with pet owners that have a daily experience of pets that “act autonomously”, which we wanted to take inspiration from. We interviewed owners of spiders, snakes and lizards, to learn about their interests, activities and experiences and use this as inspiration for design. We then used the design technique Personas to describe different potential interests and experiences of the design.

This work has been a collaborative effort with the co-authors. I was in charge of the project, supervised the fieldwork, and contributed to brainstorming sessions and the continuing analysis of the data. Katarina Walter conducted the interviews and an initial analysis of the data.

Chapter 11 - Transfer Scenarios: Grounding Innovation with Marginal Practices


This publication presents a design method that exemplify how early technology concepts can be matched with a specific practice to investigate potential applications. This paper is especially grounded in the design case of Personal Embodied Agents, but also in Context Photography. We clarify how such a “matching” process can be achieved by providing different steps that can support reflection in such activities. Furthermore, we discuss challenges of coming up with innovative design within HCI, and how we strive to come beyond them.
I have developed the reflection on previous work and the resulting design steps. However, they stem from previous design cases, which are collaborative work. The model to describe different design methods in HCI was a collaborative effort with Lars Erik Holmquist.
Background

The overall research in this thesis takes a technology-driven starting point but stems from a user-centred perspective. In the following, we will describe an emerging research trend in Human Computer Interaction (HCI) that opens up for alternative perspectives when learning about novel designs. We will also describe our design-oriented standpoint, and existing design tools. Furthermore, we will present instances where experiences or activities that are not necessarily found among the users, have been considered to support design.

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\footnote{An alternative term for HCI is “Interaction Design”. This term emphasise a greater variety of focus and methodology that is becoming more present in the field (Preece et al., 2002). However, we will use the terms HCI and user-centred design to refer to a central research tradition of studying, designing and evaluating the use of interactive computing systems. This is done deliberately to stress the evolution of the design activities conducted in this thesis.} 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 & Stolterman, 2004).

User-centred design and usability is an established research tradition or design philosophy for grounding the design of computer or digital artefacts\footnote{A digital artefact is described as the result of an interaction design process, intended to operate in a close relation with humans in social contexts (Löwgren & Stolterman, 2004).} in
users needs (Preece et al, 2002). This involves making the user central in the design, and engaging them in an iterative design process with early evaluation activities (ibid.). Such a perspective of design is different from other types of HCI research that represent more technology-driven traditions. For example, research in Mobile HCI does not necessarily engage users in early design and evaluation activities, and ground the design in trial and error instead of user studies (Kjeldskov & Graham, 2003). Similarly, research about ubicomp technology is not necessarily based on existing human practices but is rather based on a future vision (Rogers, 2006). Human Robot Interaction is yet another field where design seems to be inspired by science fiction, reinforced by robot designers (Kiesler & Hinds, 2004). These fields also explore technology that may not yet exist in society, which can be difficult to design and evaluate with users (Rogers & Belotti, 1997).

The tradition of user-centred design brings a specific perspective of why and how design activities should be conducted, which not necessarily support alternative perspectives of design. Norman and Draper (1986) give an early perspective of user-centred design. They describe usability guidelines and a design process that would consider e.g. the users cognitive and perceptual ability. Similarly, Gould & Lewis (1985) provided early principles that describe (1) an early focus on users and their tasks, (2) empirical measurements of users, and (3) iterative design consisting of design, test, measure and redesign. Different research trends such as cooperative design (Greenbaum & Kyng, 1992), contextual inquiry (Beyer & Holzblatt, 1998), and participatory design (Ehn, 1988) have also contributed to specific design perspectives within user-centred design. Today, user-centred design can be used as an umbrella term for HCI research that focus on users throughout the design process with established methods and techniques to ensure usability (Preece et al, 2002).

HCI moves towards including many different disciplines, approaches and perspectives of interaction design, such as to include more experience-related issues of design, ubiquitous computing, and interaction with robots (Preece et al, 2002). However, the field can still face challenges when it comes to understanding or conducting design beyond a usability perspective (Harrison et al, 2007; Boehner et al, 2007). Even if new perspectives are desired within the field (Norman, 2004; Schneiderman, 2002), research perspectives beyond user-centred design and usability are not necessarily well understood.

This thesis is not a statement against usability or user-centred design. In fact, methods and techniques that are common in user-centred design have also been used in this thesis. However, instead of starting with the intended users, we take a technology-driven starting point to investigate novel applications and

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1 There are many definitions of usability, and perspectives of how to achieve a user-centred process (e.g. described in Nielsen,1992; Hackos & Reddish, 1998; Preece et al, 2002)
interaction. Furthermore, the work evolves towards learning from experiences and activities that may not be found among the intended users.

**Experience-centred HCI**

*Experience-centred design* is a research orientation that opens up for new perspectives of HCI research, beyond usability and the traditional user-centred design philosophy. It can support researchers and designers to take a perspective beyond usability and to explore novel design and design tools.

Generally, experience-centred design strives “to include wider qualities of peoples experience with technology” beyond usability (McCarthy et al, 2006), and has also been acknowledged in literature as an important research direction (e.g. by Preece et al, 2002; Norman, 2004; and Schneiderman, 2002). Such research can for instance involve design approaches to understand different experiences by physically engaging in brainstorming activities (Buchena & Suri, 2000), describe the value of ambiguity in design (Gaver et al, 2003), or design for ludic aspects of everyday life, e.g. to support reflection, exploration and non-utilitarian activities (Gaver, 2002), and investigate aesthetic or fulfilling experiences (McCarthy & Wright, 2004). The research can also point towards the value of open and interpretative evaluations (Sengers & Gaver, 2006), describe how to evaluate affective designs (Sundström et al, 2007) or to evaluate ludic aspects instead of usability in a design (Gaver et al, 2004b). Thus, within such a research-orientation computer artefacts can be investigated for entirely new roles and the potential to fulfil many different types of desires, beyond making tasks efficient, effective and satisfying (e.g. McCarthy & Wright, 2004; Gaver et al, 2003). However, there is also experience-centred research that e.g. aims to establish a theoretical framework in order to understand experience (Forlizzi & Ford, 2000; Forlizzi & Battarbee, 2004; McCarty & Wright, 2004), or research that considers that experience is ineffable and can not be understood by deconstruction (Boehner, 2006). Furthermore, there is research that draws upon a cognitive perspective of experience (Norman, 2004) and for instance considers experience to be an extension of the term usability that can be measured (Hassenzahl, 2004; Mahlke, 2006). Our research is related to experience-centred research that investigates *novel perspectives* of the design and evaluation of computer artefacts, and investigates their potential use, interaction and role. Our emerging focus concerns how existing experiences, activities and desires can be used as inspiration in technology-driven design situations.

**Design-oriented research**

Our design activities have taken a technology-driven starting point, and the outcome of the design activity has evolved throughout the process. This is related to a design perspective where the problem and the solution develop in
parallel (Lawson, 2006). This has involved an ongoing conversation with the
design situation as it emerges, and uses of existing design tools to support the
process. Thus, we have conducted design activities differently from when
methods and terminology are taken from engineering and from natural sciences,
and where the design activities strictly follow a prescribed action (Jones, 1970).
Our approach is also different from a more romantic perspective, where the
design is entirely a hidden process of creativity (ibid.). It is more related to the
pragmatic account of design described by Fällman (2003a). Within this
perspective, the designer has capabilities to assess the process, and can to look
for potential ideas, solutions or methods to support it. Furthermore, this
perspective is related to Schön’s (1983) perspective of how professional
knowledge can be generated from reflective design activities:

“When someone reflects-in-action, he becomes a researcher in the
practice context. He does not depend on the categories of established
theory and techniques, but constructs a new theory of the unique case”
(p.68).

Reflective-design activities have been considered suitable for design in HCI
by for example Fällman (2003a) and Löwgren and Stolterman (2004).

**Design tools**

Methods and techniques can be seen as vehicles for extending the designers
ability, and need to be appropriated to fit a unique design situation (Löwgren &
Stolterman, 2004). By learning a new method or technique, the designer can
extend their languages and repertoires for different design situations. Methods
can even be considered as more powerful when the designer can go beyond them
(Löwgren & Stolterman, 1999). Below we will describe how design ideas can
emerge, how to stimulate novel designs, and some approaches to visualise
design. Several of these are more user-centred or experience-centred, and some
are oriented towards learning more about specific technology properties.

**Design ideas**

Design activities can take different starting points, and have various types of
constraints that frame them. There are also many techniques that support
generation of ideas, such as various forms of brainstorming techniques (Löwgren
& Stolterman, 2004; Holmquist, 2006).

In a user-centred design process, users can be actively engaged in idea
generation (Bødker et al, 2000; Dixon et al, 1997). Ideas to inform o inspire
design can also come from field studies (Beyer & Holzblatt, (1998). However,
design ideas can also be driven by opportunities provided by new technology or
technology visions that is not yet grounded on existing practices (Araya, 1995;
Rogers, 2006; Bell & Dourish, 2007). However, from an innovation perspective,
it can be considered less crucial where the original idea first from, and that the
process of implementing it is more important for something to become an innovation (Berkun, 2007).

**Techniques for defamiliarization**

It can be difficult to come up with novel design ideas and perspectives, and to “think out of the box”, in design activities. However, methods and techniques can support taking alternative perspectives or to de-familiarize something that is very familiar (e.g. Bell et al, 2005; Djajadiningrat et al, 2000; Gaver & Martin, 2000). Defamiliarization is a common technique in art and critical design (e.g. Dunne & Raby, 2001). In HCI, such techniques can also be useful for different situations. For instance, Interaction Relabelling is a technique that can support a de-familiarization a product, by combining or merging two different products into one (Djajadiningrat et al, 2000). Extreme Characters is another technique to stimulate a new perspective of design, by designing for an extreme individual (Djajadingrat et al, 2000). This means to e.g. explore a design concept for the Pope, a stereotypical drug dealer or another extreme character. Such an exercise can stimulate alternative viewpoints think beyond the most familiar designs. Another technique called Analogous Experiences (Battarbee, 2007) can support new perspectives on an existing design, by using an analogy to associate the design with experiences that it is not usually associated with. Furthermore, the method Extreme Users (Gilmore & Veláquez, 2000), stimulate de-familiarization by learning from atypical users instead of the typical users. Another technique related to this is Pastiche Scenarios, where for instance the use of a computer artefact is described through a famous character from a film or book, to stimulate a new perspective (Blythe, 2004). However, also studies of less general practices, for instance technology-adoptation in specific religious practices (e.g. Umble, 1999; Woodruff et al, 2007) can potentially stimulate alternative perspectives of existing designs and technology development. Overall, approaches that provide specific constraints for creativity can support designers to come up with novel designs and ideas. In our work, creativity is constrained or affected by properties of the initial technology idea (e.g. sensors, or emergent behaviour etc.) when learning from specific activities and experiences in a practice. Similarly to defamiliarization techniques, an early focus on the technology properties, as well as taking inspiration from a specific practice, provide specific constraints for creativity, different from a more user-centred design process.

**Visualizing design**

There are several methods and techniques to visualize and conceptualise a potential design, for example by sketching, creating narratives and conducting other types of prototyping activities (Preece et al, 2002; Löwgren & Stolterman, 2004). Some prototyping activities involve designing a more or less working artefact, whereas others are more oriented towards investigating potential use
situations. For example, some role-playing techniques, such as *Informance Design* (Burns et al, 1994), and *Experience Prototyping* (Buchenau & Suri, 2000) can support an understanding of the use situation by “acting out”.

**Scenarios and narratives**

A variety of narrative and scenario techniques can support to understand the existing users needs and a potential use situation (Carroll, 2000; Beyer & Holzblatt, 1998; Grudin & Pruitt, 2002). Depending on how scenarios and narratives are constructed, they can also reveal more experience-oriented design issues, for example as a written “story” of a use situation where it is possible to get glimpses of someone’s experience with a system (e.g. McCarthy & Wright, 2004). Another approach is *Design Documentaries*, where a film for instance can describe a fictive user’s everyday life based on data from real users (Raijmakers et al, 2006).

A well-established technique that also involves fictive users, to reflect field data is *Personas*. Personas can generally be used to illustrate users’ needs, goals and actions (Cooper, 1999). A persona is a fictive representation of a user, for example consisting of images and text, developed from user data and consisting of a rich description of her motivations and goals (Pruitt & Grudin, 2003). Personas is a useful tool to guide the design process and to help a design team to engage in potential users and their needs or desires. This technique has also been considered more engaging than other types of scenarios that focus more on use issues, than to describe the person and his or her motivations for a certain use (ibid.). Similarly to other techniques and methods, it can be applied differently to fit a unique design situation. We have used Personas in one of the design cases, but have applied the technique somewhat differently. Here, the fictive users are based on data from a studied practice where the practitioners are not intended as users. However, the data is still used to reveal potential experiences and interests for the design outcome.

**Prototyping**

Prototyping activities are a way to visualize the design, and to learn how this may work and be experienced in a realistic use situation. Houde and Hill (1997) have specified different types of prototypes. For example, some prototypes do not have technical functionality but are instead created to provide insight in the “role”, and the “look and feel” of a potential design. Other prototypes can be technically working to reveal issues that concern the technical “implementation” as well as the experience and the role of the design (Sundström et al, 2007; Brunnberg & Juhlin, 2006).

Cardboard prototypes or mock-ups can provide insight in “look and feel” issues, and users can be asked to imagine technical functionality and “pretend” technical functionality in a realistic use situation (Ehn and Kyng, 1991; Iacucci et al, 2000). Also, storyboards can be considered as prototypes when they
describe the role and “look and feel” of a design (Houde & Hill, 1997). Other related prototyping activities where scenarios and narratives support the understanding a potential design are video scenarios (Mackay et al, 2000) for example in combination with performances (Iacucci et al, 2002). Compared to technically working prototypes, these prototypes have “imagined” technical functionality, which may thus limit knowledge about how technical properties can become a meaningful part of the experience. Mock-ups have especially been considered as a useful tool early in the process, when it is desirable to reduce the time and cost to build and program working prototypes.

Technically implemented prototypes show that the technology actually works, and do not create an illusion of products that are impossible to implement (Holmqvist, 2005). Furthermore, they make it possible to incorporate and investigate specific technical limitations or properties that can become a meaningful part of the experience (Chalmers & Galani, 2004; Gaver et al, 2004b). This makes it possible to learn about how to take advantage of specific technical limitations or possibilities to create a meaningful user experience, for example using limited network coverage as a feature in a game experience (Chalmers & Galani, 2004). Thus, even if technically working prototypes may have technical obstacles, they can provide valuable knowledge about a potential use situation as well as the potentials and challenges of the technology in use. Furthermore, a prototype can be partly implemented and have some functionality that is “simulated”, intended to appear to work fully for a user (Dahlbäck et al, 1993). This can also provide technical insights as well as other knowledge when it is tested with users (Östergren & Juhlin, 2006).

Understanding design in use

Similarly to how prototypes are designed for different purposes, studies and evaluation of them can be conducted with different perspectives and approaches.

For a more traditional user-centred design, an evaluation can involve identifying potential usability problems, for instance by inspection-based evaluations (Nielsen, 1992), model-based evaluations such as GOMS (Card et al, 1983), or lab studies where for example users think aloud when interacting with the system (Preece et al, 2002). Lab studies in combination with for example a Wizard of OZ approach has been used to understand how people interact with robot technology (Dautenhahn, 2007). In a Wizard of OZ study, the technology is not fully working but is controlled by a person (Dahlbäck et al, 1993). Overall, lab studies can support controlled experiments, but this not suited for all types of research problems where uncontrollable variables are considered to provide valuable knowledge.

Field studies, or studies “in the wild”, can be desirable when aiming to understand the potential role and use of e.g. novel ubicomp technologies or mobile technologies in a realistic situation (Iachello et al, 2006; Weilenmann
Background

2003). Generally, such studies can be conducted in several ways, from different perspectives and at several points in an iterative process (Preece et al, 2002). For example, field studies can involve evaluations in home settings (Gaver et al, 2004b), on the streets in a city (Benford et al, 2006), at a sport event (Jacucci et al, 2007), or in everyday use situations (Sundström et al, 2007). In field studies, users can try existing products (Jacucci et al, 2007), technically working research prototypes (Iachello et al, 2006; Kjeldskov & Graham 2003; Benford et al, 2006), or even early mock-ups (Iacucci et al, 2000) in a realistic use situation. Wizard of OZ approaches can also be used, e.g. to study a partly technically implemented mobile application in a dynamic use situation (Östergren & Juhlin, 2006).

Conducting field studies or other types of evaluation is challenging, especially with technically working prototypes where the technology can be unreliable. In field studies the use situation is dynamic and not possible to control. This can also provide technical challenges e.g. that limited coverage affects the user experience in a game situation (Crabtree et al, 2004). However, technical limitations can also be deliberately incorporated in the experience (Chalmers and Galani, 2004).

Different data collection techniques such as interviews, observations, and questionnaires can be combined with the field studies (Preece et al, 2002). This can for instance involve collecting data with video and sound recording. Furthermore, the prototype itself can collect use-data automatically (Iachello et al, 2006). Data can also emerge from the use of a prototype, for example when participants in a study create messages in a mobile messaging system (Sundström et al, 2007).

Experience-oriented evaluations

One of the design cases has involved a longer exploratory study, where we learned about the use and the experiences of our design. Even if this study was not conducted to be primarily experience-centred, some of the issues that are considered important in this emerging field are also relevant for our work.

Experience-centred research is opening up for alternative perspectives of design. However, it is still unclear how to conduct evaluations or studies (Kaye et al, 2007). For example, existing interpretative user-centred approaches can potentially be modified to capture more experience-oriented aspects of a design in evaluation activities (ibid.). It is also possible to learn from other fields, for instance from interpretative research traditions that have a long tradition to reveal values, provide thick descriptions, and to understand situated actions (Kaye and Taylor, 2006), or from other fields that can provide insight in tools to approach or describe experience (Gaver, 2007).
**Chapter 2**

**Separating design and evaluation**

It can be beneficial to treat design and evaluation as separate activities, where the design activity is an exploration of the actual design, and the evaluation is an exploration of the interpretations of the resulting design (Sengers & Gaver, 2006). Multiple perspectives of a design outcome can especially be useful for systems that are expected to have other than work-related values, and e.g. are intended for play, exploration and reflection (Gaver & Martin, 2000). Furthermore, this is relevant when the researcher is interested in how users create their own meaning of a certain design (Höök, 2006; Sengers & Gaver, 2006). Such openness can for example be achieved by explaining only how the system technically works for users in an exploratory study, but not explain how the system should be used (Sengers & Gaver, 2006). This is seen in Dunne and Raby’s (2001) Placebo project, where people adopted furniture with electronic properties, and in the study of a digitally augmented living room table by Gaver et al (2004b). This has also been the approach in an exploratory study by Sundström et al (2007). Overall, this is a different perspective from more traditional HCI research that focuses on tasks and strives for one type of interpretation (Sengers & Gaver, 2006).

**Describing the user experience**

McCarthy & Wright (2004) consider narratives as potential tools for describing experience-oriented aspects of an existing design, where the readers should see “felt life” for themselves and to draw their own conclusions about the experience of the design from the narrative. Narratives can describe actions and feelings, but also describe reflections about those actions and feelings (ibid.). However, McCarthy & Wright argue that narratives constructed from someone’s “lived” experience, should not be seen as mirrors of what “actually” happened, but instead be seen as selective interpretations, constructed for a purpose and an audio. Similarly, for one design case in this thesis, short narratives are used to provide glimpses into different experiences and approaches of people that used a design.

A possible approach to investigate and describe experiences of a design is to use “commentators” from other disciplines, such as filmmakers, journalists and ethnographers (Gaver, 2007). In the Placebo project (Dunne & Raby, 2001) people “adopted” furniture with some technical properties. The result of the study was presented as “raw” interview-material, with questions and answers and pictures. Such lack of analysis can make the reader free to make their analysis – and thus open up for different interpretations of the results (Höök et al, 2003). Finally, instead of trying to evaluate or describe someone else’s individual experience, the designer can use and reflect upon the designed computer artefact and describe her own experience (Sengers, 2006).
Grounding design

Our design cases evolve towards grounding design in activities and experiences that are not necessarily found among the intended users. This section will describe some general data-collection activities and other methods to ground or inspire design. This includes more traditional user-centred tools, as well as tools and perspectives that relate to the emerging experience-orientation in this work. Furthermore, we exemplify that design can be grounded in experiences and activities that are not necessarily found among the intended users.

Tools to understand design requirements

In HCI, interpretative inquiry methods such as interviews, observation and focus groups are often used to collect data as requirements or specifications for design (Beyer & Holzblatt, 1998; Preece et al 2002). Such perspective is seen in the two first design cases in this thesis. Data-collection can also be technically oriented, for instance where sensors automatically collect data from activities in a home setting to inspire early design (Beaudin et al, 2004). Furthermore, specific design approaches can also support data-collection. For instance, the design method Making Tea (Schraefel et al, 2004) shows how analogy can be used to improve the understanding of an unfamiliar setting.

Inquiry methods or techniques that stem from interpretative approaches, such as Ethnography (Atkinson & Hammersly, 2007), can be conducted with different perspectives or intentions (Flick, 2006). For example, observation and interviews can be conducted to understand more experience-oriented issues, such as meaning making in human practices (Flick, 2006) or to understand a usability concerns in a work context (Beyer & Holzblatt, 1998). One potential challenge with methods that originate from fields such as ethnography is that they were not originally intended to support design, but instead to “understand” a setting (Dourish, 2006; Button & Dourish, 1996). Thus, data-collection can support understanding and to interpret existing activities and practices, without necessarily being a design tool in itself (Dourish, 2006).

Tools for design inspiration

Some methods in HCI use tools for data-collection primarily as inspiration for design and to support a creative process. This perspective is especially prominent in the last two design cases in this thesis. Methods such as Cultural Probes (Gaver et al, 1999) and Technology Probes (Hutchinson et al, 2003) exemplify how data gathering can be conducted to stimulate a creative design process.

In Cultural Probes, evocative tasks are given to users “to elicit inspirational responses” that can be used as inspiration for design (Gaver et al, 2004a, p.53). The underlying idea with the method was to encourage play, exploration and subjective interpretation as a resource for design. The results in Cultural Probes can provide inspiration for design, but do not give a clear guidance to the
process. Several other designers and researchers have appropriated the design method, and even created new methods. Sometimes this has also involved an ambition to collect factual descriptions of user needs, which thus is a different perspective than the method’s original intention (Gaver et al, 2004a; Boehner et al, 2007).

Cultural probes have inspired many different types of “probe methods” (Boehner et al, 2007). For instance, Technology Probes are technical devices with one single main function, preferably open-ended (Hutchinson et al, 2003). They can be placed in a home to log the users’ activities, complemented with participatory brainstorming activities. This method analyzes potential interests and needs, but also open up for creative appropriation of the introduced technology (Hutchinson et al, 2003). Furthermore, this method allows both the technology and the users to provide the ground or inspiration for design. Thus, specific technology properties will colour the data collection. This is related to how this thesis work evolves towards having specific technical properties in mind, when deciding where to collect data and what parts of the data that are especially inspiring for design.

Finally, technology probes and other types of “probe” methods (Boehner et al, 2007) illustrate how researchers can use an existing design method or an example of a design process, as learning tools. Such tools make it possible to take new perspectives and investigate new approaches or even new design methods. This is relevant as this thesis contributes with several examples of design processes and provides an overall reflection of these, which other researchers can learn from.

Interpreting experience to ground design

Even if human experience is subjective and situated in its nature (Dewey, 1934), it can still be interpreted to inspire design. This perspective is also prominent among other researchers that investigate how experience-centred design activities can inform, inspire or understand HCI design beyond usability (McCarthy & Wright, 2004; Wright et al, 2006; Sengers & Gaver, 2006).

The last two design cases in this thesis are more experience-oriented than the first ones, and describe analysed parts of the data as qualities of specific experiences. Such qualities includes properties or characteristics of an interest, activity or experience and might for instance include that something is joyful, meaningful, challenging or exiting in certain ways, which can inspire design. This is related to a holistic and situated view of experiences and experiential qualities intended to support a design situation (Wright et al, 2006). This is a different perspective than for instance studying individuals to understand tasks and needs, without necessarily considering their motivation and desires as the most interesting features to ground the design. Furthermore, which experience, or what qualities of an interest or activity that will inspire the design, is here dependent on the initial technology concept and its technical properties. Thus,
the experiences are interpreted by using existing or intended technology properties as an “analogy”, to support reflection on potential experiences in an application. This use of analogy will be further discussed in the coming sections.

Other researchers have previously used the term “qualities”, for instance when referring to use-qualities that describe characteristics or properties that emerges in the use of an artefact (Arvola, 2004). Such qualities can be described with the intention to support a more general design language, intended to be used in different design situations (Löwgren & Stolterman, 2004; Löwgren 2007; Löwgren, 2006). Qualities have also been described with more traditional usability perspective to denote criteria for effective interaction design (Alben, 1996), and as measurable characteristics of usability, e.g. as instrumental and non-instrumental qualities of usability (Hassenzahl, 2004; Mahlke, 2006). The term “qualities” already have several different meanings in HCI (Sutcliffe et al., 2006), and can for instance refer to more pre-defined attributes or even be considered as measurable. In this work, the investigated qualities have instead emerged from the study and from the specific design situation at hand.

Design inspiration beyond the intended users

Experience-centred research can strive to study and engage users in the design (Sundström et al., 2007; Sengers & Gaver, 2006; Buchenau & Suri, 2000; Swallow et al., 2005). However, the design cases in this thesis evolve towards investigating experiences that are not studied among the intended users. Instead they are studied among people that are engaged in activities and experiences that can inspire design. A motivation for this is that people who are involved in the design process are not likely to generate inspiration of for a novel design that is fundamentally different from what they are used to (Von Hippel, 1986). This section will describe different design methods and other existing perspectives that involve learning from other people than the intended users, to inspire design. However, first we will describe how using an “analogy” can support design activities, and to find potential experiences that can inspire design.

Interpreting experience as analogy

We can be considered to be using an analogy when matching a specific technology concept, with experiences found in a specific practice, in order to ground design. According to the online version of Cambridge Dictionary\(^1\), an analogy is “a comparison between things which have similar features, often used to help explain a principle or idea”. An analogy can support early creative design activities (e.g. MacLean et al. 1991; Beyer & Holtzblatt, 1998), improve communication between designers and users (Schraefel et al, 2004) or be

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\(^1\) Online Cambridge Advanced Learner's Dictionary
implemented as a metaphor in the design to simplify understanding for users (Hackos & Redish, 1998).

Some design methods and student exercises in HCI make use of an analogy. For example, *Making Tea* (Schraefel et al, 2004) is a design method that illustrates how experiments in a chemistry lab were interpreted as “making tea”. Here, an analogy was used to support an understanding of the “unfamiliar” activities in the chemistry practice, and the communication between the designers and the chemists (ibid.). This is different from our work, where the analogy is used to understand the design material, as well as potential experiences that this can involve. Another technique, that is more related to our use of analogy is *Analogous experiences* (Battarbee, 2007). Such approach takes the design material into consideration, to reflect upon the experiences that can be associated to this. For example, to understand the painful experience of removing bandages or plasters – when designing plasters – an analogous experience could be to experience the pain of waxing off hair. Similarly, when designing a car, analogous experiences could involve investigating other types of travel experiences, such as horseback riding or from other activities on wheels (Battarbee, 2007). Finally, Jensen and Stienstra (2007) describe a student exercise that makes use of an analogy. They studied practices that involved movements, for instance observing someone giving massage or sculpturing, to inspire interactive sculptures with qualities from movement. However, even though they took inspiration from movement into design, this did not focus on for instance understanding the enjoyable or meaningful qualities that the practice involved. Thus, this is not the same as using an analogy to understand a technology, by learning about meaningful or enjoyable qualities of existing experiences that are seen as analogous to what the technology potentially could give rise to.

*Extreme users*

A related approach to investigate potential qualities of experiences that currently might not be found among the most typical user is to investigate *Extreme users*. Extreme users are real people, deliberately chosen to provide alternative inspiration for the design. This design technique thus deliberately looks at different, extreme and atypical users that can “embrace diversity” (Gilmore & Veláquez, 2000). This has been used at the consultancy firm IDEO¹, for example for a client that has a well-defined market segment in mind for a new product. By seeking out people at the edges of that segment, it is possible to stimulate novel ideas. Battarbee (2007) gave the example of a car design, which could involve extreme users such as driving professionals, people with a passion for driving and people who hate to drive. She describes extreme users as individuals with extreme interests that are relevant for the design, holds an extreme relation

to, or are involved in other unusual conditions that are relevant. At IDEO such people would typically be invited to generate ideas in a workshop, which the designers then would continue working on. A related approach to this is unfocus group, where people with entirely different viewpoints are gathered for a design challenge evening (Battarbee, 2007).

Some of the design cases in this thesis have been reflected upon as extreme user approaches by Holmquist (2004). However, in our work, the practices are chosen to involve experiences or activities that are analogous to what the design material i.e. the technology properties, could support. Thus, the practices are not chosen to be extreme, but to reflect relevant experiences considering the technology at hand. Furthermore, whereas IDEO invites entirely different individuals as extreme users to an unfocus group event, the cases in this thesis have involved to study one practice – that is especially selected to match an initial technology concept.

Lead users

Another motivation for studying people beyond the most “typical” user is found in the lead users approach (Von Hippel, 1986). Von Hippel found that when regular users are selected to provide input data to consumer and industrial market analysis, they provided input that was restricted to their own real-world experience. Lead users are not the most dominant group of users, but are used as a resource for design. They can for example be a group of very advanced and atypical users\(^1\), whose inventive use of a product is considered as a resource for design. Lead users are people that find their own ways to solve problems or a specific solution or experience, coming beyond the ideas that users can contribute with.

The lead users approach has also been considered useful in user-centred design (Kujala & Kauppinen, 2004). For example, it has been used to explore experience-centred and accessible design in domestic environments (Jacobson & Pirinen, 2007). In this project, disabled people were considered as lead users, because they had adapted existing design solutions in their home to fit their own special needs and desires. In the project, the “lead users” documented their lives to generate data about emotional and aesthetic aspects of their experience, to inform experience-oriented and novel designs intended for people both with and without disabilities.

Von Hippel (1986) argues that when lead users attempt to fill the need that they experience, they do not only provide a potential general need-forecasting, but can also provide new design concepts and data into the design process. He also argues that lead users present strong needs – and that such needs are likely

\(^1\) Lead users are sometimes mistaken to be early adopters. Early adopters are individuals who quickly adopt new technology (Rogers, 2003). They do not necessarily appropriate an existing product to fit their own specific needs, such as lead users do.
to become more general. The approach that emerges in this thesis is related to lead users, because the studied practices in the design cases are approached as lead users more than users. They are intended to reveal potential enjoyable experiences that can inspire novel design.
Research

This chapter describes four design cases, that all have technology-driven starting points. They are part of an overall process that started with a user-oriented perspective and moved towards a more experience-oriented one. Each design case has used methods and techniques that are common within user-centred design (e.g. Preece et al, 2002).

The design cases evolve towards taking inspiration from people engaged in specific practices, but who are not necessarily the intended users. We can consider this a more experience-oriented perspective, which also affects the final design. In the following, we will provide an overview over the design activities in each design case and how this has contributed to the thesis. A more detailed description of each design case is provided in their complementing papers in chapter 6 to 11.

Informative Art

Informative Art (see chapter 6) introduced us to experience-oriented design issues and the challenges that these may involve. This case concerns a technology concept that initially was developed to allow for qualities other than task-oriented problem-solving activities, e.g. relating to aesthetics. However, in the end, what we designed and evaluated was a task-oriented system (e.g. Hackos & Redish, 1998). The design process provided valuable knowledge about usability-related issues of Informative Art, but did not provide knowledge about potential experiences that it could give rise to. This was despite the fact that such a perspective was considered important for the design. This represents a first lesson that guided us towards looking for alternative perspectives and approaches to design, and learning about design with a more experience-oriented perspective.

The concept of Informative Art is related to HCI and ubicomp research that investigates how the appearance of information technology could be aesthetically
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and physically integrated in everyday surroundings, with so-called ambient displays (e.g. Weiser & Brown, 1995; Ishii & Ullmer, 1997). Related research includes different information visualization techniques where everyday artefacts are augmented with digital information, for instance colour-changing textiles that present information (Holmquist & Melin, 2001). Other examples of ambient displays are e.g. wall-mounted computer screens where graphics and visual objects change according to specific data sources (Miller & Stasko, 2002; Fogarty et al, 2001) and picture frames that change their graphic appearance to reflect changes in the data source (Mynatt et al, 2001). Informative Art is also related to research that investigates how information technology can be designed to have a meaningful presence in everyday life, beyond a tool-oriented perspective (Redström, 2001).

The technology-driven starting point

Informative Art is a display that resembles visual art to show information and at the same time “decorate” a place, for instance the corridor or the room where it is situated. An early idea was that such displays could show information, but also could provide moments of reflection, or qualities of experiences relating to aesthetics (Redström et al, 2000). It could either be projected on a wall, or showed on a wall-mounted display. The display is generally connected to a digital information source, and the visual appearance changes according to updates in the data source. The data can for instance be a video stream from a web-camera situated in a room, or from an Internet site that is regularly updated.

Different information sources and visual aesthetics have previously been explored, for instance the activity in a room, displayed in the style of a painting by Bridget Riley, and earthquakes around the world, displayed as a landscape art in the style of Richard Long (Holmquist & Skog, 2003). Several prototypes have been designed with inspiration from the Dutch painter Piet Mondrian. One example is a display where the typical coloured squares of certain Mondrian compositions each represents a person in an office. Each square would change its size as an abstract display of how much emails a certain person received (Redström et al, 2000). In another prototype, the squares also changed their

Figure 1: Informative art displaying: email-traffic (left), the actual weather in six different cities around the world (middle) and, a weather forecast for Gothenburg city situated at the IT University (right).
colours between red (clouds), yellow (sun) and blue (rain) to reveal weather information in six different cities. The position of each square represented a city and their size reflected the temperature (Holmquist & Skog, 2003). Finally, another prototype was designed in a similar manner, but as a forecast of the local weather in Gothenburg. Each square instead represented the weather, one for the current day and the others as forecast for the next four days in Gothenburg, (Skog et al, 2002). Overall, Informative Art has been designed to display a variety of information. However, it had not been designed with tools that investigated how to support a specific kind of experience, or how different kind of art pieces could support certain kinds of experiences. Instead the design simply “borrowed” the visual language from existing art pieces to display information.

Investigating a potential application

We decided to design and evaluate a new piece of Informative Art, with potential users in order to learn more about the potentials of this kind of technology. As presented before, Informative Art already had already been implemented in several prototypes (Holmquist & Skog, 2003; Redström et al, 2000; Skog et al, 2002). We also had conducted a preliminary study of a weather forecast in the style of Mondrian (Ljungblad et al, 2003). At that time, we investigated if such a display was enjoyable as an information display, if it was readable, and e.g. how people that did not know that it was an information display would experience it (ibid.). We found out that several people enjoyed it when they knew it was a weather display, but that other people who did not know that the display showed information could e.g. experience this as inspiring digital art, or even as a bad paraphrase of Mondrian. After this preliminary study, we now wanted to learn more about challenges and benefits of Informative Art as a potential application.
Design process

The new design was a display of bus departure times intended for students at a local university, who used a special bus line that connected the university to the city. Here, Informative Art would use a web-based service that kept track of buses and trams with real-time data as information source. The users could use Informative Art to directly see when the next bus (and the bus after this) would arrive, instead of looking in a timetable to plan their trip.

The first design of the display was based on the previous prototype of a five days weather forecast. Four squares each represent a bus with a specific time for arrival. The colours and the size of each square displayed the time left until the next bus would arrive. Two of the squares represented buses heading to the city centre, and the other two represented the buses in the other direction.

To get feedback on our design, we interviewed a few students who used the bus service. They identified a number of problems with the display, e.g. to understand which bus that was heading in which direction, and which end stop it had. Based on their feedback, we re-designed the display to include a rectangle to represent the local river as a geographic cue and a line to indicate two different final stops. We then installed this to run for 15 days at the university, with a complementing caption for how to read it.

A preliminary evaluation

After the display had been implemented for 15 days, we conducted on-site interviews with six students who were situated near the display or were passing by at the time of the interview. The interviews were semi-structured, and we first asked more open questions about if they already knew what the display was showing, if they used the bus and had used the display, and if they had used the same information on the Internet. We also asked more detailed questions about
how the display worked, to see if they really had used it. Finally we asked what they thought of the display, concerning the aesthetics. The interviews were documented as notes, and their understanding of the display was documented on a sketch of the display.

In this preliminary evaluation we focused mainly on readability issues, but we also learned about issues concerning where such a display should be physically situated when asking why they had used it or not. From the results, and in relation to our previous designs, we reflected upon issues that related to the information scope, the update rate, and the visual encoding. For example, we found that the chosen artistic template actually could support readability, even if some of the graphics were used inconsistently – e.g. a few lines presented information concerning the final bus stop, whereas others were only used as decoration.

**Lesson learned: The intended users are not necessarily the most knowledgeable in experience-oriented design issues**

In the beginning of this project, we considered the aesthetics to be a primary issue. Despite this, the design and evaluation was oriented towards the practical task of catching a bus and how to make the display readable for this task. The results from the design and evaluation of the bus display provided valuable insights, and made us reflect on overall issues for designing Informative Art, concerning information source and visual encoding. However, this approach did not succeed in providing knowledge about potential experiences that could be relevant for the design process of making a real-time information display out of an art piece. Nor did the evaluation provide an understanding about the potential

![Figure 4: Informative art installed to display bus departures at the IT-University in Gothenburg.](image-url)
enjoyment and other qualities related to art, e.g. as an engaging emotional or even provocative experience. The challenge to conduct more experience-oriented research of ambient displays has later been acknowledged by Harrison et al (2007). They argue that ambient displays need to be evaluated beyond a task-focus, but that such design and evaluation activities are difficult to conduct in a field with a strong tradition of usability. At the time of the Informative Art project, approaches such as usability inspection methods were also considered as low cost evaluations and guidelines for ambient displays (Mankoff et al, 2003). This also exemplifies how such displays would be designed and evaluated to “fit within the existing knowledge within the field, primarily focusing on usability.

In the previously designed weather forecast, we reflected upon qualities that were beyond usability – striving towards enjoyable information displays (Ljungblad et al, 2003). The users were also asked what they felt about the visual appearance of the display, and could express in what ways they enjoyed or disliked the graphics, for example if they were considered decorative, fun or provoking. However, this did not result in knowledge that we could use to make the visual art an important property of the design. For example, we did not learn about experiences related to specific kinds of art and what makes such experiences enjoyable. This would require a different approach, preferably learning about such experiences early in the design process.

The above does not imply that Informative Art is unsuitable to support everyday “tasks”, such as catching the bus. We focused on designing a display that would be usable. In this process we learned much from the design and evaluation activity, for example about how the location of the display matters, and about readability and other usability issues. However, it does mean that we as designers did not focus on investigating the specific types of experiences that Informative Art potentially could contribute to, which would have been suitable to bring out in an early phase of the design process.

Overall, Informative Art can be seen as a first step towards an experience-oriented research perspective. Our design and approach did not address the aesthetic qualities that we originally intended to cater for, but it made us reflect upon the challenges to explore applications that have a technology-driven starting point – from a usability and task-oriented perspective. This provided the starting point to more closely consider existing technical properties and potential experiences or activities that can be relevant to take inspiration from at an early phase in the design process.

**Pin&Play**

Pin&Play (see chapter 7) investigated a potential application for a not yet mature ubicomp technology. This design case is not experience-oriented, but contributed with knowledge on how studies of an engaging practice can guide an early technology concept. We strived for grounding an early technology concept in an
existing practice, by matching it with the scheduling activities at a local film
festival. This included interviews and observations to learn about the team’s
activities and interaction with paper notes on larger notice boards used as
scheduling tools. We developed a working prototype, which also was tested with
the people in the practice. This design activity gave us a better understanding of
the existing technical properties, and about the challenges and benefits that a
potential application could involve. Furthermore, this design case made us reflect
on how people that engage in specific practices can support a design process of
ubicomp technologies and other not yet mature technologies.

This design case is related to research of ubicomp technologies that
investigates networks on boards or table surfaces, such as Networked Surfaces
(Scott et al, 2002) where objects placed on a surface becomes connected, and
Pushpin Computing (Lifton & Paradiso, 2002) where pushpins communicate
with each other to create a network. These ubicomp technologies are not based
on studies of existing practices, but are similar to the first Pin&Play prototype in
that they represent early technology concepts. Furthermore, this design case is
also related to studies of collaborative work practices (Perry & O’Hara, 2003)
and to technologies that have been investigate as support for such practices. This
includes the Collaborage System (Moran et al, 1999) where paper notes are
tagged with data glyphs and Senseboard (Jacob et al, 2002) that uses physical
tokens with electronic ID tags.

The technology-driven starting point
The initial Pin&Play technology was developed at Lancaster University by Van
Laerhoven et al (2002). The technology was exemplified with a prototype that
allows pushpins to be connected to a network when they are attached to a board.
A conductive surface (on the board) provides the pushpins with power and data.
Each pushpin has a needle, which is a connector to the surface and to the
network. The pushpin also consists of a switch with an ID, and has an iButton (a
component that contains memory, battery, calendar, clock and alarm) and light
emitting diodes (LEDs). Artefacts such as paper notes or posters can be attached
with a pushpin, and the system can be programmed to e.g. make a pin lit up to a
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paper note on a certain time and date. The existing prototype showed the technology properties, but it had not been developed for users but instead to verify technical features.

Investigating a potential application

We wanted to explore the benefits and challenges for a potential application for Pin&Play. The properties of Pin&Play, i.e. that the pins could hold paper notes, and be connected to digital information, led us to look for a practice engaging in activities involving notice boards and paper notes.

Matching the technology concept with a practice

We brainstormed and searched for different types of practices that used notice boards and preferred this compared to other types of tools. Finally, the Göteborg Film Festival was chosen as a relevant site to explore for the Pin&Play technology. The staff used entire walls, filled with small paper notes, to schedule the annual festival. Their practice involved an explicit preference of paper, and they believed that digital technologies and screen-based interaction would not provide sufficient overview. Their practice was relevant for learning about a technology that potentially could support paper-based practices. Their activities were also suitable to study, as they had specific “scheduling sessions” where they would actively collaborate and schedule on the boards.

Field work

We conducted observations and interviews similar to participant observation (Atkinson & Hammersly, 2007), during the planning of two consecutive festivals. This means that the observation was held in the field setting and was combined with interviews using open-ended and flexible questions, affected by the observed activities. The observations were conducted during hours of intense scheduling, and interviews were held both before and after the scheduling process. The data collection during the observations involved field-notes and video, which preferably can be used in combination with observation and interviews. The interviews held after the scheduling processes were conducted to clarify the previous field data and ensure that we had interpreted the practice correctly. The first year’s session provided more general insights into the scheduling activities, and led to preliminary implications for the design (Håkansson et al, 2003). The second year provided further understanding of the process, and led to more detailed implications for the prototype.

Paper-based collaborative scheduling

The data provided insight into how the festival scheduling process was conducted. The scheduling was a highly collaborative activity, which lasted for several weeks and ultimately resulted in that 700 paper notes were attached to large boards. Each paper note represents a film screening, and each day of the
The Gothenburg Film Festival staff, using their office walls to schedule the annual film festival.

festival has a separate matrix. In the matrix, each of the 14 festival cinemas are represented by a column, and the 8 possible screening times are represented by rows. When the schedule is finished it is proofread several times, and then transferred to a digital database by giving each film a screening number, and typing this into a digital database. The database is connected to an SQL server, and is also used for the catalogue and the ticket vending. A separate group that works with arranging seminars also need access to the schedule. They are located in another room, and can not see the boards. However, if a film changes its screening time and has a related seminar, the seminar also needs to be changed.

The team uses “tacit” fingertip knowledge to determine which screening slot that is suitable for which film. This includes the anticipated audience, their own feelings about the film, and current and expected publicity for a film. Other information is more practical, such as the film format (that only some cinemas show), length, availability, transport time between screenings, awards screenings etc.

The coloured paper notes provide overview of the large-scale schedule and covers several walls. Most films are prepared as hand-written paper notes before the actual scheduling takes part. However, it did occur that films were also booked on the fly by a spuriously created Post-it note or other paper pieces, to
temporarily represent a film or an unavailable screening time. The paper provided for a flexible process, where it was fast and easy to make changes. Someone in the team would hold the paper note when discussing the screening, and then physically attach it to its place in the schedule. Paper also provided the opportunity to improvise and create new functions. For instance, a note could be folded or positioned askew, to represent not fully settled decisions. However, the paper also had some drawbacks. The team members suffered from the high cognitive load of the task, and needed to use both their “fingertip” knowledge, and to keep in mind the more practical information. This made it easy to make errors, e.g. by calculating the ending times wrong, or forgetting to notice that a film cannot be displayed on a certain cinema, due to its film format. It also becomes difficult to localize a film, when the boards are filled with paper notes. When the schedule is transferred into a digital format, there is a risk of transferring the wrong details to the ticket database, which according to the festival manager would be “a disaster”.

Design
To learn about the possibilities and limitations of the Pin&Play technology, we developed and tested a scheduling prototype with the team. The prototype was intended to provide insights into potential benefits and challenges of this not yet mature technology. It represents a section of the full-scale schedule, and allows 15 films to be distributed over 2 days. A web-based version of the system allows the users to search information and to display additional information. This also makes it possible to digitally transfer the final schedule to the database, and give each film a screening number – a task that is otherwise done by hand, potentially risking many typing errors.

In the prototype, each paper note is given a unique digital ID with a pushpin. The ID is connected to information in the database, such as film length, film format. When positioning the note on the board, the system is updated by associating the pin ID with the selected slot that has specific screening time, cinema and day. The system then compares the length, format, availability, and possible planned guests of the film with the criteria of the slot.

Testing the prototype
The prototype was first pilot-tested with four people with no knowledge of scheduling, and then tested by two of the team members. Both tests took place at our lab, and involved scheduling tasks based on scenarios developed from our field data. The pilot test was done to identify technical problems and to prepare for the test with the festival team. We videotaped the film manager and one team member who were thinking aloud when doing scheduling tasks. After this we also discussed the overall system with the team. Overall, the evaluation and the discussion with the team lasted for approximately two hours.
Evaluation findings

The film festival team said that the Pin&Play scheduling prototype captured the scheduling practice well. The prototype was considered to have the potential to keep the overview, while at the same time include the benefits of tracing and representing actions digitally. The team was pleased that more practical issues could be off-loaded to the computer, and that corrections needed for screenings appeared as notification icons in the web-interface. Furthermore, the web interface was appreciated because it made it possible for people that were not present in the room to follow the scheduling. The prototype made it possible to locate films on the board, and search entirely new parameters, e.g. new genres that were not displayed on the paper. This was considered as a desirable function, according to the team. Finally, the transfer of the schedule to the database was considered as one of the most important features of the system. We also learned how some tasks are better for screen-based interaction and visualization of information. Thus, existing computers could complement the
prototype and for example provide more suitable interaction for tasks that concerned searching and counting specific films.

**Lesson learned: A practice can reveal situated challenges and potentials of a specific technology**

Investigating ubicomp technologies by conducting studies of existing practices have been encouraged e.g. by Rogers (2006) and Bell & Dourish (2007). This case study is an example of how ethnographically inspired field studies can support the investigation of ubicomp technologies. We learned from an engaging work practice, that appeared to have similarities with what the technology potentially could support. Studying the film festival team helped us to better understand the properties of the technology, and provided knowledge existing practices and qualities that such technology potentially could support. The studies and the design activities also resulted in knowledge of more general challenges to support paper-based practices (Ljungblad et al, 2004b).

We focused on designing the system so it would allow the people in the practice to still be experts of planning films with a tacit “finger-tip” knowledge. Thus, we especially focused on supporting existing tasks that were considered dull and difficult, and to not override their expertise in scheduling films or other meaningful activities. However, adding digital support to an existing practice will lead to changes in routines and approaches. For example, even a pin without computational properties has tangible and visual feedback and is not necessarily something that the user reflects upon. However, computational pins are not only pushed into a board but should also be connected to a network. This provides new demands on feedback to prevent that pins are mistaken to be connected when they are not. During the test of prototype, the digital connection between a paper and a pushpin was hard-coded i.e. the paper with written information was already attached to the pin (which ID had a film number and additional information connected in the database). In a real situation, a pushpin and a paper note would have to be manually connected at some point, and this would require a new routine. Finally, this system addressed another important challenge for ubicomp and tangible computing systems such as pushpins – that not all physical actions are possible to trace digitally (Dourish, 2001). For example, the team sometimes attached a paper note askew, to communicate a potential change. However, this could not be traced with the system. This suggests that the people in the practice need to be aware of the system’s limitations so they can appropriate their own practice to avoid mistakes.

We were interested in learning about the activities in the practice and how to support their expertise. However, the main goal of this design activity was not to find out the best potential technical support for the studied practice, but instead to learn more about the Pin&Play technology and its potential applications and challenges. Doing this, we also learned about how useful existing activities and meaningful practices can be to guide design for not yet mature technology ideas.
Context Photography

The Context Photography project (see chapter 8 and 9) started with an early idea of augmenting a digital camera with sensors. We wanted to explore this as a potential digital photography application and to design for a meaningful photographic experience. To achieve this we decided to look into an existing practice to learn from, in order to focus on potential meaningful and enjoyable experiences at an early stage. We decided to work with amateur photographers that engaged in a practice called Lomography. We learned about their enjoyment and experiences of this photographic practice in order to support our design process, but without considering them as the intended users. The resulting prototype was used in a six weeks long exploratory study, consisting of amateur photographers interested in novel types of digital photography.

Context Photography is related to research that studies emerging digital photography practices, for instance where people take images as form of self-expression (Kindberg et al, 2005; Van House et al, 2005). It is also related to ubicomp research where context data is derived from sensor data, for example by logging the users activities or her environment (Dey, 2001). Context data can directly influence a system, but it can also be collected with the intention to be used later, for example as support to learn how to take pictures inwith a digital camera (Holleis et al, 2005). Furthermore, Context Photography relates to research that combines sound recording and picture taking (Frohlich & Tallyn, 1999; Bitton & Agamanolis, 2004) and video applications that are influenced by sound data (Healey & Picard, 1998; Lockerd & Mueller, 2002).

The technology-driven starting point

For Context Photography, the starting point was an overall idea of everyday use of digital cameras, where many pictures can be taken without high costs. Even if digital camera technology is different from a traditional film-based camera, it currently very much resembles the analogue counterpart. Our idea was to investigate how sensor data, such as sound, temperature etc. could visually affect pictures as they were taken, and be saved as contextual information with the picture. However, this early technology idea was not enough to design for a meaningful photographic practice.

Investigating a potential application

To investigate a potential application of Context Photography we wanted to take inspiration from existing interests and engagement in photography. We had previously learned about the difficulties of not starting the design process by investigating potential experiences. Similarly, we had also seen that matching an early technology concept with a practice could result in valuable knowledge and guide the development of a potential application. In this project we wanted to understand more how to design for a meaningful photographic experience. Such
knowledge was likely to be found among existing practices. The people in the practice would not necessarily have to represent the potential users, but to more importantly they should provide us with insights into enjoyment and experiences that could guide our design.

Matching the technology concept with a practice

When first starting to look for suitable practices to learn from, we took inspiration from various sources in the field of photography. For example, we were inspired by photography that pushed the technical borders of photography (such as pictures taken by Billy Name at the Andy Warhol Factory in the 1960’s). We also searched for inspiration in various kinds of professional photography and amateur photography, such as people that enjoyed taking pictures with infrared cameras. To learn about existing camera technologies, we also we tried different cameras ourselves and looked into the existing trends among companies that developed digital camera technology.

To get in touch with real photographers, we first contacted some amateur photography students. We conducted a small exercise with them, where they showed their pictures and talked about their interest in and enjoyment in photography. We found that these individuals preferred to take planned and controlled pictures. They were also interested in taking well-balanced pictures, and learning photography as a traditional craft. We imagined an application with creative use of sensor input that potentially could be unpredictable or difficult to control, and this was not likely to “match” their interests in photography.

Another practice that we had come across during our search for inspiration was Lomography. Here, amateur photographers take spontaneous snapshot in everyday situations. They used obsolete Russian cameras (lomo-cameras), and would for example “shoot from the hip”, instead of looking through the viewfinder when taking pictures. Their practice resulted in the creation of colourful pictures, with special aesthetics. The lomographic practice also had also made their own “rules” for how to take pictures, such as shooting from the
hip and to getting close to the subject. This also included bringing their camera everywhere and to be ready to take pictures at any time. The lomographers’ interest in photography was different from a more traditional perspective of photography. Furthermore, their interest in special aesthetics and their enjoyment of taking quick pictures with less control, matched our initial idea of sensors and camera technology well. We tried out some lomo-cameras, and decided to investigate if people practicing Lomography could teach us about photography experiences that would be relevant for the technology concept.

**Lomographers in the design process**

We arranged a meeting with three lomographers to investigate if we could use their interests in photography as inspiration for our design. However, our intention was not to design a digital version of their lomo-camera, but to learn about their experiences and their enjoyment of photography.

The lomographers enjoyed the unpredictable results in Lomography, and one of them even expressed how unexpected technical mistakes in the development process could lead to interesting aesthetics. Thus, an enjoyable moment was to get the developed pictures, as it was exciting to see how the results had turned out. In Lomography, the desired aesthetics affected how pictures are taken. For example, an aesthetically pleasing picture could be an askew, colourful close-up of a neon sign. This practice also included to “dare” to take pictures without having full control, e.g. by shooting a picture from the hip, without looking in the viewfinder. This also resulted in pictures that were askew, instead of centred. Furthermore, specific technical features, such as the lack of zoom, contributed to the picture taking approach and the resulting lomographic aesthetics.

After learning about the lomographers interests and activities, we held a brainstorm with them about a potential design of the Context Camera. For example, we tried to explore potential visual effects that the Context Camera would have. However, such visual effects were difficult to imagine for them, and would be likely to require a different kind of expertise.

Overall, our understanding of the lomographic practice provided insights into potential qualities that Context Photography could involve. For example it might be difficult to foresee or control the sensors that would result in visual effects,
but similar to Lomography, such *unpredictability* could potentially be appreciated with Context Photography. Furthermore, just as the lack of zoom affected Lomography, technical features of the Context Camera would be likely to affect *how pictures are taken*. For example, sensors such as sound and motion, would potentially lead to another type of picture-taking approach than a temperature sensor would. Also, the Context Camera should involve specific *Context Photography aesthetics*, which could be differentiated from other types of photography. These would not only be a result of the pre-defined visual effects, but also depend on how the context photographers would take their pictures.

Later in the process, the lomographers and other photographers tried an early prototype of the Context Camera, implemented on a Tablet PC (Ljungblad et al, 2004a). This testing provided important feedback in the design process. For example, the visual effects were constantly visible in the viewfinder in the prototype. According to the lomographers, this made the photographic experience more similar to video, as the effects were continually changing. It also created high expectations on the resulting picture, by providing a glimpse of how a picture could appear with effects. They suggested that the effects should only be possible to see “after” the picture had been taken, to increase the joy of the unpredictable and to create a moment of surprise. Furthermore, they found that many pictures looked similar, and asked for a way to increase the possibility to be unique, when taking pictures. They also stressed that the context effects should arise from the situation they were taken in, and that the visual effects should only be possible to attain in real time.

*The Context Camera*

The final prototype is implemented as an application on mobile phones, compatible with the Nokia 6600 and the Nokia 6630 (Rost et al, 2005). The device’s own microphone is used to measure sound level. Movement is retrieved as a vector field. To explore different visual effects, four effects were implemented in the prototype. They are grouped in the following way:

- **Colour shadows:** Traces of colour follow movement and the colour of the shadow changes with the frequency spectrum.

- **Zoom:** Movement is zoomed in and layered as a semi-transparent image over the picture that is not zoomed in. The sound level affects the transparency of the layer.

- **Pixels:** Small white dots follow movement as a decaying trace. The size of the pixels in the picture is proportional to the sound level.
Waves: Movement creates liquid-like waves in the picture. The size of the pixels in the picture is proportional to the sound level.

In the picture-taking mode only the original unaffected image is visible in the viewfinder. The visual effects are applied after the picture has been taken. The user can select an effect, capture images, see the resulting photographs and save or delete them. The user can also calibrate the visual effect of the camera’s sensitivity to sound and motion. Furthermore, for each picture taken, two versions are saved – one with effects and one without.

**Exploratory study**

The final prototype was deployed in a six weeks long exploratory study. People from different countries, and with different backgrounds, participated in the study. They used their own camera phone, or borrowed one from us. Seven participants uploaded a total of 303 pictures, and the most active participant
uploaded 113 pictures. The study involved two questionnaires, one when half of
the time had passed, and the other after the study was finished. Each user’s
response was analysed separately as a use case, complemented with his or her
pictures. For each context picture, an original picture (without effects) was saved
automatically. Such picture data provided more information about what the
participants had been taken pictures of.

Each participant’s unique use case is presented in chapter 9. However, a brief
overview of the results is provided below to describe the photographic
experience the Context Camera gave rise to.

The Context Camera supported new photographic goals. Pictures could be
taken to capture sound and movement in a specific situation. However, sound
and motion could also be used to explore aesthetically pleasing pictures. This
made the camera to appear as an “action camera”, where sound and motion was
actively searched for, or created to get interesting effects. The participants
described this as a new photographic experience. Furthermore, they were taking
pictures of things that they normally would not have taken pictures of. For
example, one participant described how he would never have taken a picture of
car, but now did – because of the visual effects that the application would give.
The context photographers also expected to get visual effects in the pictures. A
good context picture had visual effects that created a feeling of (or could
represent) sound or motion. For example, one participant liked one context
picture of her daughter. It made her imagine the sound of screaming. Another
participant liked a picture of a guitar that he considered to look like it had been
taken inside an amplifier. Even if a picture had a good composition, it was not a
good context picture, unless it also had visual effects. However, the effects also
needed to be balanced and appear aesthetically pleasing, which is a matter of
individual taste. We asked the participants how they liked Context Photography
compared to image manipulation after a picture had been taken. Context
Photography was considered to be something different, and one participant
expressed that it felt more real, because it represented “how it was” in a specific
situation, which post editing could not achieve.

Lesson learned: A practice can guide design, if it involves
experiences that are similar to what a specific technology could
give rise to

The Context Camera resulted in a novel digital camera application, but the
experience also appeared similar to Lomography. For example, one of the most
active participants said that the fun with Context Photography was to not be in
total control over how the picture would turn out and how this was affected by
the current situation. Similar to Lomography, the technical functionality of the
camera as well as personal expectations and desires created a certain
photographic behaviour. In Context Photography, photographers searched for, or
created, movements and sounds when they took pictures. However, by not taking
advantage of such situations, the camera could also be used and perceived as an ordinary camera. Similarly, one of the lomographers expressed that she occasionally had used her lomocamera as a “regular” camera.

This design case shows how the lomographers’ interests and experiences of photography was relevant for our technology concept, and could provide guidance to design for this kind of photography experience. This is different from user-centred design, where the intended users contribute to the design. The experiences and the practice of photography that guided the design were considered to not yet exist among the intended users, i.e. amateur photographers interested in digital photography.

This design case provided valuable insight into how a practice can support a design process, without the participants being intended as users. However, the lomographers’ practice was used as a more implicit support for our design. It was not until after the design process, that we articulated in which way their experiences had guided and supported our design. Thus, even if an individual case can provide guidance, the lack of more explicit tools can make it difficult for other researchers who would like to take inspiration from our approach in another design situation.

Personal Embodied Agents

With Personal Embodied Agents (Chapter 10 and 11) we investigated potential roles and appearances of robot- and agent-based applications for everyday settings. This work is part of the ECAgents (Embodied and Communicating Agents) project\(^1\) that investigates how agents can interact directly with the physical world and communicate between themselves as well as with other agents or humans. Here, we were also interested more general agent behaviour, where an agent can be seen as “a system that tries to fulfil a set of goals in a complex, dynamic environment” (Maes, 1994 p.2). We had previously experienced difficulties with coming up with applications grounded in existing needs or desires, when brainstorming about novel ideas of applications with robot researchers and interaction designers (Ljungblad & Holmquist, 2005). Now, we instead wanted to learn and take inspiration from existing and meaningful everyday practices, to learn how people could appreciate agent behaviour of artefacts or systems. We also wanted to structure our design process by early on articulating experiences and interests that the design could build on. We appropriated the design technique called Personas, and created four different personas to visualize potential designs and the interests and experiences that they could involve. Two of the designs have been implemented as working prototypes.

\(^1\) http://ecagents.istc.cnr.it/index.php (Accessed March 8, 2008)
This project is related to the field of Human Robot Interaction (HRI), that investigates robot and agent applications for everyday settings. In this field, robots have been investigated as social companions with anthropomorphic properties, i.e. to replicate how humans interact and communicate with humans (Tanaka et al 2006; Fong et al, 2003). Several types of socially interactive robots have previously been investigated with sophisticated platforms for e.g. speech and advanced computer vision and cognition (Fong et al, 2003). Robots have also been designed with a zoomorphic perspective, i.e. animal-like behaviour, for instance a dog-like entertainment robot (Friedman et al, 2003) and a seal-like robot intended as a therapy object (Shibata, 2004). Other robots are designed as products or objects augmented with robotic properties. For example, assistant robots can take the appearance of a wheelchair (Argyros et al, 2002), and service robots can be implemented as a product for everyday living such as a vacuum cleaner (Forlizzi & Disalvo, 2006). Our research is particularly related to research that investigate robotic products for everyday life, for example by conducting ethnographic studies of homes and elderly as inspiration for design (Forlizzi et al, 2004).

The technology-driven starting point

Science fiction may have contributed to the existing anthropomorphic perspectives of robots, and this has then been reinforced by designers who create robots that look human (Kiesler & Hinds, 2004). We wanted to avoid anthropomorphic or zoomorphic perspectives, and instead investigate some agent-like properties that could give rise to for example autonomous behaviour, emerging behaviour, or other robotic features as a starting point for the project. First, we did not take a specific technical platform as a starting point. We discussed existing robotic platforms in everyday environments such as the robot dog AIBO (Friedman et al, 2003), and robot platforms within the ECAgents, for instance small wheel-based robots with “swarming” behaviour (Cianci et al, 2007) as well as other existing platforms. We also learned about existing agent-like and robotic properties and features of such technology, and discussed different perspectives on embodied agents and their role in everyday life. Thus, the starting point for this project was a general interest in how robotic properties and robotic communication capabilities could be designed for meaningful everyday practices.

Investigating a potential application

In the beginning of the design process, we brainstormed about various situations and practices where humans already experience “agent-like” behaviour, and for instance have to deal with things that have a mind of their own. For example, plants or animals can potentially already be experienced as if they had agent-like properties, similar to how machines and computer artefacts can be ascribed personality (Reeves and Nass, 1996). The motivation was to find a practice that
could reveal existing interests and experiences, which we could take inspiration from. We considered that people who already enjoyed or appreciated agent-like artefacts in a practice could potentially also reveal qualities of experiences that could guide our design.

*Matching the technology concept with a practice*

The initial vaguely defined technology concept was matched with owners of pets. People in such practices enjoy animals that behave with a mind of their own, and interact with them on an everyday basis. Currently, it is difficult to implement advanced cognition and behaviour in robots that is similar to pets such as a dog or a cat. However, a design does not necessarily have to take inspiration from the cognition or the behaviour of the pets. Instead we can take inspiration from the human activities, interests and their relationship to pets. Pets such as spiders and lizards have specific abilities that may be different from cats and dogs, which affect how they are experienced. They may also involve different activities than how a dog is cuddled, played and walked with. This can thus result in an entirely different type of enjoyment and experience of having pets. Such pet owners could potentially reveal qualities of having pets that could be relevant for robot and agent applications.

Our ambition with this design case was not to give the agents an animal-like behaviour or appearance, which has been done with e.g. the robotic dog AIBO (Friedman et al., 2003; Decuir et al., 2004) and the robotic baby seal Paro (Shibata, 2004). Instead we wanted to take inspiration from the human enjoyment and *relation* to a specific type of pets, rather than designing a computational version of the pet. Furthermore, we believed that their practice could provide an understanding of potential human interests in robots, fundamentally different from human interests in having advanced robotic companions that appear in science fiction (such as R2-D2 and C3PO in the Star Wars movies).

*Interviews with pet owners*

We conducted interviews with 10 pet owners, six men and four women. Three of them were made face-to-face, and seven by phone. Three of them were found through friends, one through a local herpetological association, and six through a reptile owners’ website. Each of them had one or several lizards, snakes or spiders. The interviews concerned their relation, activities and interest in having such pets. For example, we asked questions about which important qualities their pet had, what they would do with them, and more specialized questions about if and how they can tell if a pet is ill or is in a certain mood and how this affects their behaviour. We also asked if they socialized with other pet-owners. The interviews were recorded, and then transcribed into text.
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Experiential qualities in the interview data

The interviews provided a rich set of data. For example, one pet owner said that the terrarium had qualities related to a piece of furniture, placed in the living room: “...well it’s like a little extra piece of furniture with a jungle theme.” Another one expressed that his pet “...should be... be like a furniture preferably, nice to look at and at the same time easy to care for”. Someone else described his enjoyment in having such pets as: “...partly it is fun to build these environments, and partly it is that I can spend hours just sitting and looking at them when I have fed them or something like that.”

We found differences in how pet owners expressed their relationship with their pets. One pet owner wished she could be more physical with her lizards and pet them. Another one regarded his pets as a hobby and did not miss any specific

Figure 11. Owners of pets such as lizards, spiders and snakes were interviewed about their interests and activities with the pets

properties: “I mean the snakes are constructed in a specific way and if you get them you have to accept that they aren’t any cozy pets something like that, you have to have them as your interest.” This person expressed that his interest was to breed lizards and snakes with interesting patterns: “Yes, well, it’s mostly that it is exciting and a challenge to develop certain colours and things like that.” However, the above is only a small sample of experiential qualities and other findings that we took inspiration from in our design.

The persona technique

The transcribed data was analysed by looking for specific excerpts that expressed qualities that made the relation to the pets meaningful. Sentences or words that expressed qualities of their relation, interactions and interests in the pets were then written on Post-it notes. The notes were sorted into different categories, to start the process of developing four fictive persons, or “personas”, that would describe different interests in agents. Each category was the ground for one persona, with the intention to engage us in potential interests of users and guide the design outcome. This is also similar to how the Persona method is used elsewhere, for example by Pruitt and Grudin (2003). However, in our design the personas would not describe interests and experiences of pets, but instead describe interests in potential agent and robot applications.
A rich collection of different excerpts provided the ground for the development of the personas. Data suggesting similar interests or qualities was grouped together. For example quotes such as “I like the thought of being a bit odd or different” and “a different kind of pet” were grouped together, and statements such as “I don’t pet them” and "It is my hobby" were put in a different group.

To structure the data further, we also sorted each category and differentiated between similar interests and experiences. This made it possible to further elaborate on different types interests and experiences that could belong to the same persona, but involve various relationships, activities or interests. To start imagining potential interests for agents we also replaced pet names with the word ”agent”. During several brainstorming sessions we discussed the notes for each persona, and also explored moving some notes between the different personas, to avoid creating a stereotyped person.

Before discussing more implementation issues and potential technical platforms, we focused on the specific interests and experiences relevant for each persona. This helped us to first establish the personas’ interests and enjoyment in the agents, without limiting our imagination with detailed implementation issues. Eventually, both the potential platform for the agents and the experiences relating to these, were explored in brainstorming sessions to further elaborate on the personas.

**Design concepts**

Four personas were developed, including a description of technical details about potential implementations. The personas describe interests or desires relating to different types of agents. Below they are briefly introduced; a more detailed description is found in chapter 10.

**Anne:** Anne feels it is good for the soul to have something alive around her, and that this creates a nice atmosphere in the room. She has no need to be in contact with other people with similar agents. She likes her agents because they are easy to care for. They are almost like a piece of furniture. Anne enjoys watching the agents slowly take form and enjoys taking part in affecting the visual outcome. The agents do not recognize her, and in fact she likes this better than if they would.
Christopher: The agent is around if Christopher feels lonely and inspires him to get out and be active. It works like a pedometer, and appear to be emotionally affected by Christopher’s activity as well as other similar agents. Christopher finds it fascinating to get to know his agent and find out what it likes. He likes to get in contact with other like-minded people, and to talk about the unique properties of their agents.

Magda: Magda is interested in agents that can extend her own identity. She wears her agent like a broche on her clothes to attract attention from other people. Magda likes the idea of being a little different. She wants to be the expert when it comes to how to treat her agent and she finds it thrilling that her agent is unpredictable. In fact, the agent can cause minor electrical shocks to someone who is not used to handling it. It also reacts to proximity to other agents and other devices with network capabilities.

Nadim: Nadim does not pet his agents, nor is he interested in different personalities of the agents. He is interested in evolving patterns and wants to learn about the agents’ visual behaviours and how to affect them. Nadim enjoys watching the patterns slowly evolve, and has lots of patience to explore how to get it the way he wants.

Prototyping and iterative design

We have created technically working prototypes for two of the personas – Nadim and Anne. They are still part of an early design process, which so far has involved testing different appearances and technical implementations. The prototypes that exemplify Nadim’s agents provide a way to physically play and engage with emerging patterns on small wheel-based robots (Jacobsson et al., 2008). Anne’s agents are instead implemented as a sort of dynamic wallpaper generated from pictures that are sent to the system from a mobile phone camera. More details on these prototypes can be found in the Applied Contributions section.
Lesson learned: Existing experiences can be visualized as potential experiences for a novel design

This design case shows how qualities of an engaging practice were used as inspiration for early design activities. The prototypes are not implemented to look or behave similar to the actual pets that were part of the investigated practice. Instead, they are designed with inspiration from the activities and the interests that we found among the pet owners.

Interview data concerning interests and desires was visualized as potential interests for agents using the Persona technique. This is similar to how the Persona technique can engage a design team with insight in users needs and be created by real user data (Grudin & Pruitt, 2002). However, in this design case the personas do not stem from data from the intended users, but from people in an engaging practice that was chosen to support our design. We learned from this practice to explore agent and robotic properties, and how people might be interested in such properties. The practice we studied involved specific interests and motivations for having pets that we used as inspiration for our design. Thus, in some sense we “transferred” their interests into potential interests and motivations for having agents.

At this point, the project is in an early stage, and the design needs to be further iterated and evaluated with users. The users are likely to be different people than pet owners, for example children or adults interested in games, or in dynamic interior design.

Reflections on the overall process

Chapter 11 provides an overall reflection on a technology-driven and experience-oriented process, and discusses this as an opportunity to explore early technology ideas and support innovative design. In that chapter the process is described as steps, with examples from the process of Personal designing Embodied Agents and Context Photography. This section will describe a similar reflection of the overall process, but includes all the design cases described in this thesis.

The technology-driven starting point

The technology-driven starting point has consisted of more or less inventive ideas with specific technology properties in mind. Usually this idea also involves a potential use situation that is not yet grounded in an existing practice or existing experiences. For all the design cases, the technology-driven starting point has involved learning about existing properties and potentials of the technology, as well as related research and existing products.

For Informative Art we had several prototypes, which provided a basis of knowledge to investigate an initial idea for a new application. We also looked into existing display technologies in related research and products. In Pin&Play
we had an existing prototype that exemplified the technology, with pushpins and paper notes. We held brainstorming sessions with the team who developed the technology, to explore different ideas of use. We also learned about pushpin technologies in other research projects. In Context Photography we did not have an existing prototype, but had initial ideas of specific technical properties that we wanted to investigate. Furthermore, we learned about existing digital camera technology applications, and other research projects that explored the borders of digital photography. We also took pictures with different types of cameras. When designing Personal Embodied Agents, we did not have an initial prototype or a technology idea with well-defined properties. Instead we started out with a more general perspective of agent properties in robotic products and an ambition to investigate designs beyond an anthropomorphic and zoomorphic perspective. We held brainstorms about potential robotic properties, and how these could be useful in everyday environments.

Matching technology with practice

The design cases illustrate different approaches to match a technology and a practice. In Informative Art, we did not match the early concept with an existing practice. Instead we involved the potential users throughout the design process, and learned about how to support their use of Informative Art as a display of bus departures. Thus, for this design case we did not learn more about the potential experiences of the technology properties in an early phase before design. However, the other cases have involved matching a specific practice to support a design with a technology-driven starting point. Each practice has been chosen based on specific technology properties, and the activities or the experience that these potentially could give rise to.

In Pin&Play, we matched the initial technology concept with the practice at the Göteborg Film Festival, which used entire walls to schedule the festival program with paper notes and pushpins. In Context Photography the technology concept included unpredictable sensor data that could affect the aesthetics of a photograph. We engaged a specific amateur photography practice, lomographers, as they already appreciated qualities of special aesthetics and unpredictability in photography. In Personal Embodied Agents pet owners were chosen due to their interests in specific pets. Instead of taking inspiration to create a zoomorphic design, we took inspiration from the human activities, interests and their relationship to the pets.

Investigating needs, interests and interactions

The design cases show different approaches to investigating needs, interests and interactions in the chosen practice.

In the Pin&Play project we conducted observations and interviews in order to learn how the film festival team did their scheduling. This focused on needs (more than experiences) to learn about their practice and which role paper notes
and notice boards had in the scheduling process. In *Context Photography*, we interviewed the lomographers as a group in the beginning of the project. This was done to find out about their specific interest to photography, their perspective of enjoyment, and when and how they took pictures. This provided insight into meaningful moments of an everyday photographic practice. In the *Personal Embodied Agents* project we held individual interviews with pet owners to learn about their interests, and activities, as well as the experiential qualities of having pets such as snakes and lizards.

**Analyzing and transferring data to initial design**

Different approaches have been used to interpret the findings in the chosen practice and to visualize this as an initial design or as an early prototype.

In *Pin&Play*, we analysed the interview data from the practice to inform a design to learn about the potentials of the technology. The goal was not to create an entirely novel design, but rather to support the needs that were prominent in the practice. This also reflects how we had a more task-oriented perspective of the design. In *Context Photography* the lomographic practice guided early design activities more implicitly. We discussed their interests and the qualities of their photographic practice throughout the design process, and they were merged into our novel design. However, we did not use any design tool or technique to make the experiential qualities more explicit in the early process. In *Personal Embodied Agents* qualities of specific interests that were found in the studied practice would more explicitly guide novel design at an early phase. This was achieved by creating fictive users from the interview data that described specific interests in agents and guided our initial design.

**Detailed design and technology development**

When leaving the early phases of a design, the focus shifts from creating an initial design towards making a design that actually works. This includes evaluating the design with the intended users in an iterative process and considering more detailed technical issues.

In *Pin&Play*, the detailed design and technology development was not done as a novel design for other users. Instead, the design was tested with the film festival team to provide further insights in how well the prototype succeeded in capturing and supporting existing needs in their practice. This provided insights into potential challenges and benefits of a potential application, even if the technology was not yet mature enough to become a product. Both *Context Photography* and *Personal Embodied Agents* exemplify designs that were intended for another user group than the practice that initially guided the initial design. *Context Photography* involved an iterative design process, both with the initial practice and intended users that were involved in providing feedback on the design. Finally, a prototype was tested for several weeks with the intended users. The *Personal Embodied Agents* project has been technically implemented
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as two different designs. The interests that are described by the personas have thus supported early designs that then can be further iterated with intended users.

Overall lesson learned: Methodological concerns for matching technology and experience

Informative Art showed how experience-oriented design issues can be difficult to approach in an entirely user-centred and usability-oriented process. The other cases have shown how early technology ideas can benefit from being matched with a specific practice. For example, Pin&Play showed how this could provide insights in challenges and potentials of the technology based on the needs in the studied practice. Context Photography and Personal Embodied Agents show how practices can reveal experiences that a potential novel application could involve.

The practice can either support the design process more implicitly, by representing specific interests and desires, such as was done in Context Photography. Here, the practice also contributed with knowledge by providing feedback on implemented prototypes. Interests and desires from the studied practice can also be made more explicit in the design process. For example, the Persona technique can be used to articulate potential user interests, which was done in the Personal Embodied Agents project. Finally, it is suitable to involve the intended users in more detailed design and evaluation activities, as exemplified in the Context Photography project.
The contributions of this thesis fall in the broad categories of conceptual, applied and methodological contributions, all of which may be of value for other researchers.

As conceptual contributions, we have shown how looking “beyond the users” can provide a basis for developing novel applications and interactions. This represents an alternative approach that can complement existing perspectives and approaches in user-centred design when investigating novel applications and modes of interaction. Furthermore, the conceptual contributions include how matching an early technology idea with a practice can ground design. This is relevant for researchers or designers that face technology-driven design situations, but still want to develop applications that are based on an understanding of existing activities, interests and desires.

Our work has resulted in several implemented prototypes, which are applied contributions since they turn design ideas and empirical findings into functioning systems. Each of these prototypes can stand as an example of a larger class of novel potential applications and have generated insights in interaction design, as described in the corresponding papers in chapter 6 to 10. Furthermore, the development of each of the prototypes exemplifies a design process where we show how we have matched a technology with a practice and documented the knowledge that such an approach has generated.

Finally, the methodological contributions can support other researchers and designers that face technology-driven challenges, or want help to “think outside the box” and explore a different design approach. This is described further in chapter 11. The contributions include reflections that are means to support matching a technology with a practice as an early design activity, supported by the design cases.

In the following, we will go into more detail on how we see these contributions.
Contributions

Conceptual Contributions

Conceptually, our work can support researchers and designers in user-centred design as well as more technology-driven research. The conceptual contributions are primarily based on the two latest design cases, as they have the most elaborate approach and are the most experience-oriented. However, the contributions are also supported by the first two design cases Informative Art and Pin&Play. Whereas Informative Art revealed difficulties of approaching potential experiential qualities in a design with a usability-oriented process, Pin&Play showed that it was beneficial to match a technology-driven idea with a practice to investigate a potential application.

Beyond user-centred design

We present empirical studies and applied design work that takes its starting point in some specific technology and investigates the potential experiences, interests or desires that a design could be based on. This should be relevant for researchers and designers that are interested in alternative research approaches. On a conceptual level, our design approach is qualitatively different from an entirely user-centred design approach and thus represents a complementing perspective on design. This is further elaborated below.

Design to investigate relations between technology and experience

Early design activities in user-centred design are often conducted with the intended users to guide the overall design to support their needs (Kujala & Kauppinen, 2004; Preece et al, 2002). Our design cases, on the other hand, have resulted in an understanding that design can be conducted not to “support” a certain practice, but to build upon certain qualities of interests or experiences that are found in a practice.

In Context Photography, we started out with the idea that different sensor values, such as sound or movement, would affect pictures as they were taken. This could potentially be a creative photography experience, but also lead to unpredictable results and be difficult to control. We learned about such features with an existing photographic practice, called Lomography. The lomographers were not intended as users. Instead, their enjoyment in photography was intended to guide our design and to make us understand what to design for. Part of the fun for the lomographers was to not be entirely in control of the result when taking pictures. This could be seen in the lomographers’ actions, for instance when they are not looking in the viewfinder but instead are “shooting from the hip” to take a picture. The camera’s optical properties and an expired film could also give unpredictable but interesting visual effects. Overall, the lomographers gave us knowledge about how they appreciated different unpredictable effects, and also enjoyed specific aesthetics and other things that affected their practice. However, our design was not created to support the
lomographers’ practice, or to create a digital version of their camera. Instead, we learned from their interests and experiences to design a novel digital camera with specific technical properties that potentially could support similar experiences for other, more general amateur photographers interested in novel digital photography.

Another example, where the design was not primarily intended to “support” a certain practice, but to build on certain qualities of interests or experiences, is found in Personal Embodied Agents. Here, we interviewed pet owners because we wanted to take inspiration from their interests in their pets for design. However, we did not aim to design pets, but to use their interests in these to investigate potential interests in agents and robots. We found that some pet owners expressed qualities of their pet that for instance were related to interior design, e.g. by comparing the pet with how a furniture or a plant can act as decoration in the home. They considered it fun to create the pets’ environments, and to watch them when they were eating or moving. On the other hand, an animal that did not move for a week could be boring. Such data inspired the early design of Autonomous Wallpaper, where the persona Anne showed interests in interior design and enjoyed to contribute to her interior design. She could “create” her wallpaper by taking pictures e.g. of a colour or a pattern during the day and then feed this to the system when she came home. She could then watch the wallpaper and its patterns grow, based on her pictures but still somehow beyond her control. Thus, both the examples above show how designing with qualities of experiences, instead of designing to support user “tasks”, opens up for a complementing perspective of design where empirical data is used to support and investigate novel technology ideas.

A complementing approach to letting users generate novel design ideas

Users can be actively engaged in idea generation in a user-centred design process (Bødker et al, 2000; Kjeldskov & Howard, 2004). However, an acknowledged problem is that users tend to come up with designs that are based on what they already are familiar with (Wilson et al, 1997; Dixon et al, 1997; Von Hippel, 1986). Even if substantial time is spent in explaining or even educating the user in technological possibilities, elaborating on novel designs might be difficult if these do not relate to something that the users are familiar with. Thus, looking “beyond users” points towards an opportunity to investigate novel applications and interactions, without necessarily involving the users in idea generation activities. Instead, studies of specific practices and knowledge of the technology can support the concepts that emerge when researchers and others with professional expertise generate ideas. However, while our design approach questions the user-centred design model, we do not intend to leave the targeted user groups entirely out of the design process. In Context Photography the intended users, i.e. amateur photographers, contributed with valuable knowledge when they tested both early and more final prototypes. Thus, even if users are
not engaged to generate early design ideas, they can provide feedback once the early technology concepts has become a more realistic design.

**Grounding technology-driven research**

Technology-driven design challenges can be seen as an opportunity for innovation. However, early technical inventions can be difficult to directly introduce to users (Rogers & Belotti, 1997). Firstly, when a technology’s potential use is novel the users may not be able to imagine how it would appear as a product. Secondly, an early technology concept can be difficult to directly implement as a working prototype to be tested with users. We show how an engaging practice and its participants can support early design. By considering the participants’ experiences and interests to be analogous or similar to what the technology potentially could give rise to, they support an understanding of the potentials of the technology. Such an analogous perspective of experiences and technology can be valuable for researchers and designers who face technology-driven design challenges, and want to ground and understand a potential design from an existing practice.

**Applied contributions**

A number of prototypes have been technically implemented and tested, including Pin&Play, the Context Camera, and two examples of Personal Embodied Agents, Autonomous Wallpaper and GlowBots. Each of them shows how a computer artefact can emerge from an interaction design process where an early technology idea is matched with a specific practice. The Informative Art prototype that emerged from the first design case is not presented as an applied contribution. This is because the initial design was done without studying any practice, and is thus not a result of matching an early technology idea with a practice. But since that process lead us to start considering our own methods of design, we have included this piece of work in chapter 6. While the first Pin&Play scheduling system is a more typical task-oriented system, the other examples are more experience-oriented technologies, and illustrate our progression towards more experience-oriented design work. Each of the prototypes point to potential new domains of applications, and can thus stimulate related ideas of use.

**The Pin&Play Scheduling Prototype**

The Pin&Play scheduling prototype and its development is described in detail in chapter 7. This system represents one potential application for the Pin&Play technology and its pushpins with limited computing capacity (Van Laerhoven et al, 2002). The development of the prototype exemplifies how as an early ubicomp technology idea can benefit from being matched with a specific practice. For example, problems concerning how to digitally trace physical
actions were both technical and social insights, which might not have appeared without developing and testing the prototype. Furthermore, we also tried to understand what was considered motivating in the practice, and which tasks that were suitable to off-load onto a computer. The study also raised questions of additional routines that would be needed, and how the existing computer support in the practice could be incorporated. We learned about realistic challenges for a potential application, which would have been more difficult to understand without the practice. Some of these pointed towards technical improvements on the technology, which have been implemented elsewhere (Kishino et al, 2006). The overall knowledge from this design case is useful for other researchers that
investigate computer support for paper-based interaction (Ljungblad et al, 2004b), and for those who would like to investigate how to ground a not yet mature ubicomp technology in an existing practice.

The scheduling prototype was built as a Masters thesis project, and was first presented as a working demo at Ubicomp’04 by Helin et al (2004). It has also been presented at academic conferences such as Collabtech’05 (Ljungblad et al, 2005a), been demonstrated at open exhibitions such as Swedish IT-Institute day¹, and has reached a public and industrial community through Swedish media².

The Context Camera

The Context Camera is a software program that runs on camera phones³. The implementation and how the lomographic practice affected the design process are described further in chapter 8. A detailed description of how the prototype was used by amateur photographers can be found in chapter 9.

The Context Camera prototype illustrates how the use of technologies such as sensors can create opportunities for new applications and modes of interaction for digital cameras, eventually opening up for new creative practices. The prototype incorporates features that go “beyond light” in photography, and thus illustrates novel possibilities that digital photography gives compared to analogue photography. Our experiences from this design case show that an initial coupling of technology and experiential qualities of the practice is something that we as designers can engage in. It can also be suitable to collaborate with people that have other professional expertise. In this case, we collaborated with a visual artist that was an expert in visual effects.

The Context Camera was deployed in a study with various amateur photographers who were interested in digital photography. They were given instructions on how the camera functioned, but not how it should be used. Our idea was to allow them to appropriate it in ways that made sense to them, and to see what kind of photographic experience that this would give rise to. By documenting the results qualitatively as different scenarios, we could analyse and learn about different types of use and experiences with the camera. Overall, the study showed that a camera extended with sensor technology gave rise to novel photographic experiences, and supported new approaches to picture-taking. As one context photographer expressed: “Context photo made me after a while search for movements and noise to succeed […] And this rendered a new and interesting experience and results”. This is a different perspective than for instance to use motion sensors to support the task of taking a “perfect picture”, effectively stopping the photographer from taking a blurry picture. Even though Context Photography was grounded in Lomography, it also created a novel

¹ A yearly conference for held for Swedish IT researchers (SITI-dagen).
² Swedish article in Elektronik i Norden (Zettergren, 2003)
³ Phone models Nokia 6600 and 6630
photographic experience. This experience appeared to have qualities of fun that were similar to Lomography, but was also based on a completely different type of camera functionality. As one context photographer expressed: “much of the fun with context photography is that you feel you are not entirely in control over how the picture will turn out. The situation will determine this...” Finally, the Context Camera affected peoples’ preferences for what was considered as a “good” picture. Such pictures needed to have visual effects. However, in what way and how much this should affect the picture, was a matter of personal taste.

The Context Camera has been presented at various HCI related conferences, such as CHI’04 (Ljungblad et al, 2004a), CHI’06 (Håkansson et al, 2006) and DUX’03 (Håkansson et al, 2003). It has appeared in Swedish media (Ryberg, 2004) and at several Internet Blogs such as Infosthetics1 and We-make-money-not-art2. Prototypes have been exhibited at several academic venues such as Ubicomp’05 (Rost et al, 2005), NordiCHI’06 (Håkansson et al, 2006) and at DIS’04 (Gaye et al, 2004), as well as at several institute open house events.

Personal Embodied Agents

The design case of Personal Embodied Agents resulted in two different working prototypes: GlowBots and Autonomous Wallpaper. They are grounded in interests and desires found among owners of pets, such as spiders and lizards. We held interviews with people in this practice, and used the Persona method (Pruitt & Grudin, 2003) to create fictive users from the data. However, the fictive persons were not created to illustrate interests and desires in pets, but instead in agents and robots. These first prototypes exemplify how interests and desires in the studied practice could guide several different designs, and how the designs were implemented on different technical platforms.

The previously mentioned applied contributions (Pin&Play and Context Photography) are described in the complementing papers. GlowBots and Autonomous Wallpaper, however, are more recently developed and are not part of the complementing papers. Thus, a brief implementation description is provided below. Both of the prototypes are technically working and have been exhibited publicly. They are thus the latest results from our design process and illustrate how a technology has been matched with a practice.

*GlowBots*

GlowBots illustrate a potential role for robots in everyday settings, as a playful game between robots and people. The development process is described in chapter 10 and 11. They have been technically implemented as fully functioning prototypes (Jacobsson et al, 2007).

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GlowBots are small wheel-based robots, based on the e-puck platform (Cianci et al, 2007). This platform was developed within the ECAgents project\(^1\) that investigates the emergence of language in embodied and communicating agents. Thus, the GlowBots exemplify potential applications for robots that are similar to the e-puck platform, and include communication and interaction between people and robots. The platform has been extended with a display module that shows animated patterns (Jacobsson et al, 2008). The emerging pattern on each of the robots can change when the robot communicates with other robots. An accelerometer makes it possible to encourage the robot to spread a pattern, by shaking it up and down. Shaking the robot sideways will instead stimulate the robot to receive emerging patterns from other robots. This creates an open-ended game, where different patterns can be discovered and manipulated, but not entirely controlled. The users can try to “breed” specific patterns by interacting with the robots.

The GlowBots show that robots do not necessarily need to have advanced cognition, or be implemented as anthropomorphic or zoomorphic embodiments when they are intended for everyday environments. Even though they were inspired from interests found among pet owners, we did not intend to “copy” the pets. Instead, GlowBots are implemented as an engaging and playful activity with emerging patterns. This was based on interests that we found among the pet owners, for example some whose primary interest was engaging with the pets and learning more about them, or those who wanted to develop patterns on the pets by breeding them. The GlowBots exemplify a new form of tangible robot interaction, where the physical embodiment of the robots have a meaning and is directly connected to how they are interacted with. Furthermore, their display makes it possible to see what is “going on” inside the robot. It is also possible to see how the robots are affecting each other as they move or communicate with each other. Thus, this provides a novel perspective on the form and behaviour of robots for everyday environments.

The robots have been exhibited at Siggraph’07 (Jacobsson et al, 2007) and at Wired Nextfest\(^2\) in 2007, where thousands of adults and children interacted with them. They have also been presented in media such as Discovery News (Staedter, 2007b), and at various Internet blogs, including Engadget\(^3\) and the New Scientist Blog.\(^4\)

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**Autonomous Wallpaper**

Autonomous Wallpaper is fully implemented as a research prototype and the design process is described in chapter 10 and 11.

Autonomous Wallpaper shows how we picked up other aspects of the studied practice – for example that of arranging with terrariums and reptiles to create for an aesthetically pleasing, living, changing everyday space. The current prototype allows users to decorate their walls with emerging patterns based on pictures that they have taken with their mobile phone. The implementation consists of a software program running on a PC, which is connected to a projector and a positioning system. In the implementation, a unique flower is created from each picture that is sent to the system. The stem and the flower leafs are calculated from the picture, and the flower will resemble the original picture in its colours. The user can physically position a flower by touching the wall with a small ultrasonic transmitter. Once a picture is positioned it starts to grow as a flower, and if there are several flowers they can affect each other’s growing behaviour.

Autonomous Wallpaper shows how the use of everyday technologies, such as to take photographs with a mobile phone, can be given a new role or meaning. In a similar way to how pictures can be taken for many purposes, here they can be used as dynamic decoration on a wall. For example, photographs could be deliberately taken of certain colours or patterns with the intention of affecting the visual appearance of the wallpaper. Different pictures will give the wallpaper different unique appearances, for example in terms of how the picture is translated into a flower and visually reflected in its petals. The system is created so that people can recognise which picture created which flower, but the form of the flowers involves randomness and distortion of shapes so that it is difficult to fully foresee the result. Furthermore, this system shows how people can take an active role in influencing their interior decorations with digital technology. This could potentially inspire or stimulate reflection for other researchers and designers that investigate interactive furniture or interior. It can also inspire researchers in Human Robot Interaction because it represents a novel perspective on the potential appearance and role for autonomous artificial agents in everyday environments, based on practices that people already engage in.

Autonomous Wallpaper has been reported in Discovery News (Staedter, 2007a) and IEEE Computer (Paulson, 2007), and was exhibited at the Mobile Life Center open house and the Viktoria Institute open house in 2007.

**Methodological contributions**

This thesis presents several design cases, where each case can inspire other researchers to reflect upon how to match an early technology concept with an exiting practice. However, it can be difficult to directly translate each case’s approach into a new design situation, even when reading several related cases.
Furthermore, to only describe individual cases may leave some uncertainty as to why and when such approach should be used.

To give a more general set of tools for other researchers who are interested in our perspective and approach to design, chapter 11 describes a design method called “Transfer Scenarios”. The method is primarily based on the two latest design cases; Context Photography and Personal Embodied Agents. However, a similar reflection over all the design cases in this thesis is also provided in chapter 3. Such a methodological reflection is intended to directly provide guidance for other researchers who want to try a similar approach. The design method in chapter 11 is presented as steps, but this is not intended to fix design activities in one specific course of action. Instead this is intended to stimulate reflection for different activities in the design process. In the same way that the design cases in this thesis are uniquely carried out, the design method is intended to be appropriated for different situations. This is similar to how a technique such as Cultural Probes provide inspiration to support a creative process for researchers and designers (Gaver et al, 1999). Such methods can also inspire new methods as well as stimulate reflection on general assumptions of design and research activities in the field (Boehner et al, 2007; Gaver et al, 2004a).
Discussion and Conclusion

We have presented a specific design perspective, where early technology concepts and experiences found in practices are matched. This has resulted in several designs that have generated knowledge about novel interaction and potential applications. Furthermore, we have contributed with methodological reflections to support other researchers and designers who wish to use a similar approach. This chapter will discuss some more general considerations of this work, as well as opportunities for other researchers to continue along these lines. Some primary concerns include coping with the limitations of investigating a technology idea instead of starting with the users, as well as concerns for how the resulting design can be evaluated. Furthermore, an important aspect is what kind of knowledge we can expect to gain when we match a practice with a technology. Finally, we will conclude this work by summarising the overall knowledge we have gained, and how this benefits the HCI field.

Beyond users

In this work, matching a technology concept and a practice is done early in the design process to explore potential applications, interaction possibilities and related experiences. This is different from when users are engaged in the design activities in a more traditional user-centred design process, which is generally done to ensure that the final design will support their needs (Preece et al, 2002). A user-centred design process can focus primarily on usability issues to ensure that a system efficiently supports the users needs. Our focus is instead to investigate novel applications and modes of interaction, and to learn about potential experiential qualities that a certain technology could involve. In a design situation where it is crucial that the final design meets the intended user needs, it is likely that it would be more suitable to also start with the needs of the intended users.
How can the final design be evaluated?

Our claim here has not been that matching technology and experience will give rise to exactly the same situated and individual experiences that were found in the practice of the user group that is originally studied. In fact, it is almost certain that the design will be different and have another appearance and behaviour than what was involved in the original practice. This may also be appropriate when the design process is intended to be creative and investigate novel interaction and potential applications. However, the design still needs to provide knowledge in order to be useful as a research tool (Fällman, 2003a).

Because the final design is likely to lead to another type of experience than the one that was originally investigated, it would be suitable to stay open for different interpretations or appropriations that the use of it may involve. Similar concerns have been raised elsewhere, for example by researchers who create systems where user appropriation is encouraged (Höök, 2006), and by researchers who show how multiple interpretations can be considered valuable (Sengers & Gaver, 2006). In the exploratory study of the Context Camera, we deliberately wanted to stay open to different appropriations and interpretations. For example, before the study we did not present how the system should be used, but only how it functioned. Furthermore, the different appropriations and interpretations were presented as short individual stories of the photographers (Chapter 9) to reveal different experiences and uses.

Another concern is that it is possible that the people in the studied practice might not appreciate the final design the way that other people will. For example, the Context Camera was built on our understanding of experiences in Lomography, and resulted in a novel digital camera experience and use. However, it is entirely possible that the Lomographers would prefer to continue to use their own lomo camera rather than the Context Camera. They are already experts in fulfilling the desires with their own camera, and may also value experiences beyond those we investigated for the Context Camera design. Similarly, the pet owners we studied might not appreciate GlowBots and Autonomous Wallpaper. They already engage in creating different patterns and environments, and enjoy living pets as interior design, something that also involves many more qualities of experiences than those we built our design upon.

The above is also related to that the Context Camera, GlowBots and Autonomous Wallpaper are designed with a creative process that takes inspiration from certain activities. This is a different perspective than to design to “support” tasks, which the Pin&Play design was closer to. With Pin&Play it is likely the people involved in the film festival practice can appreciate the system, because it was specifically designed to support their needs. In fact, this system would need a re-design to be useful for another group. Thus, issues of the differences between our approach of designing with existing interests, activities
and desires from a practice, versus designing to support the practice that is studied, is an area that can be further investigated.

**Matching technology and experience**

An important consideration is which kind of knowledge that a specific practice can generate to support design activities. This is also an issue that can be investigated beyond what was done in this thesis.

**What kind of knowledge can a practice provide?**

Individuals can be seen as experts in experiences that they are very familiar with, but they are not necessarily good at imagining and supporting design for novel experiences that they are not familiar with (Von Hippel, 1986). This is also true for people in the type of activities we have investigated here. For instance, people can be experts of their work practice, how they take pictures, and their own interests or hobbies. However, it can be just as difficult for the people involved in such practices, as it is for the intended users, to come up with novel design ideas. This is also why our approach stresses that there is value in learning from people in a practice, but also that one can not necessarily expect that they will generate innovative designs if they are involved in idea generation activities.

**Methodological concerns**

We believe our methodological reflection can inspire and contribute to an alternative approach to design activities, one that can complement a user-centred design perspective. It may, similar to other tools, support researchers’ and designers’ existing repertoire of design methods (Löwgren and Stolterman, 2004). However, it is also crucial that others are aware of the limitations and intentions of specific design tools (Boehner et al, 2007). Furthermore, the methodological reflection in this thesis invites others to investigate additional more or less structured approaches, as well as different ways of using experiences or interests that are not found among the intended users as inspiration in the design process.

*Explicit or implicit guidance, and early feedback on design*

While the methodological reflection can support an overall design process, the actual process may vary depending on the design situation. For example, the people in the studied practice can be more or less engaged in the prototyping activities. Furthermore, interests and activities in a practice can support the design process more or less explicitly.

In Pin&Play, we learned from the same practice throughout the entire design process. The working prototype was not deliberately designed for other users than those that were studied. Thus, even if the resulting knowledge about the
technology could be applied elsewhere, the resulting prototype very much resembles the artefacts and the activities that existed in the original practice.

In Context Photography, the final design was not intended for the studied practice. We learned about the lomographers’ interests in photography, and used this to implicitly guide the design of a camera intended for other amateur photographers. Thus, the lomographers’ cameras were different than our intended design, but their interest in photography was considered to be similar to what we hoped could be achieved with Context Photography. In this design case, we did not explicitly articulate which qualities would guide our design, and the lomographers also provided feedback on early prototypes, which complemented feedback from the intended users. Both studying them and engaging them in the process was useful to guide the design of the Context Camera.

In Personal Embodied Agents the final design was also not intended for the studied practice. We took inspiration from people in a practice that were not engaged in robots, but in a specific kind of pets. Thus, their engagement with the pets would inspire our robot design, and was used to point towards specific interests that could be used as inspiration. We then articulated these interests by using the persona technique, which constituted a more explicit guidance of the expressed qualities of interests and activities from the studied practice.

Overall, this shows that it is possible to use different approaches to learn from practices to inspire design, and that these can be more or less explicit in the design process.

Which practice is suitable to learn from?

Some practices may be less suitable to match with an early technology concept. For example, a practice may not be able to provide the right type of knowledge, or it may be too difficult to study.

In Pin&Play, we first looked into the use of notice boards at a primary school. Even though the teachers used notice boards for messages to other teachers and sometimes in class, we found that this practice was less suitable to study. In Pin&Play, pushpins were an essential part of the technology concept, but these were also too fragile and sharp to be used in a setting with young children. Furthermore, the teachers used the boards only occasionally, which made the practice more difficult to study.

In Context Photography, we first held a workshop with traditional photography students. However, we found that their interests in photography did not correspond to our intended design. They were not likely to appreciate this kind of photography, nor were they likely to provide relevant desires and experiences that could be used in the design process. Thus, their interests did not match the initial technology ideas, and they were also unfamiliar with the kind of experience that we were interested in learning from.
In Personal Embodied Agents, we discussed several experiences and activities that could be seen as analogous to autonomous behaving robots. However, the practice that consisted of pet-owners was regarded to provide suitable knowledge and they would also be accessible to study and possible to learn from.

**Can data be re-used for another design situation?**

The experiential qualities that stem from empirical data in the Context Photography and in the Personal Embodied Agents design cases are specifically articulated for a situated design situation. However, in a similar way to how use-qualities are intended to support various design situations (Löwgren, 2006), it is possible that data that reveals qualities of activities or interests in a practice could be used as inspiration in other types of design situations. For example, in Context Photography, we learned how the lomographers appreciated not having full control in some situations. This might support other researchers that investigate designs, where the technology may provide unpredictable results. Using parts of the empirical data for a different design situation is not something that has been explored in this thesis, but could be an area for further study.

**Conclusion**

This thesis contributes with a design approach that takes a technology-driven starting point and does not involve the intended users in early design activities. Instead, the early stage of the design process involves learning about possible experiential qualities that a potential application could involve. These are found in a practice that has been matched with an early technology concept. This process can support novel designs, in terms of new applications and modes of interaction. It is also a way to ground technology-driven ideas in existing practices, including the interests and experiences that are found there.

Several design cases each exemplify how a technology can be matched with a practice, and how this can support design. Each design process resulted in novel applications and interaction modes, which were implemented as working prototypes. A more general methodological reflection is also provided, which supports other researchers and designer who want to try a similar design approach. This might for instance be researchers and designers that face technology-driven challenges, or those who want to investigate design approaches and perspectives that are complementary to user-centred design. We also reflected on overall considerations for this work, such as how to evaluate the design outcome and how structured a design process needs to be. Finally, we bring up considerations regarding if the empirical data from the practice can be re-used or not. Overall, we hope that other researchers will continue this work, and contribute to different perspectives of design that can support HCI research by providing complementing perspectives and approaches to design. This work
has investigated how one design approach that goes “beyond users” can benefit a design process, with the goal of investigating potential innovations that both considers early technology ideas and are designed based on existing practices. We look forward to see what more there is to learn, and how far others will dare to go – beyond users.
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Part 2

The Papers
Between Aesthetics and Utility: Designing Ambient Information Visualizations


Abstract

Unlike traditional information visualization, ambient information visualizations reside in the environment of the user rather than on the screen of a desktop computer. Currently, most dynamic information that is displayed in public places consists of text and numbers. We argue that information visualization can be employed to make such dynamic data more useful and appealing. However, visualizations intended for non-desktop spaces will have to both provide valuable information and present an attractive addition to the environment – they must strike a balance between aesthetical appeal and usefulness.

Introduction

Information visualization can augment human cognition in many ways, and has proved useful in professional application areas such as scientific visualization and business management. But what are the potentials of information visualization in everyday life? Could infovis techniques be used to support “mundane” activities, such as catching a bus or finding out what the weather will be tomorrow? There are many places where there is no immediate access to a computer, but where information visualization might be used to provide time-critical, localized, or otherwise important information. In this paper, we explore
how ambient information visualization can take infovis out of the desktop computer screen and into the real world.

Designing information visualizations for off-the-desktop use is different from designing for other electronic media, such as interactive software or web sites. One cannot simply put up a computer screen in a living room or a train station and run some standard visualization software. First of all, we cannot expect potential users to be immediately familiar with the visualization techniques involved. Thus, even more than with ordinary information visualization, it will be necessary to carefully design the mappings in the visualization so that they can be grasped quickly and are easy to read, even from a distance. Secondly, aesthetic concerns become a major issue when a visualization is integrated with a larger environment. It will be necessary to design visualizations that not only provide useful information efficiently, but also blend in with the surroundings and are appealing to look at. Furthermore, ambient infovis should contain only a minimum of animation, since the human eye has a tendency to automatically be drawn to moving images, which could prove to be a major distraction (Sekuler and Blake 1994). These two conflicting concerns – aesthetics and utility – must be reconciled to create truly useful ambient information visualizations.

In previous work, we have been drawing inspiration from famous artists when designing information visualization, creating so-called informative art (Redström et al. 2000, Holmquist & Skog 2003). By basing our visualizations on well-known artistic styles, we hope to create ambient information visualizations that literally look “good enough to hang on the wall”, while still providing useful information. In this paper we will describe the iterative design of our most recent example, a dynamic visualization of bus departure information inspired by the Dutch artist Piet Mondrian. The visualization was designed in collaboration with prospective users and deployed at a local university (see Figure 1). Based on this experience, we outline important criteria for the successful design of ambient information visualizations, and how their design relates to that of traditional infovis applications.

Ambient Information Visualization

Information visualization is commonly defined as “the use of computer-supported, interactive, visual representations of abstract data to amplify cognition” (Card et al. 1999, p. 7). By ambient information visualization, we mean information visualization applications that do not reside on the screen of a desktop computer, but in the environment or periphery of the user. Using ambient information visualization, dynamically updated data sources can be presented in new environments, where a traditional computer display may not be suitable.

Using the physical environment to present information has been explored previously, in particular in ambient media (Ishii et al, 1997). In ambient media,
information displays are designed to present information in the periphery of the user’s attention. For example, the authors introduced a lamp that uses different intensity to indicate variations in an information source. Closely related to this is the term calm technology, which was coined to define technology that moves between the periphery and the centre of the user’s attention (Weiser and Brown, 1995). When correctly designed, calm technology should become a natural part of the user’s everyday surroundings. An example of calm technology was the dangling string, an installation where a hanging piece of wire would shake more or less depending on the traffic in the local network.

Many ambient displays have been based on physical constructions, but this puts limitations on the flexibility of the display and the complexity of the information that can be shown. A natural choice would therefore be to use computer graphics for ambient displays, but the cost, size and capabilities of computer screens has been a hindering factor. However, display technologies are rapidly advancing and becoming more affordable, and therefore it should soon be possible to hang a high-resolution display on a wall as if it was a poster or a painting. In the future, technologies such as electronic ink and color-changing textiles may make it possible to display computer graphics on almost any surface, even wallpapers or curtains (Jacobson et al. 1997, Holmquist and Melin 2001).

Several peripheral displays using computer graphics have been presented recently. A common approach seems to be to take information from traditional wall-hung art to inform the design and use of such displays. InfoCanvas are specialized computer displays that provide awareness of some source of information using images, creating a form of “virtual paintings” (Miller and
Stasko 2002). Information collages are automatically generated, aesthetic collages in the style of certain artists that reflect dynamic information (Fogarty et al. 2001). Digital family portraits mimic the appearance and function of a picture frame, placing updated information about the health of an elderly family member in the border of the photo (Mynatt et al. 2000). Our own related work in informative art will be further discussed ahead.

Ambient information visualizations present new challenges to the application of established infovis techniques and evaluation methods. For example, an important criterion for information visualization in science and technology is display effectiveness, where time, accuracy and cognitive workload are measured (Nowell 1997). Such a measure of effectiveness is relevant when applied to systems that are designed to perform work-related tasks. Ambient information visualizations, on the other hand, will be lived with rather than used, which means that traditional measures of effectiveness may not necessarily be the most relevant (Hallnäs and Redström 2002). More specifically this suggests that factors such as calmness and appearance might be just as important issues for an everyday application as effectiveness is for professional tasks. This in turn means that new evaluation criteria, based on long-term usage studies rather than lab experiments, may need to be developed.

**Informative Art**

Informative art is a subset of ambient information visualization, in that it is situated in an everyday environment rather than on a computer screen. In the design of informative art we were inspired by the appearance and function of paintings, posters and other objects that people use to decorate their living spaces (Redström et al. 2000). Previously, we have created several examples of informative art, inspired by artists ranging from Andy Warhol’s pop-art, Bridget Riley’s op-art and Richard Long’s landscape art (Holmquist and Skog 2003). Data sources that were visualized included the passage of time, the movements of people in a room, and world-wide earthquake activity.

The most fruitful template for informative art so far has proved to be the Dutch artist Piet Mondrian, who did a number of recognizable works in an artistic movement called “De Stijl” (literally, “the style”). In the section below we will describe three previous generations of informative art, all inspired by Mondrian.

**Previous Mondrian Designs**

Within De Stijl, Mondrian created a characteristic and immediately recognizable style of painting. His most famous compositions consisted of arrangements of colored fields and black lines over a white background. In these works, he used only three primary colors, namely red, yellow and blue. This style is immediately recognizable, and its surface characteristics are easily reproduced
with computer algorithms (in fact, some of the earliest experiments in computer graphics-based art mimicked some of Mondrian’s black and white compositions (Noll 1995)).

We found the characteristic look of Mondrian’s compositions to be a good basis for an abstract information visualization. The use of three easily distinguishable colors together with geometrical shapes seemed ideal for our purposes. We have so far used Mondrian’s style to visualize dynamic data concerning e-mail traffic, current weather, weather forecasts, and most recently bus departure times. Typically, data has been mapped to the size, position, and color of the fields in a composition, giving us three possible dimensions to use for visualization, although not all were used in all examples.

E-mail
The first example of informative art can be seen in Figure 2. It is a dynamic display of e-mail traffic, designed to be situated in an office (Redström et al. 2000). Each of the colored fields in the visualization represents the e-mail traffic for one person. The size of a field is mapped to the amount of e-mail sent and received by that person during the last 24 hours. The color of the fields carries no information, but is randomly appointed at start-up. Every field has the same position every time, so by time it may be possible to differentiate between the different persons in the office. However, in this case we were more concerned with the overall impression of activity in an office, rather than that of individual users, which is why there is no immediate way of determining which field represents which person.

World Weather
A second example of a Mondrian-inspired visualization was one of four pieces exhibited at the Emerging Technologies section of SIGGRAPH 2001 (Skog et al. 2001). Here, we displayed current weather information for six cities around the
world, which was taken in real-time from a web page. Each city is represented by a colored square, whose size is mapped to the current temperature in the city. The higher the temperature is, the larger square gets. The color of the square is mapped to weather conditions, where yellow means sunny or clear, blue means downfall, i.e. rain or snow, and red means overcast.

The distribution of the squares is loosely based on a world map metaphor. Each square’s position in the visualization roughly corresponds to that city’s placement on a world map, with Europe in the center. The cities shown here are, in the top row, from left to right: Los Angeles, Gothenburg (in Sweden) and Tokyo. The bottom row shows Rio de Janeiro, Cape Town and Sydney. This mapping turned out to be quite easy to learn for visitors at the exhibition, and we felt that the visualization gives a good overall view of the weather situation in the selected cities.

Local Weather Forecast
This visualization is an altered version of the one described in section 3.1.2. This visualization was adapted to show a weather forecast for the local Gothenburg region, taken from a web page (Skog et al. 2002). Each square represents the weather of one day. The size and color are mapped to temperature and weather respectively, as in the example above. The position, however, does no longer give geographical information, but indicates what day the weather forecast is for. The left-most square in the upper row shows the current weather condition and the right-most shows the forecast for the next day. The forecast for the following three days is shown, from left to right, by the squares in the bottom row.

This prototype was installed for evaluation purposes on a large plasma screen at a university in Gothenburg (Figure 4). We first asked students what sources of information would be interesting to have visualized by informative art, and weather information was one of the most common suggestions. The visualization was then created and we had it running at the university for an evaluation period.
of one week. We found that students were able to learn to use the visualization after a brief introduction, but we also identified several problematic issues in the design. For more information, see (Ljungblad et al. 2003).

Designing an Ambient Information Visualization of Bus Departure Times

During the design of the weather forecast visualization (above), another of the most frequently requested data sets was public transportation information. At the time, there was no source providing reliable data of this kind. Timetables could have been used, but since a timetable does not provide actual real-time data, and since the buses to and from the university often were delayed due to passenger overload, we decided not to use this data for the visualization.

In early 2003, however, the local transit authority started providing a new web-based service keeping track of buses and trams in the public transportation network. This service uses the transit authority’s sensor system, installed to keep track of buses and trams in the city. This information is available for commuters at larger bus stops, in the form of large text-based LED-displays, indicating how

Figure 4: Informative Art visualization of a local weather forecast, running in a university setting

Figure 5: LED-display showing bus & tram traffic information (left), and the same information displayed on a webpage (right).
many minutes remain before the next bus or tram arrives (see Figure 5). The web site has a page for each bus/tram stop in the network. In turn, each page contains traffic information for all bus/tram lines trafficking that stop, showing when the next two buses/trams are due to arrive at that stop.

When this information was made available on the web page (Figure 5) we saw this as an excellent opportunity to create a new visualization for the students at the university. Almost at the same time, a new bus line was added (line 16), connecting the university and the central parts of the city. Many of the students have started to depend on this particular bus for their commute to and from the university. With over 300 students and teachers regularly spending time in two main open areas, we considered the departure times of this bus line to be a suitable source of information to visualize in this space.

**Preliminary Visualization**

We created a visualization that shows the departure times of the buses on line 16, two in each direction. Several ambient displays of local transport data have previously been presented, e.g. in the form of a hand-held display that the user could bring along while going to the tram stop (Lunde and Larsen 2001) or a physical “mobile” where numerical indicators attached to strings would move up and down to show bus departure times (Mankoff et al. 2003). For our visualization, we again chose to use Mondrian as inspiration to create an informative art installation.

We let each bus be represented by a colored square. The size of the square shows the amount of time before the bus leaves the university bus stop, so that the less time remains, the smaller the square is. The color is used to shows intervals of time it would take to catch the bus from the position of the display. The timing used for these mapping were based on our own experiments of walking from the university to the station. Again we mapped information to Mondrian’s three primary colors, where:

- **Blue** means you have plenty of time before the bus leaves.
- **Yellow** means it is time to pack your stuff and start walking to the bus stop.
- **Red** means you’re in a hurry. You may have to run to catch the bus.

We used the position of each square to indicate where the bus is headed. The squares are laid out so that the two squares on the right hand side represent buses travelling towards the city centre whereas the squares on the left hand side represents buses travelling from the city centre (See Figure 6).
Feedback from Users

In order to get feedback on the preliminary visualization we interviewed three groups of students (a total of eight students; five male, and four female) who all used the bus for their commute to the university. We ran the visualization on a laptop, using real, online data. The use of size and colors to indicate departure times seemed intuitive and the students understood it quickly. They also seemed enthusiastic about having this type of visualization available. They were aware of the web page containing the same information, but rarely used it.

The students helped us identify a number of problems with the proposed visualization. The most important issues were:

- **Direction:** The students found it hard to identify what buses were traveling in which direction. It seemed our use of position to indicate direction was not intuitive.

- **Connection to the physical world:** During the interviews, we noted that the students used the visualization as an abstract map of the bus stop, in order to make some sense of which bus was heading in which direction. They asked on what wall the display would be situated, using the physical surroundings as a point of reference. Since we had not taken this into consideration when designing the visualization, the readings turned out to be ambiguous and arbitrary.

- **End stop:** During rush hour traffic, an extra bus is used to offload the regular bus service. This extra bus runs as a shuttle between the university and the central station. Students traveling past the central station stop wanted a way to differentiate the two lines, so that they did not risk ending up on the wrong bus.

- **Relevance:** Two of the students pointed out that there was no need to show buses that when it is too late to catch them.
Redesigning the Visualization

Based on the input from the students, we chose to change the visualization in a number of ways. The resulting final visualization can be seen in Figure 7.

We chose to adapt the map-like connection to the physical world suggested by how the students tried to read the preliminary visualization. In the redesigned version, we added a blue line in the right hand side of image, to represent the river running through Gothenburg. The area to the left of the blue line acts as an abstract map of the bus stop. The two squares on the left now represent the buses traveling from the city center and the ones on the right represent buses traveling to the city center. In contrast to the first version, the squares are also arranged vertically according to the direction of the bus, so that for the squares on the left the, closest bus is represented by the square at the bottom, whereas the reverse is true for the right-hand side. The resulting visualization was intended to give a more intuitive impression of buses running in both directions along the river.

Furthermore, in order to differentiate the rush hour extra buses from the regular buses, we decided to add a black line, indicating the final destination of the buses travelling towards the city center. As can be seen in figure 7, the bottom square has a line that starts in the upper right corner, and ends up in a small white square that represents the central station. The top square has a line that starts in the upper left corner and that ends up at the edge of the screen, indicating that it continues past the central station bus stop. None of the remaining lines in the visualization carry any information.

In order to deal with the problem with the visualization showing buses that it is too late to catch, we decided to represent such buses with white squares. This means that the squares are still there, but they are less visible than squares of other colors. The reason for not removing squares representing these buses altogether was that it would be too disruptive to the visualization as a whole.

A final modification was introduced soon after we started running the visualization at the university. The database server running the application at the transit authority turned out to have a lot of down time, and we realized that we had to add some kind of mechanism to indicate breakdowns. We did this by changing all the squares’ colors to black whenever the server went down. The
black squares would then indicate that there was no reliable data available for the application.

**Preliminary Evaluation**

The visualization of bus departure times is currently running at the university, on a plasma screens in a public area close to the main exit (as seen in Figure 1). The over 300 teachers and students at this department of the University will pass the display every day. Our plan is to let the application run for an extended period of time, to get long-term usage data. When we did our first study, it had been installed for 15 days, but effectively running only for about 10 days, due to server breakdown at the public transportation network and other technical problems.

There have been comparatively few evaluations performed of ambient displays in use, although some heuristics have been developed to influence the design of such displays (Mankoff et al. 2003). We believe that it is difficult to capture the value of an ambient information visualization using traditional usability measures, and in particular that they have to be studied in situ and in actual use rather than in a lab environment. Therefore our approach has been to conduct on-site interviews to see if and how the visualization is taken up and used by the people in the area. We have tried to provide open-ended ways for people to use the visualization, so that the usage is natural rather than forced for the sake of evaluation. The authors themselves do not belong to this department of the university and are not regular visitors to the area where the display is installed, and should thus have minimal influence on the use of the visualization.

When we first set up the visualization, a caption with instructions for how to interpret the information was placed next to the screen. Unlike for our previous evaluation (the weather forecast, above), we did not arrange any public presentations. Instead, about 30 handouts with instructions were placed on a shelf immediately beside the display. Furthermore, the IT University added a news item on their homepage about informative art which included instruction on how to read the visualization. Thus, while noone was directly instructed or asked to use the display, information on how to use it was readily available for those who wished to do so.

We conducted our interviews during the afternoon on an ordinary weekday. Seven people were asked for an interview, when passing by or staying in the area of the display, three men and four women. Out of these, one woman was not interviewed, since she only made sporadic visits to the University. We wanted to involve only those who were constantly spending time in the area.
Results

Comprehension

When trying to assess the comprehension of our ambient information visualization, we used the broad framework of a three-step scale, where each step is a pre-requisite for the next:

- That something is visualized – does the subject know that the display is an information visualization and not simply decoration?

- What is visualized – can the subject tell us what data the visualization reflects?

- How the data is visualized – can the subject read and interpret the visualization correctly?

Only when reaching the third step does a person have enough understanding to actually use an ambient information visualization.

Out of the six persons who were interviewed, one person did not know that some data was visualized on the display. This person did not travel with the bus line in question. The remaining five people knew that the display visualized dynamic data, and also what was visualized, i.e. departure times for bus line 16. All of these five subjects travelled with this line with some regularity.

Two people knew what was visualized, but did not know how to read it. However, both of them could explain that the colors on the “buses” represented something like “hurry”, “leave now” and “there is time left”. One of the two pointed out one square and suggested that it represented a bus that probably went to the town, which was correct. Therefore, although they did not have sufficient understanding for practical use of the visualization, they had still picked up some of the essentials.

Out of the five, three people knew how to read the visualization. One of the three first claimed that she was unable to read it, but in fact, when asked to explain the visualization, she could read it correctly.

Use

Two of the three persons that knew how read the visualization, had also used it to catch the bus. One of them had used it three times and the other once. Both of them said that they planned to continue using the display, providing it would continue to provide reliable information. One of them commented that it was great to get “information at a glance” and that it was particularly good in this place.
The person who could read the visualization, even though she thought that she could not, said that she was on her way to use it once. At the time she did not have the “energy” to get herself into it, and because she already had her outdoor clothes on, she simply left for the bus instead. She said that she would like to use the display, mainly if she was going home. If she was planning to continue the trip, she would rather use the website provided by the public transportation, where more detailed information could be found.

The two people who knew what was visualized, but did not know how to read it, believed that they would not use the display in the future. Both of them usually did not look at any timetables, unless they were staying late, something they had not been doing lately. One of them preferred more exact, number-based information, and suggested that people might need different amount of time to get to the bus, which he thought the current visualization did not support.

Designing Ambient Information Visualizations: Lessons Learned

In this section we will briefly discuss some of the lessons we have learned from designing several generations of ambient information visualizations. A summary of the development and features of our Mondrian-inspired informative art can be seen in Table 1 and Table 2.

### Table 1: Information Source

The choice of what information to visualize is obviously important when designing ambient information visualizations, as it would be in any infovis application. But unlike ordinary infovis, where users can be expected to actively seek information, ambient information visualization provides users with this information in their everyday environment – whether they ask for it or not. This means that whereas we can rely on users of desktop infovis applications to actively work with an application, and to be prepared to give it their full attention for some amount of time, this is not always the case for ambient infovis applications. In particular we found that information used in ambient infovis has to have a relevant scope and a suitable rate of change.
**Information Scope and Relevance to Users**

The scope of the information used in our examples of informative art range from covering an office (e-mail traffic visualization), to encompassing the entire world in (world weather visualization). The bus visualization, which spans a local bus stop, was somewhere in between: it goes outside the user’s immediate surroundings, yet it concerns something that potential users are very likely to be familiar with. We feel that ambient information visualizations must be designed so that the scope of the information is clearly linked to the placement and possible users of the display.

World weather has relevance to users from all over the globe (or at the very least in the six cities being visualized). This made it suitable in an exhibition situation, were visitors were likely to come from many different countries. The e-mail example, on the other hand, was really only relevant to the people working in the particular group whose e-mail was being visualized. Both of these examples therefore worked well as illustrations of the concept of ambient infovis, but neither was compelling enough for it to see continued real-world use.

The bus visualization, on the other hand, is relevant to a place, in this case the area around the university bus stop. This means that all visitors to the place where the visualization was situated were potential users of the display. To a similar extent this was true for the weather forecast, which was relevant to the local city area. But the bus visualization has proven to be by far the most compelling of our designs so far, which is probably related to the fact that it also helps in carrying out a certain activity (catching the bus) which is not so much the case for the weather visualization.

**Lesson 1:** By finding information that is relevant to the place where the ambient display is located, every person spending time at that place becomes a potential user.

**Rate of Change and Update Rate**

All our ambient infovis examples have been based on dynamic data, but update rates have varied. We found that the selected information source should have a suitable rate of change – so that on the one hand, the display changes often enough that users perceive it to be dynamic, but on the other hand, not so often that it becomes a source of distraction.

On the worldwide weather display, even though the update was based on real-time weather data, hours could pass between perceivable changes. The weather forecast could be perceived as static, since it only changed a few times per day, when the new forecast became available. People would thus sometimes believe that the visualization was “broken”, since there was no perceivable change. Also, because of the low rate of change, there was no “urgency” to the information, and in the case of the weather forecast it was actually sufficient to look at it once per day to get all information it had to offer.
Chapter 6

The bus visualization, on the other hand, was based on real-time data that changes quite often. Furthermore it provides time-critical information that directly helps the users with an everyday activity. However, since the buses run very frequently during the daytime, many users would simply not bother checking when a bus was due – they would just go to the bus stop, expecting a bus to come. This situation changes during the evening and our impression is that the visualization will see more use when the buses are less frequent.

Although the rate of change in the information source is something that cannot be changed, the update rate of the display is under the control of the developer. Our experience indicates that it would be fruitful to include some minimal amount of animation to the display of data that changes with a low frequency, to make the users aware that the application has not frozen. This might have promoted the impression that the weather displays were showing real-time dynamic data. On the other hand, for information that has a very high rate of change, e.g. a stock market index, it can be necessary to slow down the update rate so that the viewer is not distracted by continuous fluctuations in the visualization.

Lesson 2: The rate of change in the information should be frequent enough to promote relevance, but the developer can affect the visual appearance by slowing down the changes or adding a small amount of animation.

Table 2: Visual Encoding

When designing informative art, it may be necessary to make trade-offs between the aesthetical template and the visual encoding. There is no question that in some sense, adhering to a visual template that has been determined without concern to the information that is to be visualized can be restrictive. At the same time, this approach has the advantage of making the designer of the visualization “see through the eyes of an artist”, which might be a good way for even a person with little visual design training construct a visualization that has aesthetic appeal. In our experience, using an artistic template does not necessarily make the visualization less useful.

Using an Artistic Template to Visualize Information

As can be seen from the table we have been able to visualize a quite diverse data set using the style provided by Mondrian. In practically all of these examples we

<table>
<thead>
<tr>
<th>Visualization</th>
<th>Size</th>
<th>Color</th>
<th>Position</th>
<th>Geographical Metaphor</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-mail</td>
<td>amount of e-mail</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>World Weather</td>
<td>temperature</td>
<td>weather condition</td>
<td>location of city</td>
<td>world map</td>
</tr>
<tr>
<td>Local Weather Forecast</td>
<td>temperature</td>
<td>weather condition</td>
<td>day of week</td>
<td>-</td>
</tr>
<tr>
<td>Bus Traffic</td>
<td>time until bus leaves</td>
<td>time intervals</td>
<td>direction of bus</td>
<td>-</td>
</tr>
<tr>
<td>Bus Traffic revised</td>
<td>time until bus leaves</td>
<td>time intervals + breakdowns</td>
<td>direction of bus</td>
<td>city landmarks + bus stop</td>
</tr>
</tbody>
</table>

Table 2: Overview of the visual encodings used in our examples
have used a mapping from some quantitative data to the size of colored fields. This mapping has worked quite well, even though it is not ideal for temperature, since the centigrade value for the freezing point is zero, and there is no simple way of making the area of a square indicate a negative value.

Nowell (1997) suggest that no more than five or six colors should be used in coding a display and that color-coding should only be used for the information that is most directly relevant. We used the three primary colors that are a characteristic of Mondrian’s compositions as important information carriers in our visualizations. The colors were used to indicate discrete data classes, such as types of weather conditions and, in the latest example, specified time intervals. This has worked quite well, although occasional users expressed a dissonance between their own associations to colors and our mapping (e.g. in our weather visualization blue means “rain” whereas many users associated it with “blue skies” (Ljungblad et al. 2003)).

But most interestingly, a side-effect of using Mondrian as a template has been that all our examples use bold and easy-to-read encodings to visualize a limited amount of information. We have been forced to carefully design the mappings to fit with the limited template. This has led to simplified visualizations, which once learned can be read very quickly, and at some distance from the display, even in busy environments. This might not have been the case if we had started from scratch, and without the visual template we could have been tempted to cram too much information into the display.

Lesson 3: Basing a visualization on an artistic style need not hinder – and might even support – the readability and comprehension of an ambient infovis installation.

Using the Spatial Layout as a Mnemonic

In our Mondrian examples we have used different strategies for the spatial layout of the colored squares. The arbitrary spatial mappings used in the e-mail and local weather forecast visualizations (described in section 3.1.1 and 3.1.3, respectively) tended to be harder to remember than the ones where we used a geographical metaphor as a basis for the spatial layout of the graphical components.

The first example that used a geographical mapping was the world weather visualization described in section 3.1.2. Although no visual cues to the mapping were given, we found that the spatial mapping in that example was of great assistance for viewers to help them remember the mapping. The users would of course need to learn which six cities were represented, but once this had been done it worked both ways, since the visualization also act as a mnemonic to indicate in which areas of the world the cities were located.

The latest example, where we let actual geographical landmarks be represented in the visualization, has rendered the best results so far. With the
representation of the river as a point of reference, the viewers could easily derive which bus was which. The visualization became a sort of abstract map of the bus stop, without breaking the adherence to the visual style of Mondrian. This builds somewhat on lesson 1, where we found the relationship to a specific place to be useful.

**Lesson 4:** Letting features of the information source affect the visual encoding, thus providing a mnemonic to remember the mapping, is a good way to support the comprehension of the display.

### Conclusions and Future Work

In information visualization, aesthetics can almost be considered an added bonus, or at least a bi-product when striving for readability and effectiveness. In ambient information visualization, on the other hand, aesthetics is considered a primary property, both in the design and during use. When designing ambient infovis, it may even be necessary to go against established infovis guidelines in order to adhere to an artistic template. For instance, the bus visualization is not entirely consistent in its coding, since the representation of the river has the same blue color as the squares representing buses. Additionally, some of the black lines carry information, whereas others do not. However, we did not find this inconsistency to be a problem in our user studies, and the design was still considered intuitive.

Graceful degradation is an important issue for ambient information displays. Since an ambient information visualization is usually not interactive, it is crucial that applications have a way of indicating when they are not functioning, or have trouble retrieving data, so that users can rely on the display as a source of accurate information. In our bus example we let black squares indicate that the server was down, and that no reliable data was available. It is particularly worth noting that this consisted a noticeable break with the artistic template, something that should make it easier for users to conclude that something is wrong with the application.

It is also important to make the most crucial information available at a glance. The bus visualization uses redundant coding – both color and size – to represent time to departure. From our preliminary study it seems that people tend to use the color, rather than size, to determine the time to departure. One reason for this might be that color is said to yield faster result than e.g. shape, when used redundantly with other encodings (Nowell, 1997). The size of the squares, on the other hand, in principle gives a more exact indication, but in practice, it is very difficult to translate the visual size into an accurate measure of departure times. In forthcoming studies it will be interesting to see if people will be able to use the size of the squares to better estimate time, and thus getting a more precise reading of the display.
Our ambient information visualization of bus departure times is currently running at the university, and we plan to conduct a long-term study of the uptake and use of this application. We are concerned with issues such as how the understanding of the display changes over time, and how it takes its place in everyday life. One measure would be to determine how likely knowledge of the interpretation is to be lost over time – i.e., once a person has gone “up” a step on our three-step scale (that – what – how) how likely is she to go “back” and forget this knowledge? The design of the mappings must be intuitive to be both easy to learn and easy to remember, and this will probably have a noticeable effect on the uptake and comprehension of the visualization. Therefore, it would be interesting to study and contrast the use of two different ambient information visualizations that show the same data but use different mappings and artistic styles.

References


Ubicomp Challenges in Collaborative Scheduling: Pin&Play at the Göteborg Film Festival

Abstract
Ubicomp technology faces many technical challenges, which makes it difficult to test in real world situations. However, understanding and building for everyday practices is crucial for ubicomp designers, in order to push the technological development in the directions needed. We have developed and tested a ubiquitous computing prototype supporting collaborative scheduling. It is based on Pin&Play, a surface-based networking technology with interactive pushpins. The team of a local film festival was engaged in the development process, which resulted in a partial implementation illustrating how their current work practice could be supported. Drawing on this particular design case, we report findings and discuss challenges for ubicomp technology in general.

Introduction
Ubiquitous computing has great potential to support everyday practices that rely on for example mobility, large surfaces or physical objects, where desktop computing is too limited to support the same factors. Ubicomp systems can involve different technologies and take on many appearances, which provides
opportunities for new ways of augmenting everyday practices with computing. However, this diversity of interaction is a significant challenge for designers and engineers of such systems, both in terms of the design of the technology and the interaction.

The vision of ubiquitous computing systems is often referred to fully integrated and embedded systems, where computing is everywhere [1]. In reality however, much ubicomp technology is under development, and is still far from being used in a practice or as a commercial product.

It is crucial for ubicomp developers to learn about everyday practices, as well as how introducing novel technology and interaction could affect these practices. How else could we learn about ubicomp in the real world, or push the technological development in appropriate directions? We believe it is necessary to introduce technology into the complexity of a realistic everyday situation, even if it is not fully developed. The point would then not be to build a complete, well functioning system, but to learn about some of the possibilities, drawbacks and challenges of the technology. Ubicomp technology offers many novel interaction possibilities, without any design standards to follow. This makes it important to learn from design cases, and to uncover challenges that can be generalised to other real-world situations.

This was our motivation to introduce a novel ubicomp technology in a collaborative scheduling activity, which is currently conducted without computer support. A prototype based on the Pin&Play technology [2] was developed in collaboration with a local film festival team, who currently schedule the entire film programme with paper notes on office walls. Pin&Play represent a specific class of technology: computationally augmented pushpins. These have the advantage of retaining a familiar interaction style, where input to the system can be achieved simply by pinning items to a surface. In this paper, we will describe our collaboration with the festival team and our experiences of how such ubicomp technology could work in this specific setting.

**The Pin&Play Technology**

Pin&Play offers a novel solution to combining physical and digital information on large surfaces. It is based on the vision that walls and other surfaces can be used as a network bus and power source for objects that become attached to them [2, 3]. With cheap and simple means, Pin&Play can turn even very large surfaces into a network, irrespective of horizontal or vertical placement. The idea is that Pin&Play will provide digital augmentation to objects that are attached to surfaces. The original Pin&Play objects were designed to be in the form of regular notice-board pins, but long as a Pin&Play object can be pinned to a surface, it can take any form and perform any function. This allows for a great flexibility and opens up the possibility to support a variety of practices.
The technology is based on the following main components:

- **Surface:** a physical medium for data and power
- **Connector:** a device (pushpin) for attaching objects to the surface
- **Objects:** network nodes that are powered and connected through the surface
- **Network:** network control and communication protocols

Using the pin connectors Pin&Play objects can be attached anywhere on the surface and instantly become connected to the network. The connectors provide each attached object with a unique addressable id and with power, so the objects themselves do not need any batteries.

The surface serves as a physical medium for both communication and power. Instead of wires, conductive sheets are used to form a two-dimensional network. The surface is currently realized using two woven fibre sheets of conductive fabric (0.1 millimetre thick silver or nickel-copper plated nylon) and an insulating middle layer of cork or rubber. The conductivity is extremely low (below 0.5 Ohms/square). A Dallas MicroLAN is used for communication. This requires two wires, one for data and one for ground, corresponding to the two conductive layers on the surface. The network is structured as a master-slave architecture where the bus master is a PC or some other device attached to the networked surface. The original Pin&Play technology has no solution to the positioning of pins on the board. However, a possible future solution involving computer vision is under development elsewhere [4].

The connectors connect an object to the network. When a connector is pinned to a conductive surface, the object becomes a part of the network, and can also receive power from the surface. The connector originally consisted of two isolated pins that penetrate the front and back layer of the corkboard, respectively; the longer was covered with an insulator, with only the tip exposed. Recently, a more robust single pin design has been developed where the short pin is replaced by an insulated cylinder around the longer pin [5]. The first Pin&Play object that was constructed was the *Smart Pushpin* (see Fig. 1). This consists of an iButton and a light emitting diode (LED) that can be switched on and off through the network. The iButton component contains memory, battery, calendar, clock, programmable alarms and communication support. The smart pushpin could be used to attach other artefacts, such as paper notes and posters, to the surface. These are not in themselves active objects, but in a sense become part of the system through the pushpin that is used to attach them.
Other Technologies for Networked Surfaces

Pin&Play is one among several projects that focus on turning a physical surface into a network. Before the design case reported here, the Pin&Play technology had only been presented as technical demonstrations, without being situated in or designed to support a real world situation. This is also the case with several similar ubicomp technologies, which have not yet been tested in everyday environments or practices. Most closely related is Pushpin Computing, a technology that uses a similar infrastructure to Pin&Play, where pushpins also are attached to a layered conductive sheet [6]. The aim of pushpin computing is to build a platform for the modelling and testing of distributed peer-to-peer sensor networks. The conductive layers provide ground and power, but are not used for communication purposes, and the network is not a bus topology as in Pin&Play. Instead the pushpins only communicate with neighbouring pushpins within a close range (~10 centimetres) through for instance capacitive coupling or IR. This requires a rather dense network of pushpins, which could be a drawback if the technology was to support an ongoing process (e.g. a large-scale scheduling process) where the initial objects might not be within this range on the surface. Moreover, each pushpin consists of four modules that handle power, communication, processing and application specific functions respectively, which increases the complexity and the size of a pushpin. This technology does not provide any solution to exactly position pins on a surface.

In another approach, researchers in the Networked Surfaces project at Cambridge [7] focus on how to augment horizontal surfaces with networking. They do not aim at augmenting everyday objects such as paper notes, but let instead laptop computers, handhelds and other high-end devices become connected when placed on surfaces like a table or a desk. Instead of using conductive layers like Pin&Play and Pushpin Computing, Networked Surfaces uses tiles that take care of connections and power. Objects can be connected to the surface with pads that are explicitly designed for the tiles. It is possible to sense position and orientation, but the network will have to manage a large number of tiles and negotiate connection points with object adaptors, which
makes the system quite complex. Unlike Pin&Play and Pushpin Computing, objects do not need to be explicitly attached to the surface to become connected. However, this limits the current technology from working on vertical surfaces.

Supporting Large Scale Work Practices

Studies of collaborative work practices and the role of surfaces to display information in such contexts have showed how large surfaces in combination with tangible objects give users control and overview of information. The information that is attached to the surfaces is often in paper format [8, 9]. Even if paper lacks many advantages of digital media, it has properties that can still make it preferable to digital solutions. This indicates that there is an opportunity to find technical solutions that supports current work practices and that keep the physical benefits of paper or other low-tech material while adding a digital dimension.

Several technologies have been developed to facilitate large-scale group collaboration. One approach is to use large touch-sensitive displays [10], where on-screen digital information replaces the physical artefacts, and users manipulate information directly on the screen. However, this approach neglects the inherent physical benefits of paper and other physical artefacts that the above mentioned studies have pointed out. Furthermore, the information shown needs to be very detailed, the resolution of large screens becomes a critical issue. For instance, today’s large screens cannot provide enough details to display the same information as small handwritten papers notes or printed text documents. Another drawback with such technology is that large screens are still quite expensive and limited in size, making them inappropriate when users need very large augmented surfaces.

Another approach is to provide interfaces that support the manipulation of physical objects that are somehow connected to electronic information and events, allowing users to continue to use physical objects. One possibility is to use computer vision technology to identify physical objects and their movements, potentially in combination with a projector to augment them with digital information. An example is The Designers’ Outpost, which lets physical Post-It notes be manipulated and identified on a large, touch-sensitive SMART board augmented with a computer vision system [11]. However, as sticky Post-It notes may eventually fall off from a vertical surface, this system is only suitable when it is not critical that notes stay in place over a longer period of time. It also saves each note as an image, which means that it is not possible to make text-based searches of notes. Another issue is that when a note is removed from the camera system, its digital representation is lost, and it will appear as a new note if it is put back. The Collaborage system instead utilizes paper notes tagged with data glyphs on ordinary walls [12]. The glyphs gives each note a unique identity. However, the system must scan the whole area and needs to zoom in on each
note to determine its glyph, which may make it less suitable for very large surfaces holding many small notes.

Yet another solution is to have a tag reader incorporated in the surface. For instance, Senseboard [13] uses small physical tokens with electronic ID tags that are attached to a board with built-in sensing. A data projector is used to overlay the physical tokens with digital information. By attaching and manipulating the tokens on the board, the user could manipulate digital data and receive immediate feedback on changes. A drawback is that the system does not allow for paper notes or other everyday objects, but requires special RF-ID tagged pucks. Since text is projected on the pucks, this approach needs a dim office space. This also means that if the system crashes, or pucks are removed from system, the projected text on them will disappear.

The Göteborg Film Festival

To learn about the possibilities and limitation of the Pin&Play technology, we wanted to situate it in a real world work practice. We found this at the Göteborg Film Festival. The festival takes place over 10 days every year, and shows approximately 700 films. When a festival is in full swing, the number of employees can be almost 200, but during the rest of the year a team of five people are employed full-time to plan the festival. Before each festival, the team conducts collaborative work on large-scale surfaces to create the film program, using a practice has been essentially the same for over 20 years. Basically, their own office walls are used as large matrixes, and each of the 700 films is represented with a paper note. This large-scale scheduling activity and the current lack of digital support, made the festival team an ideal user group for our purposes. Observing them and using their knowledge in scheduling activities, helped us explore if a novel ubicomp technology like Pin&Play could support practices involving collaborative scheduling.

Fieldwork

After initiating contact with the film festival team, we conducted several interviews and observations during the planning of two consecutive festivals. For the first festival, two observations were conducted during intense scheduling activities, lasting for approximately three hours each. During this time we observed and took notes without asking any questions, but occasionally the festival crew gave us spontaneous explanations about their activities during the process. Interviews were carried out both before and after our observations of the actual scheduling process. One was held with the film festival manager, the person who is in charge of and also an active participant in the scheduling process. Another was held with the team member in charge of the current
database system. The manager also provided additional comments and details via e-mail throughout the process.

For the second festival, one observation was conducted that lasted about two hours. This session was videotaped but otherwise conducted in a similar way as the first one. The number of team members who were active in the scheduling varied from two to five during any of the occasions, but always included the manager. In between the two festivals there was a change of offices, but the setup of the schedule and workplaces was basically the same on the two locations. In relation to the second session of observations, the manager was interviewed again about the entire work activity at the festival; from visiting other festivals (e.g. Cannes) to the organization of the local activities.

The first year’s session of fieldwork gave us a general insight into and an understanding of the activities, which lead to preliminary implications for design [14]. During the second year’s session we focused more on understanding the entire process in greater detail to be able to draw more specific and concrete implications. Our general aim was to keep the benefits of the current scheduling process, while gaining digital benefits by augmenting it with Pin&Play technology.

In between the first and the second session of fieldwork, we gathered members from the festival team for a workshop to evaluate the preliminary implications. This made it possible to get feedback on both technical limitations and work-related issues important for the design of a prototype. The team was also able to get some initial hands-on experience with the original Pin&Play technology, the surface, the pins and its functions.

### Scheduling the Film Festival

The fieldwork and interviews gave us a rich understanding of the complexity the team has to face when scheduling the festival. It gave us insight in their specific use of large work surfaces and paper notes, as well as lack of computer support for this activity. Below we will present an overview of our analysis, to provide a background to the prototype described later.

Overall, the festival work can be viewed as five different activities:

- Research about what films should be shown
- Schedule preparation, completing information needed for each film
- Scheduling
- Schedule-check and transfer to database
- Practical use of the schedule: catalogue making, web site etc
The research starts at the end of the previous festival. The program group travels to different international festivals collecting information, enters possible films in a database, and eventually invites selected films to the festival. As films get accepted, additional information is added to the database and the schedule preparation can start. This involves first writing physical paper notes representing the screenings for each film, with basic information (title, format and length). There are usually three notes for each film, which corresponds to the number of screenings. A paper note can also represent a “package” of short films that will be viewed at the same screening. There will be approximately 700 paper notes in all, corresponding to the number of screenings. Each note has a specific colour, depending on which category the film represents, such as the country of origin or some other theme. The preparation also includes blocking certain times in the schedule, for example to show that a cinema is not available at certain hours.

During the scheduling, the schedule is built by pinning the notes representing films to large boards, covering two entire walls. The boards have a number of “slots” arranged in a sort of matrix (see Fig. 2). On the boards, each of the 14 festival cinemas is represented by a column, and each of the 8 screening times by a row. Every day of the festival has a separate matrix, meaning there are 10 groups in all, with 112 slots each. Thus, by physically pinning a paper note to a specific position in this very large matrix, the corresponding film is scheduled to be screened at a certain cinema, during a certain time on a certain day.

This is a highly collaborative process, simultaneously conducted by at least two persons. The team has to handle a lot of information, which creates a heavy cognitive load. They take advantage of their previous experience of festivals, as well as their own research about the films. They use tacit “fingertip” knowledge to determine the screenings that are suitable for a film. This includes expected audience, subjective feeling, and current and expected publicity for the film in question. Other information is of a more practical nature. For example, this can be film format, length, availability (a film might be booked for other festivals), transport time between screenings, award screenings, seminars, school screenings, director visits and so on. On top of this there is a risk that sudden
changes happen, for example a visit that gets cancelled, new films that are accepted or others that are dropped from the program. Most films are already prepared as paper notes before they are scheduled. However, it does occur that a slot is booked “on the fly” by a spuriously created Post-it note or other paper piece, that can temporary represent a film or an unavailable screening time.

In addition to this, there are other people who need to have access to the schedule. A separate group works with arranging seminars, and have their own board filled with seminar information, located in another room. If a film with a related seminar has to change screening time, the seminar arrangements will have to follow the film. This sometimes creates problems since the seminar group cannot see the main boards and has to switch between rooms to get a complete view of the situation.

Finally, when the physical schedule is considered to be finished, it is proofread several times before a screening number is written on each note. After this, the schedule is transferred to digital format. One person starts reading in one corner of the board, consecutively dictating each number and film, while another enters this data into a database. This also involves manually calculating each film’s end-time. When this is done, the final screening database is compared several times with the physical schedule. This database is then the basis to run an SQL server, which is used in ticket vending at the cinemas and on the homepage. The finished schedule database is also used in the making of the festival catalogue.

The team stresses that they need the large boards for overview and collaboration, claiming that an entirely desktop-based solution would not work. The current process with paper notes provides a flexible work practice, where it is fast and easy to make changes. It also gives them many opportunities to improvise and create new functions. For instance, notes are sometimes folded or positioned somewhat askew, which represents a scheduling that has not yet been fully decided. Furthermore, the system with different colours for different categories of film gives them support in gaining overview of the schedule as it is created.

However, there are some obvious difficulties with this way of working. As mentioned, the team members currently have a heavy cognitive workload. The information on the paper notes can be incomplete and there is a risk of getting the manually calculated end time of a screening wrong. If the information that the team members have to keep in their heads could be reduced, errors could be minimized. Currently, the schedule has to be constantly checked manually for possible errors. Potential errors include that there is not enough time for transportation between cinemas, or that a screening is not synchronized with a guest, that the film’s format is wrong for the cinema, and so on. Another problem that becomes increasingly important as the schedule grows is to locate a specific film on the board among hundreds of other notes; this can sometimes take up to fifteen minutes.
Finally, when all 700 notes are up, the schedule needs to be manually transferred to the digital database. Not only does this require a lot of work, there is also a risk of transferring the wrong details from the schedule to the ticket database and then on to the program brochure, which, in the words of the festival manager, would be “a disaster”.

Fig. 3. The prototype board (left) and the web application (right)

**Pin &Play Scheduling Prototype**

Based on these findings, we constructed a Pin&Play-based scheduling prototype (see Fig. 3). The aim was not to build a full-working system that could support the entire scheduling. Instead we wanted to use the film festival as a real world case when learning about the potentials and limitations of the specific technology, as well as exploring potential general challenges for ubiquitous computing in a real world situation.

We decided to build a prototype supporting the scheduling of 15 films distributed over 2 days, as a section of the full-scale schedule. This would be a way to illustrate how the Pin&Play technology could support the essential features of the scheduling. It would not have been feasible to build a full-scale prototype at this point. One major reason for this was the current lack of positioning, which had to be solved with a temporary and less optimal solution, making the system slow. The small-scale prototype would still be enough to find out about realistic limitations and possibilities of the technology for scheduling practices. The finished prototype was first demonstrated in [15].

The prototype was implemented so that each smart pin is attached to a paper note that represents a film screening. A database, accessible via a web interface, represents the current state of the scheduling by directly polling the state of the board. It is thereby possible to interact with the digital representation simply by pinning notes to the surface, thus preserving the original work practice.
Since each pin represents a screening, it is important to create an association between a pin, a film and its corresponding note. The two physical items also must continue to stay together since their connection is a condition for making an accurate schedule. For this prototype we decided to hard-code the digital association between film and pin, but a potential solution to better facilitate this association will be described in the section on implementation details.

Based on the fieldwork and the design implications, we first defined detailed scenarios to identify what the prototype should do and how this could be implemented. These scenarios, described below, helped specifying the interaction with the prototype and the core functions it should implement.

Fig. 4. Scheduling a film (left); attaching the query pin to a slot in order to get more information about a film (middle, right)

Scheduling a film: When the user schedules a film, he or she takes an interactive pin with a paper note (which together represent a film screening) and pins it to a slot on the augmented board, see Fig. 4 (left). This is the same as with the current scheduling system without computer support. Each slot in the matrix corresponds to a specific time, cinema and date. The pin is identified and located by the system and a check is performed whether the chosen slot is suitable or not. The system compares the length, format, availability, and possible planned guests of the film with the criteria of the slot. In a separate web interface, the user can see a schematic representation of the current state of the board. If the film is not suitable for the selected time slot (e.g. it is too long, or the format of the film is not supported at the chosen cinema), the user is notified with icons on the web interface, and can get additional information on what caused the notification (e.g. “The film is only available on day two to four”). In that case, the user might consider moving the film to another slot. Furthermore, the user might want to schedule several films in the same slot, for instance to let a short film open a screening. In this case, he or she simply pins additional notes to the same slot.

Searching for films with certain criteria: As the scheduling progresses, it becomes increasingly difficult to locate a certain film on the boards. Sometimes the user needs to find all films that correspond with a certain criterion, say a
genre section or director. Other times, when one is about to schedule the last screening of three in total it can be necessary to know where the other two screenings are located. In the prototype, when the user wants to locate one or several films on the board, or wants to find films that share certain conditions, he or she enters the search criteria (e.g. title, director, genre section, format, etc.) in the web interface. The LEDs on the pins of the matching films will then light up on the physical schedule for a short time, making them easy to locate. This also provides the user with an overview of the result in a larger spatial context. The user can also see the resulting film(s) of his or her query highlighted in the web interface.

**Displaying additional information about a film:** When the user needs to find more information about a film than what is visible on the physical paper note (e.g. director, exact dates it is available, specific comments, genre), he or she takes a special pin we call a query pin and attaches it to the same slot as the film occupies, see Fig. 4 (middle, right). The query pin’s presence triggers the web interface to display all additional information about the film. This information does not fit on the paper note, but is nonetheless necessary for the user during the scheduling process and should be easily accessible.

**Transferring the final schedule to the database:** When the user considers the schedule to be finished, it can be automatically transferred to the database. First, the system calculates the end time of every film and gives each film a unique screening number. If several films (e.g. a short film and a feature) are placed in the same slot, they will get the same screening number since they are treated as a unit in the film programme. The web application then displays an updated schedule with screening numbers. The user checks the schedule and finally exports the complete schedule to the database.

**Implementation Details**
Fundamentally, the prototype consists of an augmented board with pins, a MySQL film database, and a web-based application providing an updated representation of the physical board and a graphical query interface to the database. The board has 15 slots, which are distributed over two days, three start times and three cinemas. The web interface provides additional information and allows several people to view the database at the same time. It also supports external access to the main schedule, for instance for the group that schedules seminars.

The pins used in the prototype are similar to the original Pin&Play pins, with the exception of the iButton, which was removed. Instead, a pin is found on the network using the unique serial number of its MicroLAN-compatible switch. However, we needed to know where on the board a pin is attached, something that was not part of the original system. We decided to use a temporary solution, enough to develop a small prototype, but not intended as a solution for the
technology in general. The prototype surface therefore consists of isolated slots, copying the matrix layout of the film festival schedule. The slots are made of the conductive material as a top (ground) layer, cardboard as insulation and a second layer (communication) of conductive material covering the entire rear of the board. They are separated by addressable switches and when switched on, each slot is available on the network and any pin(s) attached to it can be identified. The solution is fairly robust but slow – in the worst case it can take up to 30 seconds to locate a pin since it is necessary to cycle through all of the slots, until the pin is found.

The position of a pin is stored in a database by saving the serial numbers of the switches of the pin and the slot. A web application provides a schematic, “real-time” representation of the physical board, where all actions taking place on the board are displayed and where feedback on the schedule in progress is shown. The web application gets information from the database and performs a check for each film and its slot (where length, format, availability and guests of the film is compared to the criteria of the slot) before updating the virtual representation. If the location on the schedule proves unsuitable for a film (e.g. the film is too long for the chosen time slot or the format of the film is not supported at the chosen cinema), notifications are displayed in the web interface.

We wanted a way of interacting with the system directly on the physical board. As the pins fundamentally are slaves on the network, there is no opportunity for them to call for attention when already connected. We solved this by using one pin as a “query pin”. When attached to a slot, its presence on the network triggers a request for more information about the film. The detailed information is showed on the web interface.

As mentioned, for the prototype to become useful it is important to find a way to associate a pin with a film. A possible solution, currently not implemented, would be to use a kind of “docking station”. Such a station could basically be a Pin&Play slot that is separate from the scheduling board but still connected to the network. Pinning an anonymous pin with a paper note into the docking station could trigger a dialogue window in the web application where the film ID is requested. The film ID and the pin’s serial number are then saved in the database and the pin is set up to represent a film on the physical board.

### Evaluation with the Film Festival

Before testing the working prototype with the film festival team, we conducted a small pilot test. It involved four people with various levels of knowledge of technology and no experience in scheduling on large surfaces. This was intended to identify unexpected technical problems with the prototype, and to confirm that a similar test would be suitable for the film festival team.

The test with the festival team took place in a lab environment, and lasted for about two hours (out of which the actual test took one hour). Two members of
the team, the festival manager and the technical manager, took part in the
evaluation. We started by explaining the prototype and its functions. As
previously in the pilot test, they were then asked to perform a number of
scheduling tasks and were encouraged to think aloud and discuss while trying
out the prototype. The tasks included: scheduling a film, re-scheduling a film,
finding detailed information about a film (by using the query pin), searching for
films and locate the resulting ones on the board, giving all films screening
numbers and finally exporting the final schedule to the database. The tasks were
chosen to reflect their current work practice, but also to bring out as much
functionality as possible from the prototype. By constraining the tasks we felt
that it would be easier for team to understand the functionality, and make them
reflect on how their work practice had been captured in the prototype. The
intention was that having the two team members working together would lead to
a broader discussion about the prototype. This approach also reflected the way
they are used to collaborate during the actual scheduling. The test was followed
by a semi-structured discussion.

![Fig. 5. The festival manager schedules a film on the board (left) and views the notifications on the web interface (middle). The team members collaborated during the test (right)](image)

**Findings**

In the following we will present findings from the evaluation with the film
festival team. The quotations are translated from Swedish, and marked with
‘FM’ (festival manager) and ‘TM’ (technical manager) when needed. After a
general introduction, the findings are presented following the same structure as
the previously described scenarios.

The overall response from the festival team was that we had succeeded in
capturing their work practice in the prototype. As the festival manager
expressed:

“...it is hard to simply convey [our practice] to someone else... Like I
said before, we almost cannot believe that you have understood all this
so well and managed to translate it. That’s really how it feels. I can’t
think of anything else that... is missing.”

Firstly, they were excited to see a technical solution that allows them to
continue with the aspects of their practice that work well. The festival manager
stressed once again that “...the overview, that’s what you want to keep the wall for... [...] the fact is that you will never get the overview there [on the computer screen]... That’s why we have it [the schedule] in a physical form...” Secondly, they were pleased to see that many critical and ‘mechanical’ tasks (such as checking format, length, end-times etc) were things which could be offloaded to the computer, while they could continue doing the craft of scheduling a festival:

“...what is most helpful is to get corrections on this [the scheduling] of course... these formats and the length, so you don’t make the wrong entries. But there are of course limitations in the system where the human brain needs to take over, when it comes to things you’re supposed to have at your fingertips like ‘how will this [film] sell?’, ‘what kind of film is it?’, ‘what cinema would suit it?’ You really can’t put this into the system.” (FM)

For example, the simple feature of supporting them with the calculation of start- and end-times of films or simply how many films share certain criteria was much appreciated:

FM: “But just the calculator... that’s not so bad in itself... it’s the simplest possible... how many films are there... because we always count manually, however unlikely it may sound. [...] It’s also interesting to be able to categorise: long and short, Nordic, Swedish, international...”

TM: “But you can get that from FileMaker right?”

FM: “Yes, you can, but you always end up counting manually anyway.”

The prototype thus seemed to provide good support for many of the critical tasks in the scheduling process. Below we further describe how the team interacted with the prototype and how they discussed their current practice compared to scheduling with the prototype.

Scheduling a Film

When scheduling a film, for technical reasons the system sometimes took several seconds to represent the attached paper note on the web interface. The participants seemed to accept that this was an implementation issue, which could be improved with a different positioning solution. When a film (i.e. pin) had been attached to the board and was shown with a graphical counterpart on the web interface, they found it very suitable that this has same colour as on the physical board: “You get an over-view... This colour [coding] is brilliant too, because then you can have recognition very easily” (TM).

The festival team found the notification icons to be an excellent function, which could make it easier to avoid mistakes, since these show immediately if a film is unsuitable at a certain slot:

“...you often forget this [formats etc], so that’s why this is good to have a small indication of error when you have done such things, in some ways an indication of ’no, no, this isn’t possible’.” (FM)
Despite current ‘double checks’ for mistakes, they still occur according to the festival manager. They even suggested that it would be possible to show more icons, for instance “school films” (that schools groups can see during daytime on regular weekdays). On the other hand, too many icons could be confusing and make the really important ones less visible. However, they also had some concerns and future thoughts about the icons. For example, the festival manager pointed out the importance of being able to override the system:

> “Then if you for one or another reason would be smarter than the computer and would want to ditch an icon that it has indicated, then you could do that too. That is if you choose to ignore a pre-programmed [option].”

Such ignored options would need to be indicated in some way, so that it is possible to go back and continue scheduling them later.

Finally, the web interface makes it possible for people that are not in the same room to take part in the scheduling. The team suggested that it would be great if the seminar schedule could be synchronized with the film schedule, since this often causes problem:

> “It would be wonderful to get this information [on festival guests] here. Because that’s really good... to have... the fact that you have made an icon [for such information]. Because this information is really good when scheduling... we simply need it... it’s too much effort and risky business the way this information is transferred today.” (FM)

This would simplify the overall scheduling of the entire festival programme.

A related issue had to do with feedback on the board versus feedback in the web interface. In the current prototype, there is no indication on the physical board when a film is attached to a slot where it is unsuitable – this is only shown through the notification icons in the web interface. The festival team expressed a need for this type of feedback, and suggested that this could be solved by having the LED on the pin blink when the pin was attached, to provide immediate notification on the board if there were problems with a screening. However, as the technical manager brought up, there is a clear need for different LED signals depending on what they are indicating.

**Searching for Films**

They found it useful to be able to search for films with certain criteria on the web interface and view the results both on the physical board and the screen. The fact that the search was visible directly on the physical board was considered a good feature, since it preserves overview. This is for example important when the team needs to see genres of films beyond the ones currently represented by paper colours: 

> Then there are subtle parameters [...] like the flow of a set of three screenings, where it should be placed something like this on the map
[makes a gesture in the direction of the board]. If this [...] starts early, this should be in the afternoon here and then maybe an evening there. So that there is a flow during the day. [...] There should be like a theoretical possibility if one wants to follow all Iranian films, so that they don’t clash with each other...” (FM)

The festival team also commented that even more items could be included in the search function. For example, searching for different types of notification icons would be a way of checking the schedule for possible errors and make sure that all films have actually been scheduled:

“Ah, but that’s also smart, because it can be a good way to control later when you... that is, when you do such a ‘counter con-trol’. You enter all [films] to see... Heck, it does actually happen that we have forgot-ten [laughing]... we realised it this year. Darn, suddenly it was like... where is it [the film]?... and then we had forgotten to pin it to the board despite the fact that it was included in all systems and everything.” (FM)

It seemed like the team would have liked just about all information regarding the films to be searchable. They also thought it was important to be able to easily count things, which could be solved with a “number of hits” display in the search function.

Displaying Additional Information

Attaching the query pin to an occupied slot to display additional information about a film was considered a less crucial feature. While it was well received in the pilot study, the festival team thought it would be simpler to just type and search directly in the web interface: “The ideal would almost be... [...] to be able to click here [points at the computer screen]” (FM) However, this result might have been affected by the slowness of the system. After having initiated a search by attaching the query pin on the board, the subject often had to wait several seconds for the query pin to show up on the screen, before they could continue. It was faster to search directly in the web interface, even though it took a while until the LEDs would light up at the board.

Transferring the Schedule

Transferring the schedule to the database was considered one of the most important functions of the prototype:

“That process in particular would be the greatest single transformation. Because this takes us two days in principle... this standing here and counting every end time and reporting...” (FM)

The team claimed that this would save them two days of work, which is extremely valuable time before the start of a festival. The liked the current implementation of this, and had only minor comments, such as how the data was displayed.
Implementation Issues

Overall the festival team members showed great patience and understanding for the fact that the prototype was in an early stage. Some technical issues were identified during the evaluations, but these primarily occurred in the pilot test, and were not related to the practice of the festival.

Generally, the issues had to do with lack of feedback from the hardware components. In combination with the slowness of the system, the participants got uncertain about if they had successfully attached a pin to the system (and thereby connected to the network). The pins were experienced as somewhat fragile in the pilot study and the insulation material was considered hard to pin through. However, the festival team did not comment explicitly on this. They were instead concerned about being able to see the LEDs in a light room, indicating that stronger LEDs or other notification channels could be useful.

Another technical issue for the future is when and how to connect a film and a pin. The festival team indicated that a docking station could be a good way to do the connection. This would not require a lot of extra work as it could be performed in the preparation phase, when information in the computer database is used to create hand-written notes.

Discussion

This case illustrates important qualities of a tangible, collaborative scheduling practice that can be generalized to other practices as well. It also points out possibilities and advantages for ubiquitous computing in situations where current desktop and other computational support existing today are not sufficient. Introducing novel ubiquitous computing into a well-established real world practice, involves many technical and practice-related challenges. Below we will discuss some challenges that we encountered, from a more general perspective.

Challenges with Ubicomp Technologies

Ubiquitous computing technology has several fundamental technical challenges where robustness, power, communication and positioning are only a few examples of this. Still, there are often ways to go around the current lack of an optimal technical solution, to make it possible to get feedback from a world situation. We studied the festival team and develop a small-scale prototype in order to learn about the technology, its potential and its drawbacks with a reference to a real world complex situation. During this process, we learned about specific technical properties that would be critical for the technology in such situations. For example, the original Pin&Play technology had no support for finding the position of a pin on the board. Our stopgap solution was to divide the surface into several slots, building a partial implementation of the festival team’s schedule. This solution made the prototype slow, but worked sufficiently
well to illustrate how the work practice could be supported by the technology. This also made it clear that making a more sophisticated positioning for Pin&Play would be a suitable step to take, supporting the work by [4] where cameras are used to identify the location of pins on the board.

Another technical implication involved the iButton component, which originally gave a pin the possibility to hold data and provided it with a certain degree of computing capabilities. In our prototype we found that a pin only needs an identification number, which already exists in the switch that is part of the pin. This also made it possible to reduce the size of each pin.

Even if ubicomp technology involves technical limitations it is important to work around these, and accept less optimal technical solutions, to be able to learn about which properties that are worth to develop further and which that are less important in a real world practice.

**Introducing New Routines**

Even if the ubicomp system builds on the existing practice, there will inevitably be changes that the users have to adjust themselves to. Our scheduling prototype is based on and designed for an existing practice, where a future full-scale system would be able to keep the familiar interaction of pinning notes to walls but would also introduce new routines and outcomes. Pinning a note to the wall was previously done without hesitation, whereas with this system, users would need to know that the pin has connected properly to the network. The system could easily give instant feedback on the successful pinning of a note, but users will still have to be aware of such issues.

A fundamental part in tangible systems that aim to connect the digital and the physical world, is to create an association between the two. In our case, associations between the physical pins and their digital film IDs, are currently hard-coded. In the future, however, such associations would have to be done without hindering the users in their work. One solution could be a docking station, where pins and films could be connected. This would introduce a new routine, which would be important to integrate well in the current practice. Here, such a new routine could be part of the phase were the team already is sitting down, manually writing a note for each film.

The prototype further illustrates possible outcomes in the work practice, due to the technology. An example of this is how the manual transfer of the final physical schedule into the database, could be done in a couple of seconds instead of the current two days. As the festival manager expressed, this would give raise to a significant change and improvement of their current practice.

The prototype functioned as a trigger to make the festival team think about their current practice and beyond. They were at first sceptical towards digital support in general, and stressed the importance of overview and collaboration, something they felt could not be supported on a desktop computer. When
evaluating the prototype, however, they enthusiastically found that the information was efficiently and successfully accessed through the system. For instance, they started to discuss that the board and the notes potentially could be made smaller with less information constantly visible, as the system would support them with such facts when needed.

When ubicomp technology augments an existing practice, this will involve new routines for users. It is essential to have enough knowledge about the practice in order to integrate these changes as smooth as possible.

**Choosing Technology Depending on Task**

The vision of ubicomp systems is often that computing is embedded everywhere. However, depending on what users need to do, some tasks are still preferably done with a regular PC. For example in the prototype, users still preferred to do text-based searches for films on a PC, but wanted to get the answer directly on the board for overview. Fundamentally, the users wanted to continue pinning notes on the board, but preferred to read more detailed information on a PC. It thus became clear that some information was better manipulated and visualised on a computer screen, whereas other information benefited from being manipulated and visualised on the physical board where one could get an overview. To support their scheduling, both physical and digital I/O channels were therefore necessary, which resulted in a system combining a physical scheduling board with a traditional PC-based application.

As a result of the users’ activity and their need for different technologies, the system needs to give them different feedback depending on the situation. We learned from testing the prototype with the festival team that if standing several metres away from the PC, it does not help that a matching digital representation appears on the screen when a physical pin was attached. They needed instant feedback from the pins themselves, for example a blink to inform that they were successfully connected to the network. A lit up LED could also imply other things, for instance that there is additional information to read on the screen (i.e. notifications). A challenge is therefore to provide consistent and intuitive feedback, although the channels to do it vary: from text based information in the PC application to LEDs lighting up on board. The festival team suggested for future implementations that the pins could be equipped with a number of differently coloured LEDs to notify the user about various things. What information, and when and where this should be accessible and visible is also something that the users would need to manage themselves as they are using the system. Even if the hardware is limited and the team only can do software changes, the entire system needs to be adoptable for changes in the practice. For example, it should be possible to implement new notifications when needed.
Inconsistency in Physical and Digital Representation

The physical and digital counterparts might never entirely match each other, and one question is also if they have to? In the scheduling prototype reported here, a crucial matter was both how to maintain a constant connection between the physical (pin and paper note) and the digital representation, and which information they each needed to keep. Paper notes are for example flexible and very valuable in this particular collaborative process, and together with the interactive pins, they could still be used in the prototype to provide overview. However, some tangible practices such as folding a note or attaching it askew cannot be represented digitally in the current implementation, which makes some information inconsistent between the physical and the digital world. The combination of technologies makes it necessary for users to know what information is digitally captured, and accessible when and where. It is thus important to clearly show the users which actions affect something in the digital world and vice versa. It is also crucial for the designer to understand the practice enough in order to know why certain representations are needed, and where they should appear. This is however not only the choice of the designer, but the users may also need to negotiate which representations to use when. For example, the festival manager mentioned an incident where team members had used different names to refer to a combination of two films. This made the films hard to find in the system: “Everyone had not agreed on how this should look, when it was entered it into the systems, which caused us some problems”.

System Shutdown

Our Pin&Play prototype would make it possible to continue doing the tangible scheduling, even if the digital system would break down. When the system is up and working again, the system would simply go through the pins and update the digital representation. This is an advantage over systems that for example uses large digital screens or projections, where the possibility to continue the process without the digital support is limited.

Conclusions

Using ubicomp technologies in prototypes for real world cases gives feedback in which directions these technologies need to be pushed or be improved. It also provides valuable understanding of everyday practices where technology support previously has not been considered desirable, or even realistic. When we first contacted the festival, the team was sceptical to if it would be at all possible to create a digital support for their scheduling process. They stressed the importance of overview and collaboration; something that they felt could not be supported by a computer. At the end, they were thrilled to see and discuss how their work could be offloaded to the computer, while keeping the essential characteristics of their 20-year-old work practice.
Although the technology was not mature to become a full-scale prototype at this time, the limited implementation still gave us valuable knowledge of how well we succeeded to capture and improve the team’s work practice of scheduling 700 films. The team saw beyond the current limitations (such as slowness) and discussed relevant improvements, such as when and where they needed feedback. This illustrates that it is possible for ubicomp researchers to get valuable feedback from real world situations, even when the technology is not fully developed. In parallel to our work, many of the technical limitations we chose to work around, have already been addressed. This shows both how it is valid to test technology in the real world even if it is not fully developed, and how findings from such studies could guide and support the development of new technology.

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References


Abstract
This paper reports on how we learned from an alternative practice in order to design engaging interactive technology intended for a more general user group. When investigating new types of digital photography we designed context photography, where real-time context data visually affects digital pictures as they are taken. To understand how to design for a meaningful photographic experience, we took inspiration from an amateur practice involving a particular type of analogue camera – Lomography. This paper shows how such alternative or marginal practices can help to ground design of interactive technology in existing human interests, while at the same time leading to a novel design outcome.

Introduction
Interactive technology is becoming more and more pervasive in peoples’ everyday lives, thus creating opportunities for new creative everyday practices to emerge. For example, digital photography can give raise to new and alternative
Designing for New Photographic Experiences: How the Lomographic Practice Informed Context Photography

creative practices, and support a variety of different interests in picture-taking. However, it is challenging to design interactive technology that goes beyond what already exists, and to extend existing experiences into entirely new ones. For this purpose, it can be useful to reach beyond the more general needs and interests that users can provide insight about. One way to trigger innovative design is to learn about the special needs of lead users [21]. Lead users are highly creative users of a specific product, and even if they are different from the average user, their creative use can guide the design to support future needs in a more general group. However, as lead users usually are inventive users of already existing products, such approach is not suitable when working with research prototypes or technology that is not yet mature.

We aim to explore possible experiences of technology that does not yet exist with the help of an alternative or marginal human practice. By learning about experiences from specific individuals practices, rather than the average user, we hope to design for a novel yet meaningful experience. The process involves learning about subjective and experienced qualities that make an existing practice meaningful, and transfer these to a different context – to the intended design outcome and the technology it will involve.

Context photography is a project that deliberately tries to break away from preconceptions of photography, and introduces new photographic parameters to the user. We wanted to design for an everyday photographic practice for amateur photographers, and to advantage of the untapped potential of digital technology. Previously, we have described the design process [14] and results from an exploratory study [9] from a more general perspective. In this paper we will in particular shed light on how we learned from a specific group of dedicated amateur photographers – lomographers, who use old analogue cameras with optical defects as an everyday photographic practice [15]. We never intended the lomographers as end-users of the final design, but we took advantage of their alternative perspective on photography in order to design for an alternative digital photography experience.

Background

Despite the fundamental change from analogue to digital cameras, not much has happened to the creative picture-taking moment for the average photographer. Even if novel technical properties (such as the digital format, and the possibility to directly view taken pictures) have changed the picture-taking, digital camera technology still has much unexplored potential as a creative practice. So far, studies of users have investigated which type of pictures are currently taken with digital devices such as camera phones [20], and how these are managed and shared [12]. More design-oriented research projects have investigated novel ways of editing, consuming or sharing the taken pictures – for example, pictures
have been augmented with audio recordings [5, 1]. Other efforts have involved mobile and simplified annotation of pictures [3]. Sensor-based metadata, such as GPS (Geographic Positioning System), is already saved with the picture in some consumer products (e.g. in Samsung SGH-E760). However, such metadata could be used for much more than providing geographic location of where a picture was taken, beyond merely constituting saved information from the moment of capture. A more active use of sensors is found in the field of ubiquitous computing, where sensor values more obviously can affect the user experience, for example in museum environments [8]. Automatic capture of pictures to generate diary data could represent a novel approach in the moment of picture taking. However, rather than being explored as a creative practice, this has primarily been investigated as an automatic wearable system for documenting the everyday, e.g. to support memory [6]. Instead, context photography aims to explore photography as a creative practice, and more specifically investigating novel experiences in the moment of taking a picture.

This paper aims to contribute to a holistic view of use, namely to design for experiences. Some researchers have a functional perspective of experience, suggesting that it is possible to classify it as a predictable behavior [17]. Others, including us, consider experience to be contextualized, highly personal and actively constructed, implying a more holistic relationship between the user and the artifact [16]. From this perspective, the users themselves create meaning, and as a designer you can only learn when and why meaningful experiences arises and try design for them to happen [4]. In a similar manner, designing for aesthetic experiences involves inviting people to be active in creating sense and meaning [7]. Such a perspective of design could also involve making users or other individuals reflect on their experiences, in order to find specific qualities that can describe aspects affecting a meaningful experience. Such qualities can then be considered as a foundation for design. This is our approach, aiming to understand, build and design upon and for meaningful experiences. Related approaches of experience-centered design, involve putting the designers into the shoes of the users. In experience prototyping [2] bodystorming is used to understand and bodily engage in the user’s situation. Another technique involves to touch upon possible diverse experiences, by inviting people with various interests and background for an unfocus group to discuss a specific design [11]. In autobiographical design [19], designers use their own system as an approach to understand the user’s experiences with the system. This paper especially aims to contribute to the field of experience centered design by investigating how different qualities of existing experiences found in alternative practices, can inform design for meaningful experiences with interactive technology.

In this paper we will first describe our initial technical and conceptual idea, followed by our exploration of existing types of photography, and how we decided to investigate Lomography. We then outline qualities found in this alternative practice, and how this informed our design of context photography.
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After this, we describe results from a study where the context camera was used by amateur photographers. Finally we discuss considerations of using alternative or marginal practices in the design process.

Designing the Context Camera

When taking a photograph, one can be creative with parameters such as light, speed and focus. But what about letting other parameters influence the image, and view the effects in real-time? Would it be possible to capture something in addition to the visuals of the scenery? Sounds in the background, pollution in the air, smell - can such contextual sensor-based information be reflected in a picture? And if so, could this become a meaningful photographic practice, intended for daily spontaneous use? These were the initial questions and the conceptual starting point, to investigate how to design for novel digital photography experiences.

Finding a Practice to Guide the Design

In the beginning of the process we explored several sources of inspiration from the field of photography. This involved looking into different kinds of photography, such as artistic pictures pushing the technical borders of photography (for example pictures taken by Billy Name, at the Andy Warhol Factory), various kinds of amateur and professional photography, and other alternative approaches, such as practices involving infrared cameras.

Besides reading about photography and study pictures, we wanted to investigate existing personal experiences of photography. We arranged a small exercise for amateur photography students, who where learning to take and develop analogue pictures in an evening class. We wanted to find out about their overall interest in picture taking and understand their views of photography.

Overall, we learned that the photography students preferred to have control during the photo taking and to take carefully planned pictures, succeeding in getting the picture right (in for example during poor light conditions). They all shared a strong interest in the traditional photographic process of taking and developing pictures, and some were openly negative to digital picture taking. This more conservative mindset of photography did not match our interest in exploring alternative experiences and pushing the borders of digital photography. We decided to look elsewhere for people that could provide us with alternative perspectives, and who could be more open-minded to explore novel digital photographic experiences.

When looking into different photographic practices on the Internet, we had come across a practice called Lomography [15]. Lomography is an amateur everyday photography practice, making use of old Russian analogue cameras with optical defects that create unpredictable effects. The lomographers have
developed their own photographic practice, with specific aesthetics and rules for how to take pictures. They take spontaneous everyday quick pictures or “snapshots” and they “shoot from the hip”, i.e. avoid looking through the viewfinder when taking a picture. We found ourselves inspired by their creative use of the cameras technical limitations as desirable aesthetic effects. We decided to investigate if Lomography could teach us something about designing for an alternative and engaging practice of photography.

Figure 1. a) Lomographers discussing their interests b) A lomo-photography in a picture album

Workshop with Lomographers
We contacted practitioners of Lomography in Sweden. We found three local ones that were willing to meet up with us to discuss their interest in photography and provide feedback on our initial concept. Our ambition to meet with only three lomographers was not to scientifically define and explain this as a practice. Rather, these individuals were intended to highlight personal experiences that their practice build upon, going beyond existing documentation about the practice. We did not aim to make a digital version of their cameras, but wanted to understand their creative engagement and motivations for being active in such a practice to explore possible qualities of experience that an alternative digital photographic practice could involve.

Whereas the first part of the workshop involved talking about their interests, the second part involved discussing the conceptual starting point of context photography. The lomographers personal pictures (which we had asked them to bring), acted as support to trigger memories about specific photography moments, and intended to enrich the discussion. The workshop participants were the following:

- Christian, who studied system design and worked with computer support. He started taking lomo-pictures a few years back, after his father had introduced him to the practice. Before this he used an SLR (System Lens Reflex) camera. Christian carried around a LC-A (Lomo Compact Automat
camera) on an everyday basis, but liked to sometimes use other, more plastic types of lomo-cameras.

- Martin, who worked at an advertisement agency, and had been introduced to Lomography by Christian. Martin had also tried plastic types of lomographic cameras, but preferred the more original lomo-camera.

- Anna, who studied photography at the university, had just recently started with Lomography after finding out about it from Christian. Similarly to Martin, she preferred the original lomo-camera, compared to the more plastic ones.

**Qualities Found in the Lomographic Practice**

Below we present some qualities of subjective experiences, like fun, confusion or other meaningful or memorable moments that the three practitioners of Lomography described. Rather than aiming to provide an extensive overview over the experience, the qualities are intended to highlight aspects of experience that this type of photography can build upon, which also affected our design. The qualities are sorted in the following categories: The Joy of the Unpredictable, Qualities Affecting How Pictures are Taken, and Qualities of Visual Aesthetics.

**The Joy of the Unpredictable**

Anna expressed that one of the reasons she started with lomography was because of the unpredictable results: *I like* this thing that you don’t really know... *how the pictures will turn out or so.*

Similarly, Martin liked how unexpected technical mistakes in the development process could lead to interesting aesthetics: *It’s good if something goes wrong too... It’s almost what you are looking for. It’s those developments when something strange has happened, that often are the best.*

The feeling of not knowing if you took a good or a bad picture, and then open the developed pictures was special. Anna explained that she liked to develop a film that had been sitting in the camera for a long time. Martin agreed, and continued by describing his experience of picking up the developed pictures as: *Well.. you go to the photostore... You open it [the bag with pictures] directly. You don’t go home and wait, as they’re burning in the bag, right there.*

When discussing Lomography in relation to digital photography, the fact that you see the result directly and that no film is developed was considered to take away enjoyment. Martin had used digital cameras in his work but the others did not have much experience of digital photography, and none of them owned one. All expressed that digital photography was useful in work settings, rather than something one would enjoy as a creative practice. Martin expressed how a specific feeling had been taken away in current digital photography, when the
resulting pictures did not involve a moment of surprise: (...) you have to download them to the computer, and then print on a photo paper for example. I feel that you lose the whole feeling then.

We considered these different qualities of enjoyment of the unpredictable to be important to consider in our design, especially as the real-time sensor data (such as temperature or sound) we intended to use also could be perceived as unpredictable. When taking pictures in different contexts, ambient sounds might for example vary in intensity and regularity, and thus not be possible to be controlled by the photographer. If such unpredictability could be part of the joy with Lomography, similar qualities might also be enjoyed in context photography.

**Qualities Affecting How Pictures are Taken**

The technical properties of the lomo-camera, are less advanced than modern cameras. The lack of zoom seemed to inspire a certain type of picture taking where the photographer got physically close to take a picture, without looking in the viewfinder (instead shooting from the hip). This approach also resulted in aesthetics that are prominent in Lomography, such as a close-up of a person taken from an askew angle. Christian expressed this as:

> I like (...) that (..) you come closer to who or what you are picturing. And then... they aren’t always aware either, so it won’t result in one of those “where everyone stands at the eiffeltower” or so. And then... if you [don’t] capture the whole body, it could turn out bad. But, it could also turn out great (...) Well, it’s more fun pictures.

Martin, also appreciated to get physically close, to explore more artistic pictures:

> It is easier to make it [deliberately] wrong with the lomo, compared to my other. The one I have, has 30 cm as its closest distance, so I cannot get closer to get everything really blurred, like I want too sometimes. It’s really a pain actually... because sometimes you want to shoot something in an extreme close up. With this thing [the lomo] you can simply go ahead and shoot, whenever you feel like it.

Even though the auto focus in Martin’s regular camera limited possible artistic explorations, he had been taking pictures similar to those in Lomography, even before he had been introduced to the practice:

(...) it’s actually through Christian that I got an opportunity to buy a lomo and I already took a fair amount of those pictures... like snapshots. I have always been doing this type of photography, very much like this book actually [pointing at a book with lomo-pictures] Straight on, without any settings or so, preferably... It should be simple.

This implies that it is not only the technical properties that invites for a certain use of a camera, but also that the photographers interests, preferences and expectations affects how pictures are taken. From this perspective, Anna had an interesting ambiguity in her experience with the lomo-camera. She had initially
been attracted to Lomography because of the lack of control that it appeared to involve: [I like] that it feels like you can’t control the camera so much (...) especially, in those [lomo-cameras] where you can’t change the settings (...) The only thing you can control then, I guess, is the choice of film.

However, having less control in the picture-taking, turned out to be a challenge. As Anna was used to a more traditional type of photography, she found herself taking lomo-pictures with a more conservative approach, as a way to gain control:

I have noticed... I mean (...) as I have been doing so much regular photography, I’m very much like: “I’ll take ten shots of the same thing and change the shutter a little bit or so”... And, I feel this is not really a good thing to do, because then you try to get it [the picture] in a certain way. It’s like you think before. And that’s not really the point. It should only be these snapshots... but I’m stuck... uh what if I open the shutter a bit more, maybe it will turn out more like this instead?

Thus, a more conservative kind of picture-taking was also possible with the lomo-camera, suggesting that the picture-taking does not only rely on technical properties but also on the photographer preferences, as well as openness and ability to explore a different type of picture taking.

Christian carried his camera with him everywhere, and expressed that the camera had to be easy to carry and simple to take pictures with. He did not like adjusting the camera all the time, but rather wanted to make quick pictures of everyday activities: (…) I see it a bit more like a diary sometimes, you have it with you, and then you shoot a little, like “here we were having some coffee” (…) That’s what I like.

Other types of technical prerequisites that affected use, was for example lack of equipment or how other properties were not suitable for a specific setting. Martin for example, did not have a flash on his current lomo-camera, which restricted his use when it was dark. Further, the possibility of unexpected results made lomography not suited to all kinds of picture-taking situations. Anna and Martin expressed that they would not use the lomo-camera in a situation when they wanted to be absolutely sure of the result. Further, the deficient optics, which give rise to colorful pictures with dark edges, would also inspired a special type picture-taking where such visual aesthetics would be prominent in the result. For example, Christian liked to take pictures of neon signs, and expressed that the camera had a good exposure for such pictures.

Thus, technical properties of the camera highly affect and limit the creative picture taking and sets expectations on the result. Nevertheless, this is also very much in the mind of the photographer and his or her own creative ability and desires. In context photography the choice of sensors and other properties, such as the technical platform, would also be likely affect how and which kind of pictures that are taken.
Qualities of Visual Aesthetics
The lack of zoom and autofocus were not the only thing that gave raise to a special type of aesthetics prominent in Lomography. The resulting colorful pictures due to the optical defects, were something that had triggered Anna’s desire for Lomography: *I think, I was really attracted by the colors, or so... because so many colors disappear. There is only red, blue and green... and much of the middle-tones disappear too, so I like this very much.*

Even if others might not understand or share the same aesthetic preference, Martin expressed that the unusual aesthetics was a reason for enjoying to show the pictures:

> Partly because it is so different. And there are many who (...) do not like this at all.. some think like this: ”damn how blurry”. But, it’s a thing in itself, this. That’s also why it is fun to show it. Because it is different from the ordinary portraits or whatever it is.

The above implies that the context camera could benefit from having its own particular aesthetics emerging, not only from a specific use of the camera, but also from the technology itself.

Feedback on the Initial Concept
The second part of the workshop was a more design-oriented activity, and involved discussing the concept of context photography. We used pictures of different situations, such as a café setting, and pictures with visual (photoshop) effects to stimulate discussions about what could be sensed in an environment, and how this could be visualized in the pictures. Similarly to their own cameras, the lomographers believed that the camera itself should not be too big physically or technically for daily use. Furthermore, it should be simple and not have too many options or choices, so the control of the sensors should not be overwhelming. They discussed how sensor data could result in pictures that would reflect a special feeling that the photographer experienced when taking the picture: Martin expressed:

> If you are in an extreme environment, where everything is affecting [the camera], in the same time... then you have the 10 options that the camera gives. You should be able to take a few away too... until... you’re satisfied. Switching off the smoke and the heat [sensors] (...) to achieve the feeling.

They also discussed how their own photos had triggered memories around the picture-taking moment, such as what people had said, and how it smelled and so on: *You always want to take pictures that show how things were.* They discussed if context photography could involve pushing this further, and make it easier for others to understand the photographer’s feelings:

> You look for moods... in a picture(...) the really good pictures are the ones where you truly feel (...) something, besides the object that you are picturing (...) You can capture a very excited mood (...) and to get that
feeling when you see the picture (...) To find that [feeling] more easy... somehow, maybe that’s what you intend to do?

However, hypothetical visual effects were very difficult to imagine, which Anna pointed out: I can’t really imagine what the effects would look like, I’m just thinking of a blurred image. Anna then suggested that context photography could involve more “arty” effects, intended to make the picture look aesthetically interesting, rather than aiming to recreate a specific feeling.

The lomographers were concerned with what would happen once the pictures had been taken. They had to be easy to print, or maybe the ones practicing context photography would not be interested in printing the resulting picture, or creating a physical album? They also came up with suggestions for how to create a moment of surprise, similar to how they experienced having pictures “burning in the bag”:

Its fun if you (...) can’t see what the picture will be like, and when you download them in the computer, then you’ll see if you succeeded, if everything was mapped right, to capture the feeling for that specific moment.

Overall, the workshop gave us insight into possible qualities in the lomographic practice that could be considered also when designing context photography. By understanding qualities relating to the joy of the unpredictable, the personal desires and technical properties affecting how pictures are taken, and the views of aesthetics, we learned about foundations to design a meaningful photography experience. For example, we now would consider how the sensors could provide enjoyable unpredictable qualities and stimulate a specific photographic exploration. Also, we learned how the resulting aesthetics could not only inspire a specific use, but almost symbolize the practice, and what pictures it would involve. Furthermore, we learned that the lomographers were great as experts on their existing practice and their felt experiences, but that discussing design ideas for something not yet existing was not as giving. Especially we found that exploring possible visual effects and combinations with sensor would require another type of expertise.

Early Prototypes
Based on the implications from the lomographers, we built a first rapid concept prototype, demonstrating the overall concept [9]. This concept prototype (Figure 2.b) was implemented on a handheld pocket-pc and allowed manual manipulation of the visual effects. This prototype had very simple visuals; hue, saturation and value, could be manually manipulated before the picture was taken (See example picture in Figure 2a).
We then built an interaction prototype (Figure 2c), which incorporated real sensors easy to implement i.e. movement and sound, visually affecting pictures in real-time as they were taken. The visual effects in this prototype were developed together with a graphic designer and artist, who had experience in visual manipulation of video streams. He presented several visual effects that he had previously worked with, from which we chose four to continue working with. This process also included matching them to sensor values, and exploring how to create interesting aesthetics in still pictures without distorting them. We also focused on effects different from regular photography, which could give visual sense of movement and sound. This prototype was implemented on a Tablet PC, with the screen acting as a viewfinder. A webcam served as a lens, and a small mouse was taped on top of it is used as a trigger. A microphone measured the sound level and movement was retrieved as a vector field from an image stream continuously taken by the webcam. Finally, the interaction prototype had the following effects, which all combined movement and sound:

1. Small white dots follow the movement as a decreasing trace + pixel size increase with sound level (Figure 2.d)
2. Traces of coloured shadows follow the movement + the rest of the colours evolves towards a grey scale with increasing sound level (Figure 2.e)
3. Wave effect + colours evolve towards a grey scale with increasing sound level (Figure 2.f)
4. Extreme zooming on movement + colours evolve towards a grey scale with increasing sound level (Figure 2.g)
Lomographers Testing the Prototypes

We arranged two user workshops to evaluate our concept and get feedback on the picture-taking experience [14]. One of these workshops included two of the lomographers (Christian and Martin). They were trying out the interaction prototype at a train station, taking pictures and then discussing this experience. Below we especially highlight some of their concerns, which were grounded in their experience with lomography and also informed our next prototype.

Towards the Joy of the Unpredictable

The lomographers found that it currently was too easy to succeed with the pictures taken with the prototype. It created a “shortcut”, and they expressed that it felt like “cheating” to reach that “special feeling” one wishes to capture. In Lomography, such successful pictures could not be planned for. Instead they were happening rarely, or even by mistake. Thus, we needed to make the effects more subtle, and harder to succeed with, to avoid making the photographers bored. The lomographers also suggested that they would rather see the effects once the picture was captured, as it would be more exciting and add some surprise in the picture-taking moment, similarly to a lomographer’s excitement when opening his or her developed pictures.

Technical Properties Affecting the Picture-taking

Whereas two high school students (and amateur photographers) at another workshop had explored to playfully create sound and movement themselves, the lomographers searched for interesting things in the surroundings to take pictures of. Thus, they seemed to apply their regular way of taking pictures, with the difference of looking for sound and movement. During this, they experienced difficulties with the default settings of the sensors, such as the camera’s high sensitivity. For instance, they thought that the camera overreacted to their involuntary hand movements when they perceived to be holding it still. They asked for a way for the photographer to have control over how much the sensors affected in the picture-taking moment, also to increase the feeling of being unique as an artist. Currently many pictures looked similar, and providing some control over the sensors could potentially reduce this. This way the sensor values would not merely be affected by the surrounding context, but also be more controlled by the photographer.

Preliminary Qualities of Visual Aesthetics

The lomographers suggested that the effect with color traces (effect 2) should be lifted from the existing scene rather than overlaid, making each picture more unique and even more influenced by the existing situation. Further, all the effects should only be attainable in real time and according to Christian: *It has to be*
something special [only achievable in real-time], otherwise you might just as well add the filters afterwards.

Thus, the resulting aesthetics should preferable be particular for context photography, and should arise from the scene. By making them arise from the scene, this could also lead to more particular aesthetics.

Figure 3. a) Context camera implemented on a camera phone. b) Visual effects
Effect 1: Colour shadows (top-left). Effect 2: Zoom (top-right),
Effect 3: Pixel (bottom-left), Effect 4: Waves (bottom-right).

The Context Camera

The final prototype is a result not only of the input of the lomographers practice, but also from a workshop held with other amateur photographers, as well as from the visual artist working with us to develop the visual affects.

The camera is now implemented as an application on camera phones, compatible with two standard camera phone models, the Nokia 6600 and 6630 [18]. It uses the device's own hardware (lens and microphone), and measures sound level and computes the power of low, medium, and high frequencies. Movement is retrieved as a vector field at different points in the picture. For this prototype we changed aesthetics in some of the visual effects. For example, the color traces now rised from the scene.

The effects were grouped in the following way:

1. **Colour shadows:** Traces of coloured shadows follow movement; the colour of the shadows changes with the frequency spectrum of the surrounding sounds (Figure 3b).

2. **Zoom:** The part of the picture with most movement is zoomed in, and rendered as a transparent layer on top of the non-affected image; the amount of transparency is determined by surrounding sound level (Figure 3b).
3. **Pixel:** Small white dots follow movement as a decaying trace; the size of the pixels in the picture is proportional to the surrounding sound level (Figure 3b).

4. **Waves:** Movement creates waves in the image, making it look like a dense liquid. As in 3, the size of the pixels in the picture is proportional to the surrounding sound level (Figure 3b).

The visual effects were made visible once the picture has been taken. The user could select a visual effect, capture images, see the resulting photographs, save or delete them, and browse through them the same way as with a regular camera phone. Now, the user could also calibrate sound and motion sensitivity, to set his or her preferences for how much effect there should be. Both context pictures and original pictures without applied effects are saved together.

**The Context Camera in Use**

In order to test how the camera would be perceived and used based its functionality, the next step involved to conduct an exploratory user study with people not familiar with the concept [10]. This study involved seven people with a general interest in photography, with different nationalities and backgrounds. The participants used camera phones to take context pictures during a six-week period, and the study involved one mid-study questionnaire and a second one after the study.

Overall, the participants contributed with 303 uploaded pictures, and the most active participant uploaded 119 pictures, whereas the least active one uploaded a total of 11 pictures. All results were been analyzed based on the received pictures and the questionnaires.

**Results From the Study**

Below we present results that illustrate how the qualities (relating to the joy of the unpredictable, personal desires and technical properties affecting how pictures are taken, and views of aesthetics) similar to those previously found in the lomographic practice, turned out in the final prototype. A more general and extensive description of the results is found in [10].

**The Joy of the Unpredictable**

The challenge of having unpredictable dynamic sensors, such as sound and movement to affect the picture-taking moment, was an enjoyable quality with context photography. One of the participants, Erik, was a student who was interested in photography on an amateur level. He was the one who had uploaded the most pictures and stated that: *(...) much of the fun with context photography is that you feel you are not entirely in control over how the pictures will turn out. The situation will determine this...*
However, the unpredictable input made Jane, a designer experienced in both analogue SLR and digital photography (who had taken 11 pictures), to make the following comment: *Although [the camera] is capable of [creating] ‘creative’ images this seems like a fluke rather than any creativity on the photographers part.*

Camilla, a participant with a background in professional photography (who had uploaded 42 pictures) expressed that this might take some practice to learn: *I’m getting more practiced to see when to use it and to get what I am after.*

For Sigvard who had a background in photojournalism (and had uploaded 50 pictures learning to take context pictures was an interesting experience: *Context photo made me after a while search for movements and noise to succeed […] And this rendered a new and interesting experience and result.*

Even though it would be more flexible to do post-edited effects to achieve a specific picture, context photographers appreciated the real time aspect of the picture-taking. This also suggests that the joy of context photography lies in the challenge of the situatedness, being in a dynamic situation where sound and motion affect, involving a different experience than manipulating pictures afterwards. In lomography, much of the unpredictable enjoyment seemed to come from the resulting unexpected picture. However, the unpredictable enjoyment with context photography is different from lomography, as it is more directly connected to the picture-taking situation.

**Qualities Affecting the Picture-taking**

Similarly to how the technical properties of the lomo-camera affected the lomographic practice, the context camera also had specific technical properties that stimulated or inspired a specific use. The context camera was used to take snapshots in everyday situations, and people preferred to take context pictures in dynamic situations, for example snapping pictures in traffic or making someone scream. One participant, Erik, made the following comment about picture-taking with the context camera: *I would probably never have spontaneously taken a picture for example of a car passing by if it hadn’t been for the effects that the application gives.*

With context photography, interesting subjects to take a picture of in regular photography may no longer be interesting, unless they involve sound or motion. This way, the context camera became a kind of action camera, yet fundamentally different from the cameras used in lomography as it involved sound and movement input. If other sensors would have been used, for example measuring temperature, it is likely that people would have explored taking snapshots in entirely different situations, for example searching for different heat sources, rather than an active traffic situation. However, one participant, Jonas, expressed that the context camera also could be used as a regular camera: *If you don’t do anything then it’s like a regular camera.* Thus, similarly to lomography, it is also
in the mind of the photographer to decide what context photography should be about, and which kinds of pictures that are taken.

The fact that the camera was implemented on a camera-phone also provided special technical properties affecting the experience. One participant commented that using camera phones in general made the attitude of taking pictures that were “less serious, more relaxed”. Another one liked the fact that he could instantly share his photos with others at the moblog or with friends.

In lomography, the optical effects informed a particular type of picture taking, but also the lack of zoom and autofocus, as they made the photographers take physically near pictures. Similarly, the sound and movement made context photographer take pictures different from the use of a regular camera (e.g. asking someone to scream).

![Figure 4. Pictures taken with the context camera: a) Sounds of boatmotor, b) Screaming girl in front of pool, c) Guitar head](image)

**Resulting Visual Aesthetics**

Similarly to Lomography, the context photographers wanted to get visual effects in the pictures they took. If a picture did not include effects and rather looked like a regular picture, it was not considered to be a satisfying context photo, even if it had a good composition. One user, Erik, made the following comment about a context picture with no visible effects: *It is a boring way to use the application. Therefore also a bad context photograph.*

For all users, the resulting pictures had to have a balance in the amount of visual effects in order to be aesthetically pleasing. However, this balance was a matter of personal taste. By giving the photographers the possibility to calibrate the sensitivity of the sensors before use, they could more easily find their preferred balance. Just like in Lomography, the aesthetics were a matter of individual taste. Thus, which combination of context effects that was preferred was very subjective.

The resulting context pictures where either expected to represent sound and movement in a specific situation, or having a special feeling, added by the effects. For example, one participant presented a picture that his girlfriend took of him on their sailboat. The motor had been running, causing the image to be
pixelized, and he expressed how the picture had captured the bad sound of his motor (Figure 4a). Another participant wanted context pictures to be different, and have a strong feeling of sound and movement in them. She described one of her favourite context picture (Figure 4b) as: Here one can imagine the sound of screaming.

Another participant expressed that he had cheated with the sensors (by tapping on the microphone), when picturing the head of a guitar. He wanted the context pictures to add something and described a resulting picture (Figure 4c) that he liked as: It looks like you were sitting in an amplifier.

The fact that the pictures had been visually affected in the picture-taking situation, rather than visually manipulated afterwards, made the resulting pictures more interesting. One participant expressed that: In some way it feels more real. I did not manipulate this picture afterwards, this is how it WAS...

The above suggests that the aesthetics in the context pictures were not only a result of visual effects, but also affected by how people took pictures. If lomographic aesthetics are affected by picture-taking such as getting close and “shoot from the hip”, the aesthetics in context pictures are a result of creative picture-taking involving sound and movement, such as asking someone to scream, taking pictures in traffic and of music instruments.

**Discussion**

If experience is considered subjective and highly personal, designing for experience could also take such experiences as a starting point. This paper describes how we informed our design with inspiration from specific individuals involved in an alternative or marginal photographic practice. Such an approach of learning from comparatively few individuals engaged in a marginal practice, may involve the risk of making the final design less appealing to a more general audience. However, we find that this is also likely to lead to a more innovative design, simply because it is based on views and experiences different from the most general and traditional ones. Furthermore, even if a specific practice is considered marginal, it may still involve specific underlying qualities of experiences that can appeal to a larger group. Thus, alternative practices do not necessarily have to involve people that are odd, or somehow very different from others. Rather, these individuals might have similar underlying needs or interests as many others, only that their specific approach is different and overseen by other people.

In a way, we have explored how to transfer and build upon existing qualities of experience into our design, as a way to ground the design for a novel yet meaningful photographic experience. The chosen practice helped us to understand how early ideas of unpredictable sensor data, could become an enjoyable integrated part of the experience. We learned that the practitioners in this alternative practice could best provide important lessons about their existing
experiences of taking pictures. Thus, to brainstorm about not yet existing designs (which was beyond the practitioners expertise) was less giving.

Our final prototype was not evaluated by lomographers, but with intended users, i.e. amateur photographers interested in new types of photography. This is because the design outcome was not intended for the lomographers, but for a more general user group. Further, we felt that evaluating with potential users (rather than the lomographers) without previous knowledge to when or why to take context pictures, could also give rise to a more open-minded exploration of the prototype.

The transfer of qualities from an alternative practice into the design of interactive technology, has inspired us to continue to work in this direction. Our more recent work has involved developing a method based on this design process; transfer scenarios [13]. This method investigates how to more systematically transfer findings from an alternative or marginal practice, into the design of technology, intended for a more general audience. This way, we aim to provide better tools for designers when learning to design for specific experiences.

Conclusion

We have described how an alternative practice could contribute to the design of novel digital photography: context photography. The lomographers provided us with knowledge about underlying qualities in an enjoyable photographic practice, such as qualities relating to the joy of the unpredictable, personal desires and technical properties affecting how pictures are taken, and qualities of visual aesthetics. This was then used to design for a meaningful photographic experience. When testing the context camera with intended users, we found that we not only had succeeded in transferring underlying qualities of experience, but also had succeeded with creating a novel picture-taking experience.

Acknowledgments

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References


Designing for New Photographic Experiences: 
How the Lomographic Practice Informed Context Photography


15. Lomographic society: www.lomography.com


Abstract

In context photography, sensors gather real-time context information, which visually affects a photograph as it is taken. We have implemented a prototype running on standard camera phones. It uses sound and movement as context information and a set of custom-made computer graphics effects which affect images in real time. To investigate how people would receive the concept, we conducted an exploratory user study with seven participants using context cameras for a six-week period. The study provided insights into how such a camera is perceived and used, revealing the emergence of new goals, expectations, aesthetics and practice in taking pictures.

Introduction

Digital cameras are rapidly becoming a pervasive presence in people’s everyday life, either as self-contained devices or integrated in camera phones. The digitalisation of photography has given birth to a new visual culture and enabled new types of practices, such as digital post-manipulation of photographs, direct image sharing using MMS (Multimedia Messaging Service), or web communities such as Flickr (www.flickr.com). However, in terms of actually
taking a picture, not much has happened since the days of the analogue camera. The photographer still points and clicks to capture an image that originates from the light reaching the camera lens. The only real evolution in the picture-taking moment has consisted of automating the adjustment of sharpness, shutter speed and aperture, and more recently the possibility of seeing a preview image on the camera display. While these changes have simplified the act of taking a picture, they still rely on preconceptions of what a camera can achieve; preconceptions that have their origin in the optical and mechanical constraints of analogue cameras. What would happen to the picture-taking moment – and to the creative practice of photography in general – if we took advantage of digital technology to break from these preconceptions and introduce entirely new photographic parameters to the user?

In order to explore alternative means of creating pictures and to make use of the new opportunities of digital technology, we have developed a novel concept for digital cameras: context photography (see Figure 1). Context photography consists of taking photos that capture not only incoming light but also some of the additional context surrounding the scene. Information such as temperature, sound, pollution, the presence of other users or their activity is gathered from sensors and used to visually affect pictures in real time, as they are taken. For example, loud music at a party could be represented by coarseness in the image that would give an amplified sense of ‘being there’, or the chill in the air on a mountain could be made visible as a bluish tint evocative of low temperatures.

Using input from focus groups of dedicated amateur photographers, we have developed a series of context camera prototypes [8,10,13]. Our current prototype is an application running on standard camera phones that uses contextual information about sound and movement. Here, we report on a user study where participants used our prototype to take context pictures in their everyday life during a period of six weeks. This study helped us to understand how people
would use a context camera in everyday settings, and the implications of augmenting the action of taking pictures with new digital parameters.

Related work
Exploring alternative means of creating pictures with digital technology, we are using a new approach to context information that could enable a new type of everyday photography with aesthetic purposes.

Creating Aesthetic Images with Camera Phones
As camera phones are becoming increasingly popular, new motivations for taking digital photographs are emerging. One category of pictures of particular interest to our project is the spontaneous, everyday, aesthetic pictures categorised by van House et al. as images for “self-expression” [17]. The authors argue that an increase in photographic self-expression is to be expected as a consequence of the pervasiveness of camera phones. A similar taxonomy of reasons for capturing images with camera phones was presented by Kindberg et al. [9]: although not explicitly using the notion of ‘aesthetic’ or ‘creative’ images, this taxonomy also showed the existence and importance of these kinds of images.

So far digital cameras and camera phones have only supported such aesthetic motivations by providing users with built-in visual manipulation programmes such as frames, filters, or colour settings (e.g. sepia, black-and-white). Although they let users affect pictures on the fly, these image renderings are static and self-contained. Therefore, context photography could provide a new dimension to the practice of taking creative pictures by adding the dynamic and situated dimension of context.

Context and Photography
Context is an important aspect of the field of ubiquitous computing [15]. Dey defines it as “any information that can be used to characterise the situation for an entity (place, person or object)” [3]. Such context information is typically derived from sensor data about the user and the environment, and is either used in real time or stored for later use. Context information is mostly utilized to support a task or practice by providing relevant information or services depending on the user’s goals, for example providing tourist information to someone based on her position and orientation [1].

When applied to photography, context is usually referred to as metadata: contextual or picture related information, such as shutter speed or ISO number, saved along the photograph when it is taken. Such metadata has been used for a variety of purposes, all enriching the photographic experience.
Supporting the Practice of Photography

Most cameras already possess a distance sensor to adapt sharpness, and some also have an optical image stabiliser that compensates for the photographers’ movements in order to optimise the picture sharpness. This use of sensors was taken a step further with the context-aware camera by Holleis et al [7], where metadata could be used as a means of supporting the practice of taking a picture. The camera gathered context information (e.g. the photograph’s movements) to help people take better pictures. Based on how the user photographed with the camera, the user was provided with feedback or personal settings.

Tagging Pictures to Facilitate Image Searching

Metadata has also been used to tag pictures and facilitate browsing through image or video databases. For instance, LAFCam [11] detected laughter to index video recording with points of interest such as scene involving fun, and simplify video editing. StartleCam [6] used a skin conductivity sensor to measure excitement, which triggered the camera to start recording without a direct action of the photographer. Position data can be used to annotate pictures for later retrieval, for instance to create a trip diary as in GTWeb [16]. Finally, Web communities such as Flickr (www.flickr.com) allow users to manually tag their own and others’ pictures for easier searching.

Enriching Photographs with New Dimensions

Metadata can also be used to provide context as a new dimension to pictures. In Audiophotography [4], recorded audio snippets were associated with photographs, giving viewers a sense of the sound surrounding the moment when the picture was taken. Audio as context information was also used in RAW [2], where a digital camera equipped with audio recording features captured a minute of sound before and after a picture was taken, providing a rich and novel means of documenting one’s everyday life. Other ways of enriching pictures by contextualising them with metadata include adding location information, a feature now available in some commercial camera phones (e.g. Samsung SGH-E760). Using GPS information, a picture is automatically linked to the specific geographical location in which it was taken.

Context as Visual Aspect of an Image

In context photography, context information is used in a novel way: it becomes a visual parameter that is reflected in the resulting pictures. This approach is related to Sonic City [5], where sensor information from the urban environment is gathered as the user is walking about in a city, and used in real time to create electronic music. In both Sonic City and in context photography, context becomes a vivid part of the outcome.
The Context Camera Prototype

A context camera senses information about the surrounding physical context and captures this information visually in still pictures, in real time. The context information is gathered from sensors, and visual modifications are applied to the image using computer graphics effects. Using an iterative process, we have implemented a series of prototypes on handheld [8] and tablet computers [10], finally arriving the current version that runs on a standard camera phone [13].

Design Process

During our design process, we were inspired by Lomography (www.lomography.com), an amateur photography practice that makes use of old Russian analogue cameras with optical defects to take images with a particular aesthetic. Lomographic picture-taking is spontaneous and explorative, and often implies “shooting from the hip”, i.e. not looking through the view-finder while taking a picture. We benefited early on from the input of a panel of lomographers and other amateur photographers, including a design workshop where the panel reflected on our concept [8], and two evaluation workshops where they tested a working version of the context camera prototype in specific settings [10]. This feedback was used to modify the effects, and we also added a calibration feature to allow users to affect the level of influence of the sensors, giving the photographers more control over the outcome.

Throughout the project, we have been working with an experienced visual artist to design effects and mappings. We investigated how sensor input can be mapped to effects and represented, with for example distortion, layers and traces, in order to make interesting and visually appealing pictures. The effects and mappings, as well as the input processing, were refined and modified iteratively during the process to best respond to the feedback obtained during the workshops.

Implementation

Our current context camera prototype is an application running on camera phones [13]. It uses sound and movement as context information. The application currently runs on two standard camera phone models, the Nokia 6600 and 6630. It utilizes the device’s own hardware (microphone and lens) as sensors: the microphone is used to sense sound level and spectral distribution, and the image stream from the camera itself is used to identify instances of movements as a vector field in the picture. The application was programmed in C++ using the graphics library GapiDraw [14], a multi-platform computer graphics library available for various handheld devices, as well as optimised algorithms from the image processing programme Optica [12] developed by the visual artist we worked with.
To explore a variety of ways in which context can be represented, we implemented four visual effects that each combines “movement” and “sound” differently. Different types of mappings of sensor input to visual effects are used: orthogonal mappings where sound and movement influence separate types of effects (for example sound affecting the overall colour, and movements leaving traces on the picture), as well as mappings where the impact of these two inputs are correlated (for example visual traces caused by movement getting a specific tint depending on the sound frequency).

The effects are the following:

1. **Colour shadows**: Traces of coloured shadows follow movement; the colour of the shadows is affected by the frequency of the surrounding sounds (Figure 2.a – correlated mapping)

2. **Zoom**: The part of the picture with most movement is zoomed in, and rendered as a transparent layer on top of the rest of the image; the amount of transparency is determined by surrounding sound level (Figure 2.b – correlated mapping)

3. **Pixel**: Small white dots follow movement as a decaying trace; the size of the pixels in the picture is proportional to the surrounding sound level (Figure 2.c – orthogonal mapping)

4. **Wave**: Movement creates waves in the image, making it look like a dense liquid. As in 3, the size of the pixels in the picture is proportional to the surrounding sound level (Figure 2.d – orthogonal mapping)
Interface

The interface allows the user to capture images, see the resulting photographs, save them, browse through the pictures and delete them in the same way as with a regular camera phone. The user can choose among the four graphical effects and calibrate the sensitivity of the sound and motion sensing. The sensitivity of the sensors can be calibrated individually; one effect might be strongly affected by the sound level, whereas another one might not be affected at all. Each picture is named after time and date of capture for logging purposes, and is saved together with a copy of the image without effects.

User Study

We conducted an exploratory user study to investigate how people would use and perceive the context camera as a new photographic device. The study comprised seven people with a general interest in photography, who were instructed to take context pictures during a six-week period, using either their own phone or one they borrowed from us.

Users were recruited through a call for participation published on our project website and sent out to a variety of blogs and mailing lists in topics such as photography, art and technology. This gave us access to a diverse user group with different ages and occupations spread over four different countries (see Table 1). After reporting their interest and agreeing with the terms and conditions of participation, people received the context photography application. Local participants who did not own a camera phone borrowed devices from us with the application pre-installed. All participants were provided with documentation on how to install the programme as well as a brief user guide to the interface and the visual effects, including example images. This user guide only gave technical guidance, and did not give instructions on what to take pictures of or how exactly, in order to avoid affecting their use of the camera. Technical support was provided throughout the study.

<table>
<thead>
<tr>
<th>User</th>
<th>Age</th>
<th>Gender</th>
<th>Country</th>
<th>Occupation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erik</td>
<td>23</td>
<td>M</td>
<td>Sweden</td>
<td>student</td>
</tr>
<tr>
<td>Sigvard</td>
<td>49</td>
<td>M</td>
<td>Norway</td>
<td>senior lecturer</td>
</tr>
<tr>
<td>Camilla</td>
<td>40</td>
<td>F</td>
<td>Norway</td>
<td>professor, artist</td>
</tr>
<tr>
<td>Jane</td>
<td>33</td>
<td>F</td>
<td>England</td>
<td>researcher</td>
</tr>
<tr>
<td>Tobias</td>
<td>27</td>
<td>M</td>
<td>Sweden</td>
<td>IT-support</td>
</tr>
<tr>
<td>Jonas</td>
<td>30</td>
<td>M</td>
<td>Sweden</td>
<td>interaction designer</td>
</tr>
<tr>
<td>Anthony</td>
<td>27</td>
<td>M</td>
<td>Australia</td>
<td>PhD student</td>
</tr>
</tbody>
</table>

Table 1. Participants overview.
We requested that the participants made their context photographs available to us throughout the study and asked them to upload their pictures on Flickr (www.flickr.com). On this popular photoblog website, pictures can be easily uploaded, tagged and commented by the original uploader as well as other Flickr members. The participants also had the option of e-mailing pictures directly to us if they did not want to have pictures on-line.

After the first three weeks of the study, we sent out a mid-study questionnaire to get more background information about the participants: we asked the subjects to describe their interest in photography, what motivates them to take pictures and what they think makes a good and a bad digital photograph. We also asked them to describe their experiences with context photography so far.

After the six weeks of the study were over, we sent out a final post-study questionnaire that went more into details about context photography and their experience of it. We asked questions such as what context photography is for them, what role context played in their picture taking, and how the fact that the visual effects were rendered in real time affected their experience. The questions also covered topics such as frequency and situations of use, physical interaction, preferences in visual effects and aesthetic qualities of context pictures (e.g. what is a good and a bad context photograph). In several questions we asked the participants to refer to and comment on some of their own context pictures: ones they thought represented context photography well, ones that did not, etc. Participants located in our city were interviewed at the end of the study. They were asked the same questions as in the distributed questionnaires and were encouraged to talk about their context pictures.

![Table 2. Pictures taken by each user, according to effects.](image)

We collected a total of 303 context pictures during the study. More pictures had been taken but some were deleted or never uploaded, for instance due to privacy concerns or aesthetic considerations. Table 2 summarises the number of pictures provided by each participant, as well as the distribution of the various effects. The 54 pictures that are categorised as unidentified (marked with a ‘?’) are images where we could not identify which effect had been used, mainly because no effect was visible. This could depend on calibration settings being set...
very low, or on the fact that there might have not been enough sound or movement to capture at these moments.

User Cases

To emphasise the participants’ individual experiences of context photography, we chose to analyse each user’s qualitative data separately as a user case, along with corresponding pictures. In the following we present each person’s use, perception and experiences of context photography in the form of summarised user cases.

Erik

Erik is interested in photography on an amateur level, and he takes photos to remember special occasions or just for the fun of taking pictures that “look nice”.

Erik uploaded a total of 119 pictures. For him, an interesting context photograph involved action. In order to find context to capture, he took pictures of traffic and movement, for example a car passing by, or when he was in movement himself. This was something which he would not have done “if it hadn’t been for the effects that the application gives.” He enjoyed pictures that both looked aesthetically pleasing and represented the context well. One picture that was taken of his bike while riding it (Figure 3.a) captured the movement and the annoying squeaking of the pedals. In another one (Figure 3.b), coloured shadows clearly reflected the movement of a flower that was being swirled between two fingers. However, representing a situation well is not enough to make a good context photograph. If for example a scene is too quiet to give visible effects (Figure 3.c), then “it is a boring way to use the application. Therefore also a bad context photograph.”

Erik plans and takes his context pictures differently than he does with a regular camera, as “There is a whole new dimension, sound and movement to experiment with”. According to him, you “sometimes experiment with different movements and settings to get the effects you want”, even becoming more physical with the camera than usual: “You move yourself or the camera more. Spin it etc. just to try to get a fun effect.” He would also sometimes involve others, for example by asking someone to scream (Figure 3.d). For Erik, manipulating images in real time “feels more real” than doing it afterwards, as it reflects “how it WAS…” The fact that sound and movement affect the pictures
can make it more difficult to control the result, “but much of the fun with context photography is that you feel you are not entirely in control over how the picture will turn out.”

Jane

Jane has a background in design and is knowledgeable in both analogue SLR (single-lens reflex) and digital photography. She says that she enjoys taking pictures of abstract, odd or surreal things.

Jane provided us with 11 context pictures. She mostly took pictures of things or “banal objects”, sometimes in motion. She enjoyed the distortion and abstraction that the context camera can cause, as in Figure 4.a that to her was “reminiscent of a painting”, and in Figure 4.b that had a “sense of rhythm and complexity”. However, when the distortion became too intense, she thought that pictures became too simple and lacked “reference to the original object” (Figure 4.c).

Jane started understanding how the camera works when she used it in a “very noisy workshop”. She then continued using it in noisy environments, mostly when on her own. She frequently used the calibration function to adjust the sensitivity of sound and movement sensing and sometimes physically moved the context camera to obtain movement effects, but she was not sure of what the outcome would look like or how much the usual parameters affected pictures, perceiving that “although [the camera] is capable of [creating] ‘creative’ images this seems like a fluke rather than any creativity on the photographers part.”

Tobias

Tobias is an amateur analogue photographer and devoted lomographer who takes many pictures in his everyday life. He also uses a digital camera. A good composition is less important to him than having something happening in the picture.

Tobias uploaded 30 context pictures, but deleted several because he thought they showed “too much [visual effects]”. Before taking context pictures, Tobias thought first about what effect would suit a particular subject: “[I] wanted that [picture] and sought out a filter that would work” (Figure 5.a). He often used the calibration mode to get a preview of how the picture would turn out, see what
needed to be changed and thereby learn how the camera works. However, after 10 years as a lomographer he still did not look at the display much when actually taking a picture. To obtain effects and learn how the camera works, he would produce sound as well, by for example hitting the camera phone’s microphone.

For him, affecting images with effects “mustn’t be just a way to ‘space-out’ [i.e. distort] the picture.” The most fundamental thing when taking pictures – whether context or regular picture – is to “add something” to an image, to augment it and make it more interesting, instead of just showing how things were. He thus liked Figure 5.a and Figure 5.b, and commented on the first one that “it looks like you were sitting in an amplifier”. He saw context photography either as a way of getting “cool pictures”, or as a visual representation of the actual context but personally opted for simply seeing it as pictures looking in a certain way in certain situations. For him, it was the real-time manipulation that made context photography special: “Here and now is important. Otherwise the whole thing loses its point.”

**Sigvard**

Sigvard has a background in photojournalism, media studies and photography. He uses his camera phone to depict and share everyday occurrences with friends. He also captures dramatic events such as fires and storms that he provides to newspapers. Sigvard uploaded a total of 50 context pictures. He focused a lot on sound and movement and was often “searching for movements and noise to succeed”, which “rendered a new and interesting experience and results.” One example of a picture he enjoyed is Figure 6a, taken of street musicians. Context was sometimes hard to capture. Some objects were too fast for the camera: “I experience that movement of cars were too fast for the context photo, making strange photos.” In other cases, input was too low and he would have to amplify
movement and sound with the calibration in order to obtain effects. He thought that pictures sometimes got too much effect (Figure 6.b) or too little (Figure 6.c).

Taking context pictures was thrilling, but he thought that the results could just as well have been obtained by manipulating the photos afterwards. He could however sometimes recall the sound and movement as he experienced it, for example in one with girls jumping on a trampoline, where “The contextphoto reflect[s] what I wanted to picture” (Figure 6.d).

Camilla
Camilla has a background as a photographer, and she uses her camera phone to take pictures as notes or small souvenirs.

Camilla uploaded 42 photos and used the context camera whenever she “had a peaceful moment and time to play with camera; in metro, on beach, by swimmingpool, in cafe, etc” (Figure 7.a and 7.b). Camilla saw herself “getting more practiced to see when to use it and to get what I am after.” Although she considered her interaction with the context camera to be mainly the same as with a regular one, this interaction also involved new practices such as “making noise or asking someone to scream ;-)” Camilla found it difficult to see how the effects worked together and also considered the calibration to have too many adjustment options.

For Camilla, nice and interesting context pictures had something “different” as well as “a strong feeling of sound / movement.” An example of this is Figure 7c, where “one can imagine the sound of screaming.” She considered that the concept of affecting images in real time was fundamentally different from manipulating them afterwards, but that the resulting pictures can look similar for someone who would not know they had been taken with a context camera.

Anthony
Anthony owns a small digital camera that he takes with him everywhere, most often taking art, travel or party pictures. He also sometimes uses a camera phone. Aesthetic qualities of pictures are important to him.
Anthony provided a total of 21 pictures of various objects, details and textures (Figure 8.a). He deleted some pictures “that didn’t significantly change after the filter”. Anthony thought that context photography “didn’t really capture “the context” of the original situation” and thought that pictures were just receiving visual alterations based on algorithms. Although he thought that context photography could “theoretically provide a new lens on the original situation”, he considered that the subject of the photography was actually lost. This was not necessarily a problem, as he said in reference to Figure 8.b: “I like this one because it isn’t at all clear what is being photographed”. Anthony did not use the calibration function, as he did not feel it impacted the pictures. He mostly used the wave effect to get “a stronger blurring effect”. Anthony thought that the quality of a context photo “has less to do with the subject matter and more with the graphic effect that can be applied to it”. As he considered the effects to be “quite limited”, he thought that applying effects to images afterwards “provides a lot more flexibility” than in real time. He did however think that “some of the [context] pictures appeared more artistic after alteration”.

Jonas

Jonas usually takes pictures during trips to document moments and experiences that he would like to share with others. He uses a SRL camera as well as a digital one. He values pictures with aesthetical qualities.

Jonas uploaded a total of 30 pictures, mostly taken during sailing holidays (Figure 9.a). His girlfriend occasionally borrowed the camera from him. When taking context pictures, Jonas aimed to capture a certain context and/or get a certain effect in a picture – as opposed to documenting a moment or an experience. His choice of effects depended on how he wanted the picture to look visually, rather than on how suitable they would be to depict certain situations. Sometimes Jonas got too much or too little effects in his pictures and could not figure out why. For instance, he could not capture the sound of seagulls that he felt was very present – probably because the sound was too weak or too sporadic for the camera. He would sometimes switch off movement sensing and focus on capturing sound only, because sound was more straightforward to grasp and control.

For Jonas, context pictures need to have clearly visible effects, which implied that “you are forced to be creative to get pictures”. “If you don’t do anything then it’s like a regular camera”. He also considered that affecting a picture in real time is important if “if you’re after capturing something”. One picture was particularly successful in representing context, as it emphasised the sound of the
motor on his boat (Figure 9.b). However, successful and aesthetically pleasing are not necessarily the same thing for him. Jonas appreciated the aesthetic qualities and evocative power of a picture where he could “see” the wind blowing although in reality it was not blowing at all (Figure 9.c); much more than being reminded of how bad the motor sounded.

Results

The user cases brought to light specificities of context photography and of the new photographic experience it provides, as well as corresponding challenges. Issues discussed below encompass roles of context in the picture-taking, the impact of real-time image manipulation, the visual qualities of context photographs, and the process of taking pictures.

Roles of Context

A fundamental aspect of context photography is that instead of providing support to the act of taking a picture (as context would typically be used in ubicomp applications), the context visually affects images as they are taken. This new approach implied that users developed new goals of and motivations for taking pictures.

User feedback suggests two different ways in which contextual information can be approached when taking context pictures, in terms of how it visually affects pictures. In the first, the user tries to capture the context of a particular situation and explicitly represent it in a picture, as Jonas does when he tries to capture sounds surrounding his boat. In the second, sound and movement are used as new camera parameters in order to obtain certain visual qualities in pictures: the context can be seen as an active ‘contributor’ to the picture. As Erik says: “The situation will determine this [how the picture till turn out]”. Two new roles of context thus emerged from the study: context as something to capture and represent, and as something to use as a visual parameter.

A challenge with trying to capture context in photographs is the potential disparity between what the user experiences and what the camera registers. The user might perceive a sound to be louder than what the camera does, or feel that temperature during a hot summer day is the prominent aspect of context, even though will not be registered by the camera at all as it senses other parameters.
This challenge also relates to the issue of subjectivity in representing context. Because of differences in how a user perceives context or the intensity of an effect, or in how the camera is calibrated, users might not interpret images in the same way. As shown in previous user workshops [10], representing and interpreting context could become a shared language to learn, or a language that some users might want to create for themselves individually. However, as Tobias expressed, one can also bypass this issue by simply choosing to look at context photography as being about taking pictures that get various visual qualities depending on where you take them, as opposed to trying to capture how you perceive the situation: “you have to see it like depending on where you are, the picture turns out cool. […] You probably shouldn’t see it like it shows what you feel [in a certain environment].”

**Real-Time Image Manipulation**

Photographs are affected by context in real time, which results in new types of connection between the user, the subject of the photograph and the time and place of the picture-taking.

The real-time aspect of image manipulation in context photography “immediately shows an alternative visual perception of the experienced environment” (Anthony). Experiencing how the visual qualities of images directly result from the situation also creates a strong connection to the original place and time in which the picture is taken: “In some way it feels more real. I did not manipulate this picture afterwards, this is how it WAS…” (Erik). This makes it fundamentally different from the usual post-image processing: “Here and now is important. Otherwise the whole thing loses its point” (Tobias).

While some users highly valued the real-time manipulation, some users considered that the immediacy and connection to the situation it provided was sometimes impaired by limitations of the effects design. Comparing context photography to post-editing, Camilla reflected that: “[The] concept is completely different. Currently [the] results look quite similar”. She also argued: “when I look at the images –and if I would have no idea that they are taken w [with the] […]-program- I would easily just assume that they are done by using filters or other image manipulation”, pointing out that the link between an image and its original situation might not hold for other viewers. Sometimes connection to the photographic subject might even be lost. As Anthony put it: “[i]t did change the original perspective from what was initially viewed, to what was shown in the altered image, which could theoretically provide a new lens on the original situation […] in practice […] it did more to obscure it, as it often isn’t clear what is being photographed.”

**Visual Qualities of Context Photographs**

Affecting photographs with context information brings with it new aesthetic considerations and expectations in terms of how a picture should look and depict
a subject. A picture that might normally be considered as satisfactory, might not be anymore as context picture.

Satisfactory context pictures should have clearly visible effects. As Jonas commented: “if you’re using a context camera, you do want to get an effect, that something happens that is more than just the picture”. However, as Tobias reflected, it is crucial that the concept of context photography is more than playing around with different graphical effects. The visual altering “mustn’t be just a way to ‘space-out’ the picture. It has to add something”. As Camilla also commented about her context pictures: “Good one[s] makes a nice/interesting image [that] has something ‘different’ in it”.

Successful context photographs in terms of representing a situation are not necessarily satisfactory ones. If for example nothing is happening and thus no visual effects are visible, a picture is not considered as satisfactory even if it faithfully depicts context. Erik commented when describing a picture of a quiet scene: “It [the picture] does indeed reflect the reality. It was calm and quiet. But it is a boring way to use the application. Therefore [it is] also a bad context photograph.”

Aesthetic qualities of pictures are higher-valued than just representing context. They partially depend on the amount of effects and of how they worked visually with the photographic subject: although taste varies from one individual to another, most users considered that effects needed to be balanced in order to look good. For Sigvard, “A good contextphoto is obviously a picture that has movement, but not to[o] much and not to[o] little.” For Camilla, it was important not to overwrite what was taken a picture of, and described a good context photograph as “An image which has a strong feeling of sound / movement, but does not overwrite the image itself.” Jane considered that pictures could lose “reference to the original object” if the effects were too extreme, but did enjoy some distortion because it brought a “sense of rhythm and complexity”.

Designing effects for a context camera thus implies more than reaching an adequate representation of contextual dimensions such as sound and movement. It is also a matter of meeting the user’s new aesthetical expectations as well as not letting effects overwrite the subject of the photograph. Moreover, having four different effects available in the context camera prototype revealed differences between the users in terms of expectations and aesthetical taste, and in terms of how they motivate them. Camilla for example preferred subtle effects leaving traces in the images because they “don’t overload the image” and are instead “enhancing some features of the image”. Jonas on the other hand enjoyed the pixel effect, but only due to a personal weakness for pixel aesthetics in general. Several users even had difficulties giving an explicit reason to why they preferred a certain effect more than another. Therefore, designing effects to suit a high number and wide range of users becomes a challenging task.
Taking Context Pictures

The context camera gives “a whole new dimension, sound and movement to experiment with” (Erik). To get interesting context pictures, the participants sought or created dynamic situations involving movement and sound. Dealing with the dynamic nature of sound and movement also implied not being entirely in control of the outcome, something that turned out to be both a challenging and fun experience.

The context camera made people strive for taking pictures in dynamic situations and look for action. While regular photography might sometimes involve taking pictures of dynamic things, looking for action was an essential part of the context camera experience: “Context photo made me after a while search for movements and noise to succeed […] And this rendered a new and interesting experience and results” (Sigvard). This search resulted in pictures taken in amusement parks, of people jumping, dancing, in traffic or when being on the move: “I snap many pictures from my bike or when I’m in a car/bus/tram :)” (Erik). It also made users take pictures of new subjects: “I would probably never have spontaneously taken a picture for example of a car passing by if it hadn’t been for the effects that the application gives” (Erik).

The context camera was designed to capture sound and movement but input from subjects were sometimes out of reach, or at least difficult to capture in a satisfying way. Movement could be too quick, as for Sigvard: “I experience that movement of cars were too fast for the contextphoto, making strange photos”. Sound could also for example be too low or too sporadic to be sensed successfully, as when Jonas tried to capture the sound of seagulls.

In situations where the surroundings did not itself provide enough dynamic input, the users experimented with various means of obtaining effects. Some acted more physically: “You move yourself or the camera more. Spin it etc. just to try to get a fun effect” (Erik). Similarly, Camilla created sound input by for example “making noise or asking someone to scream :-)”. Tobias sometimes “faked” audio input by tapping on the microphone: “I had to cheat a little. Had to make some sounds. Sometimes it happens you try to achieve [visual] effects.” The calibration was also used to increase or decrease the sensitivity of the camera and thereby the amount of effects, the way Jonas did by switching off the movement sensing to focus on sound. As he pointed out, with context camera “you are forced to be creative to get pictures”. “If you don’t do anything then it’s like a regular camera”, meaning that you might not otherwise get satisfying effects in the pictures.

Still, even when actively searching and creating sound and movement, succeeding in getting effects was not guaranteed. As input were dynamic and hard to control and to capture in the static medium of still images, participants were not entirely in control of the visual outcome. Jane felt that creative context images seemed more like a “fluke” than anything she felt responsible for as she
did not feel in control of the results in spite of using the calibration: “I control the sensitivity and in some way the measure of it by the amount I move it but I don’t feel at all in control of the outcome.”

However, some users were actually only moderately interested in being in control. Tobias only used the calibration in order to learn how input and effects were connected, and foresaw that he may in the future lock the calibration on a “specific sensitivity”, once “you have found your calibration [settings]”. Erik as well happily gave up part of his control. For him, not having complete control was new and exciting: “Much of the fun with context photography is that you feel you are not entirely in control over how the picture will turn out. The situation will determine this…”

Conclusions

We have presented our exploratory user study of context photography and resulting user experiences. By adding a new dimension of context to photography, context photography gave rise to new picture-taking experiences and implied new types of goals, expectations, aesthetic considerations and practice of taking pictures.

**Goals:** Context photography brings innovative ways of associating context to photography by enabling at least two different new aspirations in taking context pictures: to represent a specific context, or to consider context as a parameter to create interesting pictures with.

**Expectations:** Users expected to get visual effects in the pictures. If a picture does not include effects and looks like a regular picture, even if it has a good composition, it will not be a satisfactory context photograph. This changes the view of what could previously be considered as a good photograph. How the camera registers contextual input can also differ from the user’s perception of them, which can lead to a new type of mismatch between perception and representation.

**Aesthetics:** Context photography has brought a new type of aesthetics. We found that preferred aesthetics of context pictures were highly subjective and very much a matter of personal taste. Two separate visual effects may have different appeal for various people in representing the same context. However, for all users, images need to reach a balance in the amount of visual effects in order to possess an aesthetic value.

**Practice:** Several new aspects have emerged in the picture-taking practice. Even though obtaining effects with post-editing would be more flexible, context photographers appreciated the real time aspect of the picture-taking. They tried to obtain effects by using the context camera as an ‘action camera’, actively seeking or creating sound and movement to achieve interesting effects. Interesting subjects to take a picture of in regular photography may no longer be
interesting in context photography, unless they involved sound and movement. Not being always in control because of the dynamic nature of the input also proved to be both a challenging and fun experience.

With context photography, we have shown a novel way of using digital technologies in photography that breaks from the preconceptions originating from the limitations of analogue cameras. Besides enabling new ways of taking creative pictures in everyday settings, context photography broadened the possibilities of using context as a resource in aesthetic practices; taking into account the qualities of the creative medium as well as the resources provided by new technologies.

**Future Work**

As future work, a deeper analysis of context pictures could be performed. This analysis could for instance investigate possible evolution of a visual language specific to context photography or the potential emergence of personal expression. More generally, much remains to be explored within the practice of taking digital photographs: trying out other sensors with context cameras themselves and even other types of sensor-based photographic devices, as well as exploring entirely different new possibilities of digital photography.

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Designing Personal Embodied Agents with Personas


Abstract

We are exploring strategies for designing novel robots, or more generally, personal embodied agents. The motivation is to open up the design space for robots in everyday environments, while at the same time grounding new designs in existing human interests. We have modified established methods from the field of Human-Computer Interaction (HCI). First, we investigated specific human interests, in this case in exotic pets, to understand and design for possible interests of future robot owners. Based on the data from interviews with pet owners, we developed four fictive characters, so called personas. Each persona has a specific interest in robots as personal embodied agents, which has a particular form, role and behaviour. From the resulting personas we derived a number of possible designs, where the agents take on different roles in peoples’ everyday activities.

Introduction

What different roles can robots have in everyday environments? Currently, robots intended for such environments are commonly considered as social companions [1], service or assistive robots [2][3], entertainment robots [4] or therapy objects [5]. When facing the richness of the everyday life people live both with and without technology, this overall view of robots is quite limited.
Further, robot appearance and behaviour in everyday environments is constrained by the existing hardware and software robot platforms.

Many robots intended for everyday settings are designed to be socially interactive, such as in [1]. An underlying assumption of socially interactive robots is that the interaction should be similar to how human are interacting with each other [6]. However, robots with a notion of sociality, social skills and bonds with people are still more of a distant goal, than actual reality [6]. There is a big gap between the amazing robot scenarios that science fiction depicts for everyday environments, and what is technically feasible with current robot technology. In parallel to developing robots to become the future “butlers” science fiction suggests, we want to look into alternative views of robots and interaction with them. We call them “personal embodied agents” instead of “robots”, which we currently find too biased with underlying assumptions of existing forms of robots, or robots inspired by science fiction. At the ECAgents website [7], embodied agents are defined as being able to interact directly with the physical world and “to communicate between them and with other agents (including humans)”. Embodied also relates to Clark’s perspective of how the physical body and its senses matters when being, acting and learning in the world [8]. Further, Maes [9, p.2] gives a definition of an agent as “a system that tries to fulfil a set of goals in a complex, dynamic environment” which we find suitable here.

In our work, we take peoples’ everyday life as a starting point. We want to see how different forms and behaviours of embodied agent can fit in the life and interests that people already have. Furthermore, instead of investigating possible applications for a specific technical platform, we start from a more general view of agent technology when looking into everyday objects and activities to learn about possible applications. We do not focus on sophisticated communication and entertainment features that the existing robot platforms such Aibo [4] or Qrio [1] provides. We will rather explore less sophisticated and more narrow agent behaviours that are technically feasible to implement and test in an everyday setting.

For this reason we have investigated specific human interests and how these can be used as input in the design process. We used and extended an established design method originating from the HCI (Human Computer Interaction) field, so-called personas [10]. We created four fictive characters – the personas – with specific personalities and interests in embodied agents. The personas were based on data from interviews with owners of pets, e.g. spiders and lizards, which we thought would be closer to existing robot capabilities than more common pets such as dogs and cats. The resulting personas illustrate potential roles, behaviours and forms for future embodied agents that we feel are both novel and plausible. In this paper, we will present the process we employed and the resulting personas, as well as the resulting design requirements for a set of specific personal embodied agents.
Related Work

In HRI (Human Robot Interaction), design suggestions for everyday or domestic environments often relate to interaction or technical implications for specific robot platforms [11]-[13] rather than investigating entirely new robot applications. Some more general design implications for robotic artefacts in the home have been provided for example in ethnographic studies of homes and elderly [3] and possible novel applications were investigated in the workshop “Designing robot applications for everyday environments” [14]. However, there is a lack of publications describing design methods suitable to inform new robot applications for everyday environments.

In the field of HCI and interaction design, several methods exist to support the design of an interactive system [15]. An example of such methods, and a common approach, is to use scenarios and personas [10], [16-18]. A scenario is a written story describing the future use of a system [17]. It has the traditional elements of a story: an actor (e.g. a system user), a setting (e.g. a hotel) and goals (e.g. booking a guest) with sub goals (e.g. printing the booking). The actor in a scenario can be referred to as a persona. A persona is a fictive representation of a user and should consist of a rich description of her motivations and goals [17]. The scenarios can be developed for example by users (who then write them), by conducting observations or interviews with people using an existing system, or having the designers themselves to come up with scenarios.

Scenarios can be used at many levels of the design process, illustrating users’ needs, goals and actions in the beginning of the process or to evaluate system functionality at the end of the design process [18]. Below we present our approach of using personas and scenarios to inform the design of possible applications for personal embodied agents.

Process

Our intention when using the Personas method was to explore forms, roles and behaviours for embodied agents in everyday environments. Our aim is to design personal embodied agents, that would have novel functionality yet at the same time be possible to implement with existing robot technology.

As a starting point we were thinking of human interests that already involve or could involve entities or systems involving some form of autonomous or related behaviour. This was done to find human interests that have similarities with the properties of the technology, and possibly could be transferred into the design of the agent technology. Here such experiences could for example involve people working with plants, driving in traffic or owning a dog or another pet. The chosen experience would preferable not involve critical work or tasks, as the technology we would develop would be in an early technical stage. We decided to interview people who have pets, and to come as close as possible to agent
technology, we chose people owning spiders, snakes and lizards. We found it suitable to understand what makes people uphold a continuous interest for example in reptiles, even though it is often not possible to interact with them directly, or teach them tricks (as opposed to more traditional pets such as dogs). This approach of matching the technology properties with specific human interests is based on previous work where we used unconventional or users with special interest as inspiration when designing technology applications [19]. However, here we will focus on learning about specific human interests and experiences, and how to transfer them to the design space of the technology, which our previous work has not involved.

Our motivation for focusing on people owning pets such as reptiles is not to design robots that look and behave like the reptiles, or to design zoomorphic embodiments of technology such as in [20]. Instead, it is done to understand the core features of this specific human interest and transfer and extend it into design of personal embodied agents. We will here try see beyond the actual artefact that this interest involves, to find underlying motivations for such interests. Here, owning an exotic pet could for example involve more general underlying human motivations such as; concerns about identity, aesthetical preferences, social networks etc. Thus, we do not intend that the pet owners will become future robot owners. Rather, they will provide us with knowledge about underlying motivations for their personal interests that can match what is possible to build with current agent technology. We believe that some of the core motivations for their interest can be transferred and extended into a new domain, and even for a different group of people – in this case future robot owners.

**Interviews**

We conducted 10 interviews with pet owners in order to get the data for creating personas and scenarios. Overall, we were interested in finding out about the enjoyment of for example having one or several lizards as pets. We were also interested in the interaction between the owners and the pets, and in related social activities. The questions we aimed to answer included:

- What they consider important qualities owners find in their pet (for example that it is easy to care for)
- Why they are interested in having this kind of pet
- What they do with their pet
- What the pets do
- How they see if a pet is sick or in different moods
- Social interaction with other pet owners.
Six male and four female subjects were interviewed. Three subjects were found through friends, one through Göteborg's Herpetological Association [21], and six through the reptile owner’s website [22]. The subjects were between 17 and 55 years old (mean 25.6 years, median 22.5). Due to time and logistic restrictions, three interviews were made face-to-face, and seven by phone.

Fig. 1. Interviews were held with people owning reptiles and other exotic pets, such as spiders.

Development of Personas

All interviews were transcribed, printed out and read through. In the data, we for example found how some people considered their terrarium as an interior design object, and enjoyed how their pets gave the room a more dynamic impression. Some enjoyed the different personalities their lizards had, whereas others mainly were interested in breeding lizards with interesting patterns. Data illustrating qualities that the pet owners enjoyed and other specific interests and experiences where cut out on Post-it notes (see Fig. 2a). The notes were then sorted into an affinity diagram, where related interests or features were grouped together (see Figure 2b). Each cluster of notes was the starting point for a Persona. For example, data such as “I like the thought of being a bit odd or different” and “a different kind of pet” was grouped together, and data such as “I don’t pet them” and ”It is my hobby” were put in a different group. Then, some duplicates were removed and the diagram further structured into four separate clusters of related features.

On the basis of the resulting clusters, four personas with quite different interests and personalities were created and named: Nadim, Magda, Christopher and Anne. At this point, each persona got their first preliminary description (or scenario), focusing more on their overall relation to agents, rather than the actual behaviour and form of their agents. Here, the interaction and behaviours that would normally have been ascribed to a pet, would instead refer to an agent. In this phase, each description was also enriched with imaginary ideas about the persona, in order to enrich and complement the interview data. Pictures representing the characters were chosen from an on-line image database [23].
After the initial phase of developing personas, we refined them as characters and further sorted out details about their specific relation to agents. Several brainstorming sessions were held, focusing on making the personas as different as possible from each other, both in terms of their interest in agents and in their interaction with them. For example, expressions such as “it’s fun to build their environments” were transferred to the persona Anne, strengthening her interest in agents as a dynamic interior, whereas “I like that they are dangerous” was used for Magda to reflect her interest for odd or dangerous creatures.

Behaviours and forms of agents, as well as their technical implications were specified and refined in the last phase of creating the Personas, when their overall role had been established. During the process we used large notice boards to re-arrange notes and exclude less interesting ones. The written descriptions of the personas were also updated throughout the process.

Results

Below we describe the resulting Personas created during the process; Nadim, Madga, Anne and Christopher. Their scenarios illustrate the overall relations between a person and his or her personal embodied agents, giving example of possible interaction. We also present some initial technical implications for the agents.

Nadim

Nadim is 32 years old and works as a network engineer, living alone in a two-bedroom flat in a small town. One of the rooms is Nadim’s hobby room and this is where he keeps his agents. Most of the people in Nadim’s home town do not know he owns agents; it is not something he goes around and talks about.
He has always has a great interest in collecting and exploring various things, and as he got older he became fascinated in having agents as a hobby. Nadim finds it exciting to try to understand their behaviour and sees them as a research area where there is always something more to learn. He has specialized in a type of agents that communicates through colours. He enjoys watching them communicating to each other and changing their patterns. Every single agent has its own specific colour pattern, and when it is put closely to another agent they both start to change their individual patterns. The surrounding light, sounds and movement etc, also affects their patterns. The changes are slow, and sometimes it takes several days until it Nadim can see how an agent is reacting. The challenge is to avoid making the result turn white or not looking so nice. Nadim is however quite good in developing agents with unique interesting patterns, and he puts pictures of the agents on his website. He has the patience and knowledge it takes to continue develop interesting looking agents. The number of agents Nadim has varies, and he has never bothered to give them any names.

It was his curiosity and the fact that the agents are easy to manage that made him buy them in the first place, and this is why he still keeps them. He likes to read everything that crosses his path; Internet pages and magazines. He also frequently visits other sites to compares patterns and sometimes he writes in a forum for people with the same type of agents. They sometimes also meet to let their agents affect each other’s patterns. He sees his agents as a sort of investment and likes to share his hobby with others at fairs. At these fairs he looks at other agents, meets new people, and sells or exchanges agents.

**Technical Implications for Nadim’s Agents**

The agents can evolve interesting patterns over time, yet have a possibility of not succeeding. Agents will be equipped with a colour-display on their back and have one or more sensors for light, movement and sound. The sensing can be different for different agents. Each agent will have a unique color pattern, developed from meetings with other agents the environment it is in. By touching the agent in a particular way makes it possible to temporarily freeze a pattern. Achieving a nice pattern requires several agent-agent interactions and timing. A new agent involves a high risk of turning white, and then forcing the process to start from scratch.

**Magda**

Magda is 19 years old and lives with her mother and two brothers. When she was 7 her dad took her to a fair where they had various kinds of agents and from that point she was certain that she wanted one for herself. When she was 13 her mother finally agreed that she could buy one.

Magda’s agent is an important part of her identity. Other people may have agents for practical use or to play with, but Magda’s makes her feel cool and strong. She is not really an expert in general in agents, but she has learned to
handle hers, and more importantly she is no longer scared to interact with it. Magda loves the fact that her type of agent is unpredictable and difficult for others to figure out. She has learned by interacting with them, taking risks, and is proud of this. She enjoys the challenge to understand the agent’s behavior and likes to experiment by letting other people touch it.

The agent is with Magda wherever she goes. It usually sits like a broche on her chest, on her high boots or on her bag. Its body has a purple blinking eye, watching people pass by Magda, and often making them a bit curious. It can give a small electrical shock to people touching it, or start to sound. Magda is the only one who knows how to touch it in order not to make that happen. She can even make the eye close and relax, when she touches it. If Magda or someone else quickly pulls off the agent, it gives off loud warning sounds. This is not only a cool effect, but also makes Magda feel more comfortable whenever she walks home alone at night. Magda is proud of the fact that she has such a cool agent. She has contacts with heaps of people with the same interests but she would like to make even more contacts. She enjoys exchanging experiences and seeing other people's agents. The agents react when they come close to other agents, each having their own way of reacting. Magda’s agent reacts by changing the appearance of its eye.

Sometimes she gets into discussions where people refuse to understand the importance of having such an agent. In order to spread her knowledge she chats on the web and has her own blog.

**Technical implications for Magda’s Agents**

The eye of the agent will be represented on a colour display and around it there will be an electrical (mild) shock-giving frame. It will also be equipped with sensors for light, movement and sound. The agent should be able to attach itself to things, such as fabric or leather. The trick for the owner to learn the mood of the agent so that clamping and unclamping it does not result in shocks. Similar agents can influence each other when being in proximity, resulting in that their eyes change colour or start blinking.

**Anne**

Anne is a 41 years old physiotherapist. When she is not working she enjoys getting together with friends and family. She lives with her boyfriend in a one-bedroom apartment in the suburb of a small city. She is interested in interior design and has a wall of the living room is occupied with agents. Her fiancé is not so fond of the agents, but he is of Anne, so the agents can stay. Anne has had the agents a long time before they got together and she is never going to get rid
of them. Anne is fascinated by the feeling the agents give the interior. She believes they create pleasant surroundings to live in, as the room feels more alive and dynamic.

Most days Anne gets home from work before her boyfriend. She enjoys this time on her own; she reads books, takes a bath, or feeds the agents with new data, a colour from a magazine, or some patterns that she wants them to draw. To do this, she picks up the agent, squeezes it to sample a colour, form or image. Then she puts it back on the wall, and it starts to draw decorations, using patterns or colours from the picked up data. The drawing is affected by whether the agent is touched or not, and whether there is activity in the room. Once, when Anne was hiking Norway, she didn't see her wall for three weeks and when she got home the agents had been drawing so much the wall looked like a mess. This was apparently too long time to stay away. She likes that they need some of her attention, to make something that looks nice, but she also appreciates that they don't need to be taken care of every day.

None of Anne's friends have got agents and she enjoys being the only one, it makes her stand out. When she needs inspiration for redecorating she visits a couple of sites on the Internet. Anne sees the agents as furniture but she has discovered that there are people on the Internet that talk about their agents as if they had feelings. Anne finds this slightly ridiculous - she is absolutely certain that hers only react to the environment. If she moves her hand in front of them, they simply react to the movement and change their way of drawing. Not because they recognize her, but because they can sense the movement.

*Technical implications for Anne’s Agents*

The agents will be equipped with camera, movement sensors, sound sensors etc and combined with a projector. They let imprints emerge on the wall surrounding them. The agents are put on the wall, like a pin or a magnet. They can be picked up from the wall and be squeezed to perceive (take an image of) a pattern or color in front of it. Based on what it recently perceived, a pattern will emerging around the agent as it is put back on the wall. The agents can also detect the presence of for example a hand and can then react to it depending their state. The agents can also communicate to each other in order to tell if something is present in front of them, to collectively change the pattern.

*Christopher*

Christopher is 22 years old and has recently moved to a big city in order to study Political Science at the university. He lives in a dormitory with eleven other students. His room is quite small and he would like a pet, but that is not really
possible. Instead, Christopher’s agent has kept him company during his first time in the new city. It is always around if he feels lonely, and inspires him to get active. Christopher finds it fascinating to get to know his agents and find out what it likes. Every agent is unique - you could say they have different personalities that you have to respect. He is certain that his agents recognize him but it would be nice if it could show it more.

By having an agent, Christopher has gotten into contact with other like-minded people. He has recently joined a society and they have met a couple of times and discussed their agents over coffees. Christopher finds it rewarding to get together with people who share his interest.

His agent is a kind of pedometer, measuring how much he moves. It likes to be brought along, and gives off little signs showing when it is happy. It also has contact with another twin-pedometer, and is affected by its state as well. It vibrates when Christopher has walked some kilometers, and can also communicate this to other agents. If Christopher passes someone else with a pedometer agent, his agents will react to how far the other pedometer has walked. If the other has not walked as far it can get angry or sad.

**Technical implications for Christopher’s Agents**

This agent should encourage the owner to get more active by using movement sensors e.g. accelerometers. It shows an emotional state through discrete expressions, such as a tactile pulsating actuator. The state of the agent is affected by other nearby agents and when the user is active it gives out for example a weak purring noise and light as a token of appreciation. This is also amplified by the presence of other active users and weakened by not so active users. Repeated meetings between agents give rise to an extra positive effect on their behavior.

**Discussion**

Even if our personas are fictive character, they are based on real data, and their description is grounded in existing needs and interests of people. However, the personas are also formed by our imagination and represent possible, but not definitive design outcomes.

The personas inform the design of different personal embodied agents. A possible role of embodied agents is to become dynamical interior, extending the furniture in a home or another setting. In our scenario with Anne, we show how the human interest can lie in what the agent can produce or achieve in its role as a design object. In such a scenario, the agents’ are considered “things” that provides dynamical aesthetics rather than living creatures with different personalities. Agents showing less personality is also visible in the scenario with
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Nadim, where they are viewed as dynamically evolving building pieces in a hobby, requiring patience and exploration.

In another scenario, the personality is the core feature of the agent, as its role is to extend the social identity of a person. In our scenario with Magda, her agent has a specific personality and appearance making other people curious, and resulting in that they give its owner attention. Another form of social contact is visible in the scenario with Christopher. The role of the agent is to motivate him to move more and make him aware of other people in a similar situation. This way, the agent acts as a support for a specific lifestyle, both as encouragement and as an indirect communication device for people sharing the same interest.

Our resulting scenarios show how the interviews with people owning exotic pets clearly affected the design outcome. For example, the behaviour of Nadim’s agents was based some of the pet owners experiences of changing sand (different granularity) for their lizard or spider. They could only notice a few days later if the changing had been successful or not, depending on the state of the pet (for example eating normally or not). We used this as inspiration for Nadim’s agents, so that they would change their visual patterns slowly over time, rather than at once. This would require similar patience and extended expectations with such agents, similar to what the pet owners currently experience when caring for their pets. Similarly, it should be possible to feel success or failure with the visual patterns that evolve over time. This is just one of several examples on how the interview data helped us to shape the personas, and the requirements for personal embodied agents. This case illustrates how possible experiences from exotic pet owners can be transferred to future robot owners. Of course we do not aim to provide exactly the same experience, but rather to bring out engaging or meaningful elements that the technology can embody.

Conclusion and Future Work

Using personas as a method is only one of many possible approaches to explore different roles, behaviours and forms for embodied agents. Here, we have focused specifically on personal embodied agents, but we believe that similar transfer of experiences also could also be useful when designing other types of technology. For us this is part of an ongoing work, where we let people with special interests or activities to inform design requirements for technology development. The interviews were used as an input into the design process, and the people interviewed are not necessarily intended as (or even representative of) the actual end users. Instead we have chosen them to provide insights into specific human interests, hobbies and activities that can be transferred into the design of new technology. In this way we are learning about how to ground the design in a real human interest, yet come up with novel ideas for technology development. The next step is to implement some of the embodied agents
described in our scenarios, for example by using e-puck technology developed at EPFL [24] and test the resulting designs with users.

With the work presented in this paper, we believe we have shown that this approach represents a fruitful way of providing inspiration for designing novel robot applications for everyday settings.

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Abstract
Transfer scenarios is a method developed to support the design of innovative interactive technology. Such a method should help the designer to come up with inventive ideas, and at the same time provide grounding in real human needs. In transfer scenarios, we use marginal practices to encourage a changed mindset throughout the design process. A marginal practice consists of individuals who share an activity that they find meaningful. We regard these individuals not as end-users, but as valuable input in the design process. We applied this method when designing novel applications for autonomous embodied agents, e.g. robots. Owners of unusual pets, such as snakes and spiders, were interviewed - not with the intention to design robot pets, but to determine underlying needs and interests of their practice. The results were then used to design a set of applications for more general users, including a dynamic living-room wall and a set of communicating hobby robots.

Introduction
Technical progress is a great source of innovation – but too often technology is developed with little regards to its ultimate use. If a new technology should make
a real difference in peoples’ lives, it has to be coupled with a holistic view of technology use. For instance, the modern desktop computer arose out of a combination of new technical opportunities such as bitmapped graphics, the laser printer, the Ethernet, the mouse, etc., not to mention steady advances in digital storage capacity and processor speed. But it was not until they were coupled with the vision of personal computer use as developed at Xerox PARC in the 1970’s that these and other technical advances gelled into a useful tool that would have a profound impact on how people live and work.

There are many design techniques used in specific points in the design process to generate inventions – such as an interaction mode, a new functionality, a specific device, etc. But for a new idea to become an innovation, it is not enough to be inventive – it must contribute to a transformation in a community, i.e. become widely adopted by users [4]. Many design techniques do not involve any inquiry into the needs of potential users, and if inventions created by such techniques do result in innovations, this is because they have been taken further and incorporated in existing social contexts. Conversely, relying solely on studies of potential users can help to produce results that solve specific problems for specific user groups, but it may also mean that many inventive ideas fall by the wayside. Ideally, any method aimed at producing innovations should therefore support both idea generation and studies.

This paper introduces transfer scenarios, a method for developing novel interactive technology. It takes as its starting point a novel technology that has an untapped potential for new applications. The method involves different steps where the designers can use their own preferred techniques to affect the design outcome. It aims to change the designer’s mindset regarding the chosen technology, while simultaneously grounding it in existing human interests and needs. In the process we draw on a marginal practice, i.e. individuals who share a specific activity that they find meaningful. Participants in such a practice have interests or needs that are particular, but their underlying motivations could be applicable also for a more general group of people. Thus, its practitioners are not regarded as end users, but are involved to provide underlying human interests and qualities of interaction, relevant for the design outcome. With this approach we aim to drastically alter the view of what a technology is and can be used for, to stimulate new application ideas and interaction possibilities.

**Supporting Innovation**

Denning [4] makes a useful distinction between innovation on one hand, and invention on the other. “Invention”, he writes, “means simply the creation of something new – an idea, an artifact, a procedure”. There is no guarantee that even the most clever of inventions will ever become innovations. Innovation, he continues “requires attention to other people, what they value and will adopt”.  

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Transfer Scenarios: Grounding Innovation with Marginal Practices
For the purpose of this paper, we choose to call the act of giving attention to other people – through studies, interviews, focus groups, and so on – inquiry.

We schematically sketch the two axes of inquiry and invention in Figure 1. This is not intended as an exhaustive taxonomy or framework for all methods, but it can be useful to map out the innovation space and identify the aims of various methods and techniques. In this schema, we can roughly place different approaches, including isolated design techniques, complete design methods, as well as specific projects. The X axis describes the degree of inquiry – how much effort is spent to provide grounding by studying and understanding users. For instance, a method or project that requires a deep ethnographic study that takes place over many years will appear much farther to the right than a daylong observation. The Y axis describes the degree of invention – how much attention is aimed at coming up with novel ideas. For instance, a project that aims to come up with a completely new device requires very high invention, while one that incrementally improves an existing device would appear much lower in the chart.

In the diagram, we can identify several interesting areas. To the left along the Y axis, we have methods and techniques that support invention with none or little attention to real-world user needs. We can call this space idea generation. On the bottom across the X axis, we have methods and techniques that purely aim to provide understanding of a certain user group or setting, without any claims to provide design input. We can call this area studies. In the middle, we find the most common category – those that mix invention and inquiry to support the design of new systems. We can call this space user-oriented design. Finally, in the top right corner we have an “ideal”, the – perhaps unattainable – methods that combine the best of both worlds and provide a high level of both invention

Figure 1. A schematic diagram of the innovation space
and inquiry. We have decided to call this “sweet-spot” in the innovation space grounded innovation.

Idea generation: invention without inquiry?

Creating new conditions for design is important from a design theory perspective. Löwgren and Stolterman [21, p. 8] describe design theory as “knowledge that can liberate the designer from preconceived notions and conceptions of how the design process can and should be performed”. In a design process where everything is possible and nothing is given, creativity has no friction and nothing to build on [21]. Therefore, constraints can cultivate creativity rather than limit it. However, when aiming for inventive ideas, the provided constraints need to force the designer thinking creatively rather than stay inside the box.

Brainstorming techniques, such as body storming [2], extreme characters and interaction relabelling [5], etc. provide constraints that force thinking in specific directions, which can trigger novel ideas. However, if a brainstorm is held to generate ideas around rich ethnographic data, it may be difficult to rise above the data and generate novel ideas. On the other hand, if a brainstorm is held without data, this may result in design that is not grounded in any real human interests or needs.

In reality, such techniques are usually applied within the context of a specific project or problem. Therefore, pure idea generation with no grounding whatsoever in human needs is rare. However, many schooled designers work with an approach closer to artists than researchers, in that they take inspiration from a multitude of different sources and often base their work on their own interests and experiences rather than on an inquiry in external users. A similar approach has been suggested when designing interactive systems, in the form of autobiographical design [29] where the researcher designs a system directly based on his or her own experiences. This approach should not be interpreted as indicating that grounding is unnecessary when designing new systems; just that it may be used in different ways, and that the sources for grounding may differ from those in traditional user studies.

Studies: Inquiry without invention?

Studies without any intention for design are rare in HCI, as the field is rooted not only in areas like social and cognitive science, but also in engineering and design. That said, there is a tension between the act of purely studying a user group or setting, and actually using this material to design new systems. Ethnographic methods, such as interviewing and observing users are well-established methods that can help designers to understand users needs and interests. But even if ethnography can provide solid ground for technological systems it does not necessarily lead to innovative design outcomes [28].
In fact, Dourish [6] claims that ethnometodology has never been intended to support design, but its purpose is to “understand” a setting. He argues that there is a current discrepancy between what is expected from ethnography and what is a potential role for design. Thus, methods that merely focus on understanding users, such as ethnography and interviews, do not in themselves provide tools for inventions that can lead to innovations. Macdonald [24] argued that even if the concept of user driven design is widely accepted and many businesses use focus groups and ethnographic research, these methods are currently not used in a way that supports inventive ideas. He stresses that designers and design team need to learn how to use qualitative methods such as ethnography to not only analyze but also to generate design.

**Stuck in the middle?: User-oriented design**

In reality, most methods that are commonly used in research and product development today are situated in the middle ground, drawing on both invention and inquiry. With more or less success they attempt to combine both idea generation and user studies to produce novel and/or useful systems and products. But different methods and techniques emphasize invention and inquiry to different degrees. Some are firmly rooted in the data gathered from users and strive to design systems that address very specific problems; others take this information as just one of many inputs to the design process.

Approaches that try to involve users more creatively in the process, and thus might include a higher level of invention, can be found in the area of participatory design [12, 26]. A high level of user involvement has produced innovative results in areas ranging from home electronics to wastewater treatment [3]. Various techniques can be used to improve collaboration between designers and users; for instance, video artifacts can be used to create a creative dialogue between designers and users, and help formulate inventive ideas that are rooted in the users’ own experience [22].

Several methods and techniques put more emphasis on invention, while still using inquiry as an integrated part of the process. For instance, cultural probes is a technique for data collection which is commonly used in interaction design [10]. By giving users packages with informal exercises, the designers hope to provoke inspirational responses to inspire design. Other methods are closer to technical invention. Technology probes takes advantage of the users to guide the design [16]. These probes are technical devices with one single main function, preferably open-ended, that log the users’ activities. This method can be effective in analyzing the users interest and their possible creative use of the introduced technology.

**The ideal: Grounded Innovation?**

The best way of producing innovations would seem to be to combine technical and conceptual novelty with a thorough grounding in user needs and interests.
From the above it seems an “ideal” method would provide the highest degree of both inquiry and invention, to heighten the chance of producing successful innovations. Such a method is not likely to exist, not least because no method can guarantee perfect results – the outcome of any design process is to a large extent determined by the skills and diligence of the designers involved. That said, we think it is useful to identify this as a sort of “sweet-spot” to strive for. The intention with the term grounded innovation is to highlight our belief that successful design projects will include a high level of grounding (provided by various methods of inquiry) while at the same time producing results that are highly innovative (provided by methods that stimulate invention).

**Innovation Based on Marginal Practices**

Spinosa et al [30] claim that marginal practices have been sources of history-making and innovation in society. Shared styles of practices make people cope with things in similar ways, have similar concerns and see similar possibilities. When a practice is dominating it becomes invisible for the people involved and they will include others in that style, losing sensitivity to marginal ways of doing things. A marginal practice is often overlooked, as an out of the ordinary approach or viewpoint. As an example, the early feministic initiative was first a marginal practice, which then spread and led to important changes in society. Throughout history, a variety of marginal practices such as citizen actions have contributed to fundamental changes, affecting the heart of perception of society and contributing to innovation [30]. Thus, the power of marginal practices lie in that they can affect or even become a central practice. In the same vein as marginal practices, lead users are a minor group of advanced users whose unusual creativity with a product has been successfully used to inform future design of interactive products [31]. The creative practice that the lead users demonstrate is marginal, rather than representing the average user. However, their original and inventive use of a product, can point towards business opportunities for a future general market.

We are interested in using marginal practices as a way to encourage a new mindset in a design process. In particular, we try to find practices that can be matched with, and provide inspiration for the design of technology. We define a marginal practice as individuals sharing a specific activity that they consider meaningful. The marginal practice should consist of people that do not reflect the majority of end-users and may even be a group of people that are unlikely to be end-users of our proposed systems. The point is that such a practice can provide a new perspective on the use of the technology, raising design ideas that are based on alternative viewpoints and ways of doing things. A practice that is considered meaningful for a minor group, can still involve underlying needs that a more general group can benefit from. This can provide a new and grounded design outcome of interactive technology, which we will exemplify below.
Previous experience with marginal practices

We have previously worked with specific individuals to develop novel user experiences based on new technical possibilities [13]. In one such project we developed a new kind of digital camera. This application intended to explore new practices for digital camera technologies, different from analogue, and change pre-conceptions of what a camera can achieve. Our technical starting point was to use sensors, such as a thermometer, an accelerometer, a microphone, etc. to change the appearance of a digital picture in the moment it is taken [14].

Early in the design process we took inspiration from Lomography, which clearly stands out from more conventional amateur and professional practices of taking pictures. It is an amateur practice, making use of old Russian analogue cameras with optical defects. The lomographers ignore traditional “rules” of photography, for example by “shooting from the hip”, i.e. avoid looking through the viewfinder when taking a picture. They are known to bring their camera everywhere, to always be ready to take spontaneous pictures. Their attitudes towards taking pictures, sense of aesthetics and enjoyment gave us important insights into what we consider a marginal, yet interesting practice to inform the design of a new camera.

Throughout the design process a group of lomographers generously shared their interests, and provided us with important considerations as they reflected on our concept. We also tested an early prototype with both amateur photographers and lomographers [19]. The lomographers were never intended as end users, but rather to provide us with insights of their view on picture taking and enjoyable moments in their practice. The concept has now been developed further and implemented on a camera phone. In a user study, the results indicated that participants used the camera with new goals of taking pictures, expectations of the results, views of aesthetics and picture-taking approach [15]. This implies that we succeeded in breaking from preconceptions originating from the limitations of analogue cameras and enabled new ways of taking creative pictures with digital cameras.

From this case we developed experience to make use of a marginal practice in design, here to explore new practices around the picture taking moment in digital photography. If the goal of the design had been different, for example to design a digital picture album with a specific technology, we would have chosen another marginal practice. Collectors of stamps or toys might have been more suitable then, to emphasize specific human interests and needs with collections – matching the intended design outcome. When working with the lomographers, we did not focus on how to describe the process so other designers could take advantage of marginal practices. We are now more systematically investigating how to transfer a marginal practice into design.
Transfer Scenarios

Transfer scenarios is both a technology-driven and user-oriented method developed to raise the level of invention in a design process, without losing the grounding that is essential for innovation. It is not an ideal design method for every situation, but useful to encourage a new mindset of an existing technology, or to explore interesting application and interaction possibilities for not yet mature technology.

This method could be used with almost any interactive technology with the potential to give rise to new innovative and useful applications. The idea is to ground the design in a group of people, which are not necessarily end users, but which share a relevant marginal practice. Such a practice, meaningful for a minor group, could potentially contribute with specific qualities for a design intended for a more general user group. It needs to be carefully chosen to match the intended design outcome, and is used to understand higher-level motivations and human interests, carried out in an alternative approach. This is then transferred to a design in a different context (involving the technology in mind), to achieve a result, which is both grounded in human needs, and takes advantage of the specific properties of a technology.

Below we introduce steps that we have developed to explain how transfer scenarios can work, when using the technology as a starting point. This involves how to learn about the technology and match it with a marginal practice, how to investigate and analyze the practice, and then how to transfer the findings into actual design. In the section after this, we complement the steps by showing how the method was used in a real design process.

1. Learn about the technology

This step involves exploring and learning about the general properties of the technology. An overall understanding of the properties and potential of the technology is needed to perform the next step, where this knowledge will be used to find a matching marginal practice. The goal is to get an overview of the possibilities and limitations of the technology, rather than to get a deep technical knowledge. With a broad understanding of the technology, it will be easier be to find a related marginal practice. This step should involve sorting out not only the existing technical properties, but also to find possibilities that combinations with other technology could give. If the technology is novel, how do other technologies with similar properties work? Has some technical possibility or functionality been overlooked? What are the current applications? What are the future trends? For some projects, the properties of the intended technology may already be well known, and thus reduce the work in this step.

Learning about the technology could involve activities such as investigating existing applications through academic papers, company websites, blogs, reading technical magazines and hands-on workshops.
2. Match the technology with a marginal practice

Another important step is to investigate potential marginal practices and decide for one. First, it is necessary to assemble information on a set of marginal practices that could be an interesting match with the technology being developed. The practice does not have to involve future users of the technology, but should be chosen to match its properties and the intended design. Members of the practice should engage in activities that are meaningful for them, preferable different from the general style or the potential users’ current perspective of doing things. Their specific practice should illustrate underlying human motivations and interests, which are carried out in an alternative way, but still can inform a meaningful design.

This step is very important for the outcome and therefore the choice of marginal practice should be considered carefully. The intended design outcome, in consideration with the most interesting properties of the technology, should determine which practice to use. For instance, when investigating a technology with possible tangible interaction possibilities, it could be useful to look into a marginal practice that involves tangible use of for example paper notes. A camera technology could be matched with people having a very unusual approach to picture taking, a robot-technology could be matched with a marginal practice of interacting with living creatures, and so on. The aim is not to improve or design artifacts that support the practice, but to learn about and make use of its underlying motivations. The matching depends on what technical properties that are interesting for the intended design outcome. A possible match of a marginal practice could also be to involve people who share an interest in using a related, but older technology. Such a practice may involve old technical properties that are creatively made enjoyable or useful in the practice, but have been lost in its modern counterpart. Another consideration is the constraints concerning the design outcome. For example, if this should involve everyday use, it is likely that it is a better match with a practice involving activities on a daily basis, to learn about motivations for upholding such a daily interest.

Exploring marginal practices can involve looking into practices and communities through websites, blogs or even contacting people sharing specific interests. Brainstorming techniques can also be useful to come up with ideas about a possible marginal practice that could be matched with the technology.

3. Investigate needs and interactions

The third step involves investigating the human activities in the chosen marginal practice. The reasons for matching the practice with the technology play an important role here. For example, if physical interaction is important in the design outcome, some questions should involve why the interaction is carried out way it is in the current practice. In the previously described case of working with Lomographers we asked about their style of “shooting from the hip” (instead of looking through the viewfinder) to understand their motivations for this kind of
interaction. However, it is also important to get a general overview of the people in the practice. For example, why do they consider their practice meaningful? What do they do, how and why? Why do they prefer doing this instead of using a more conventional approach? How did they get interested in this practice? The questions should relate to the intended design, and can thus be different depending on the goal with the design.

To investigate general needs and interest in the practice a suitable inquiry technique, such as interviews or observation is needed. Several techniques can also be combined. With the Lomographers we combined interviews with a workshop, where they could show and talk about their pictures [14]. Overall, this step should provide answers to what the marginal practice is about, how do they do things and why, to inspire design in the next step.

4. Analyze and Transfer Data to Initial Design

This step is about analyzing data, such as transcribed interviews or videos, to transfer the findings into design. This involves determining which properties in the practice that are the most interesting for the intended design. Furthermore, this step involves selecting and organizing specific data as a basis for design. The data should be used as design input during idea generation, for which a variety of design techniques could be used. The chosen design technique is intended to help combining the data and the emerging ideas into a coherent whole.

One technique that can be used in this stage is Personas [27]. This involves creating fictive, but realistic user profiles based on the data. First, this technique should be done without giving any regard to the look and feel of the technology. Not until the personas reflect some interests and meaningful activities that are possible to be shared with end-users, the design of technology starts. This approach helps to make the human interests and motivations more vivid, before going into technical limitations and possibilities. This also prevents technical considerations to take over the discussions too early.

5. Detailed Design and Technology development

In the final step of transfer scenarios, interactions and meaningful activities found in the marginal practice have already been transferred into the proposed design. This step continues with the actual design of the technology, involving intended users. Even if the marginal practice is the underlying motivation for the overall design, further development and detailed design has to face real users, which can provide a more detailed feedback of realistic use situations. In this step, it is also likely that the view of possible users have shifted. New perspectives are likely to have emerged compared to the beginning of the process, as a result of new insights arising from the marginal practice.
If the previous steps have involved a specific technique such as personas, this step can involve working in more detail with the design technique to meet technical limitations. This may for example involve rewriting and taking the personas further, while finding a balance between the technical development, the persona and from testing the design with real users.

**Case Study: Autonomous Embodied Agents**

In the European project *Embodied Communicating Agents*, ECAgents [7], we are exploring applications for autonomous embodied agents, e.g. robots, which can evolve their own behavior by communicating with each other as well as with human users. The field of Human Robot Interaction, has traditionally focused on developing social robots with human-like behavior and appearance, or other forms of high level social communication [9]. Here we wanted to investigate alternative types of meaningful and interesting robotic products for everyday environments, and used transfer scenarios in the design process.

**Learning about the technology**

As a starting point for this case, we looked into which core features that agent and robot technology may involve. This involved reading research articles, websites about communication between embodied agents (such as [7]), blogs about various robot projects, emerging behavior and robotic products for everyday environments (e.g. [11]), different types of robots and agents etc. Descriptions such as Maes [23] definition of an agent as “a system that tries to fulfil a set of goals in a complex, dynamic environment” were discussed in relation to descriptions of communicating embodied agents as being able to interact directly with the physical world and “to communicate between them and with other agents (including humans)” [7]. We considered that one of the most prominent properties of embodied agent technology was to be able to act autonomously and to take advantage of the physical world. We also discussed the history of robots in everyday environments, how to avoid the anthropomorphic view and high-level communicating robots, to open up for enjoyable relations to agents that involve much less complex communication. Future possibilities, and current challenges in human robot interaction were also discussed. Overall we got a broad understanding as well as some starting points for which agent properties that would be interesting to investigate.

**Matching the technology with a marginal practice**

We were interested in a marginal practice that could provide insight into possible roles for robots or other autonomous artifacts in everyday environments. To find this we brainstormed about human interests that already involve or could involve entities or systems involving some form of autonomous and emergence related behavior. The brainstorms touched upon a variety of practices that involved
some form of agency-like interaction, such as pilots in automated airplanes, people growing plants, and people owning pets. When discussing further we found it suitable to understand what makes some people uphold a continuous interest for very limited interaction, something we saw as a possibility to create interesting robot applications with less complex interaction and communication possibilities.

Ultimately, we chose to focus on the marginal practice of people owning unusual pets, such as reptiles and spiders. This practice was likely to provide us with knowledge the underlying reasons for showing continuous interest in such pets, even though it is often not possible to interact much with them, e.g. play or teach them tricks, as opposed to more conventional pets such as dogs. Rather than aiming for the anthropomorphic tradition of designing robots as pets, we hoped that this practice could provide insights in alternative agent behaviors for everyday environments. We were not aiming to use our insights into the practice to design robots that look and behave like reptiles, or zoomorphic embodiments of the technology (e.g. [25]). Instead we wanted to see beyond the actual artifacts involved, and find underlying motivations for this kind of interest, reaching beyond limitations in interaction and communication. Thus, our interest concerned things like engagement, enjoyment, identity, and social networks that the practice entailed for them – to transfer these qualities into the design of interactive technology.

**Investigating general needs and interactions**

We held interviews with 10 pet owners, six men and four women, who owned pets like snakes, lizards and spiders. Three of them were found through friends, one through the local Herpetological Association, and six through a reptile owners’ website. Their age was between 17 and 55 years old (mean 25.6 years, median 22.5). Due to time and logistic restrictions, three interviews were made face-to-face, and seven by phone.

The questions we asked to the pet owners aimed to answer for example:

- What they consider important qualities owners find in their pet (for example that it is easy to care for)
- Why they are interested in having this kind of pet
- What they do with their pet
- What the pets do
- How they see if a pet is sick or in different moods
- Social interaction with other pet owners
Each interview was recorded and then transcribed.

Analyzing and Transferring Data to Initial Design

Analyzing the data involved looking into why the pet owners consider their practice meaningful. We focused on understanding their key activities, motivations and interests. We also tried to understand differences in how the pet owners reflected on their relation to their pets. However, we did not look into for instance how a snake owner’s interest was different from a spider owner. Rather, we were interested in finding out variations of relations, interests, interaction and enjoyment for this kind of practice.

Sample findings

In the transcribed data, we looked for underlying motivations for people for being involved with reptiles. For example, we found how some people considered their terrarium almost as an interior design object. One participant was asked where he kept his terrarium and answered: “Well, I have had it (...) in the living room, and then... well it’s like a little extra furniture piece with a jungle theme.” Another person described the following as important qualities of a pet: “Well, it should be... be like a furniture preferably, nice to look at and at the same time easy to care for”. This person was asked why he wanted a pet in the first place and replied: “That’s a hard question, why do we want to have flowers in the windows?” And then he continued: “But it is fun to have, it is nice with a living thing.” He did regret that his pet (a spider) was not more lively, as sometimes it could decide to not move at all for a week. Another person expressed similar reasons to have snakes: “Eh, the company and to have something living around you, I feel this is good for the soul (...) you feel good from it.”

Simply watching the animals and creating their environments was a major motivation for someone to keep this kind of pets. “Well, I don’t know really, partly it is fun to build these environments, and partly it is that I can spend hours to just sit and look at them when I have fed them or something like this.”

We noted some differences the relation to the pet. On a question if any of the animals where more special than others one person replied: “Eh... here is a leopard gecko, it is partially sighted, so I have fed it with tweezers since it was small, and now it is a bit over a year, so it is pretty special to me.” Someone expressed that she regretted not being able to pet her lizards: “Yes, [I miss] that you can’t hold them and pet them, you can’t do that with a lizard because they can get dust mites, and die.” Another one expressed that he did not consider that his snakes lacked any properties as pets: “Well, no, I mean the snakes are constructed in a specific way and if you get them you have to accept that they aren’t any cozy pets or alike, you have to have them as your interest.” This person expressed his interest as a hobby, and his reason for enjoying it as: “Yes,
well, it’s mostly that it is exciting and a challenge to develop certain colors and things like that.”

Using Personas as a Design Tool
To transfer our findings about people’s relation with reptiles into the design of personal embodied agents, we used personas as design tool. We selected data that illustrated qualities that the pet owners enjoyed and other specific interests and experiences on Post-it notes (see Fig. 2a). By replacing the word pet (in excerpts where one or several pets were represented) with the word agent or agents on each note, we forced ourselves to facilitate the transfer from the data’s content of interacting with reptiles, to the outcome of this design process.

Figure 2. a.) Selected data was taken out as notes from the transcribed data. b.) The notes where sorted in clusters, each being a starting-point for one persona. c.) Affinity diagrams were used to sort out the different interests of each persona.

The selected notes were sorted into four groups, where each group was discussed as the starting point for one persona, illustrating specific interests and behavior (see Figure 2b). On the basis of the resulting clusters, four personas with different interests and personalities were created and named: Nadim, Magda, Christopher and Anne. At one point in the process we also placed the notes into affinity diagrams of each persona, where related interests or features were grouped together (see Figure 2c). At this point we focused mainly on the persona’s life, interests and activities, rather than the form and the behavior of the agents.

To explore different properties of the agents we brainstormed further about interests and interaction with the agents, and how this was different or similar from the other personas. This was complemented with brainstorming about possible appearances and behaviors of the agents. Throughout the process we also explored moving specific notes from one persona to another, to take new viewpoints and to avoid creating too much of a “stereotype” persona.

Personas
Below we give an overview of each persona and how they relate to their agents. These are not the complete personas; a detailed description can be found in [20].
Anne:

• Anne feels it is good for the soul to have something alive around her, creating a nice atmosphere in the room

• She has no need for being in contact with other people who own similar agents

• She likes her agents because they are easy to care for and that they are almost like a piece of furniture

• Anne enjoys watching the agents slowly take form and likes to be part in affecting this

• The agents do not recognize her, and in fact she likes this better than if they would

Christopher:

• The agent is around if he feels lonely and inspires him to get out and be active

• His agent works like a pedometer, and appears emotionally affected by Christopher’s activity as well as other similar agents

• Christopher finds it fascinating to get to know his agent and find out what it likes

• He likes to get in contact with other like-minded people, and talk about the unique properties of their agents

Magda:

• Magda’s agent extends her own identity. It is worn like a broche on her clothes every day, attracting attention from others

• Magda likes the idea of being a little different. She wants to be the expert when it comes to how to treat her agent

• She finds it thrilling that her agent is unpredictable and can cause minor electrical shocks to someone that is not used to handle it

• Her agent reacts on proximity to other agents and other devices with network capabilities
Nadim:

- Nadim does not pet his agents, nor is he interested in different personalities of the agents
- He is interested in evolving patterns and wants to learn about the agents’ visual behaviors and how to affect them
- He enjoys watching the patterns slowly evolve, and has lots of patience to get it the way he wants

**Detailed Design and Technology Development**

After the initial design, we have continued the work with personas, and started to build working prototypes. Currently we are working on the design concepts that are represented in the personas Anne and Nadim. We are now combining the technical development with the development of personas, adapting to technical challenges while retaining the important human considerations from each persona. The prototypes will soon be tested by intended users and then developed further. Below we describe the results of each design, and give a brief example of its intended use and the state of the prototype development.

**Anne’s dynamic living room wall**

While most people change their wallpaper every other year or so, Anne cares for her dynamical wall almost every day. She takes pictures when browsing in trend magazines, or during a stroll in the city, to use for her wall. For each picture that Anne sends to the wall, a flower with specific properties and behaviour is created. If Anne adds several pictures, there will be several flowers affecting each other’s behaviour on the wall. Anne does not have full control over her dynamic visualization, but cares for it on a more or less daily basis by adding new pictures, with different colors or motives. Some days she is less active and only watches the patterns slowly take shape.

In the prototype, a camera phone with a Bluetooth connection is used to take and send pictures to the system. For each picture, a unique flower (agent) with a specific behavior and appearance is created. The flower visually grows based on the pictorial input and its relationship to other flowers. The prototype is projected on a wall from a
PC, and we use an ultra-sonic positioning system to allow the user decide the position of each flower. The system will be evaluated with potential users, for instance people with an interest in interior design.

*Nadim’s dynamic hobby pieces*

Nadim has his robots as a hobby, rather than as pets. He is especially interested in robots that have visual patterns that evolve over time. Nadim explores different ways to affect the visual outcome, and to do this he experiments with different lights, sounds and motions for his robots. He also brings his robots to friends that have the same kind, so that the robots can affect each other’s patterns at different points in time. Nadim does not care if the robots evolve different personalities, nor is he interested in petting them. He simply wants to develop interesting evolving patterns, an interest he shares with his closest friends.

The robots we are developing are based on the E-puck platform [8]. We have extended the basic hardware platform with LED screens that can display dynamic and colorful patterns. We are investigating how visual patterns can be created and evolve, and how they can be communicated between robots. We aim to continue the design with possible users, for example people that enjoy computer games, to evaluate this concept.

![Figure 4. Small mobile robots communicate and evolve visual patterns for users to enjoy by actively contributing to.](image)

**Discussion**

Transfer scenarios is a technology-driven design method, where human motivations and interests are transferred from a marginal practice into design requirements for interactive technology. The intention is to *ground* technology
with the help of existing human needs, and at the same time *elevate* empirical data to support inventive design (c.f. Figure 5). While we cannot claim that transfer scenarios will lead to the “ideal” of grounded innovation, it does represent a conscious effort to get nearer to that goal. The fact that the studied practice is different from the intended users, is challenging, while at the same time being the reason why it is possible to get new ideas that are both based on the technical properties and a human practice. In a way, transfer scenarios is a way to *defamiliarize* a viewpoint of a technology. It changes our mindset to see the design from a new perspective, matching the technology with a practice instead of the other way around. In ethnography, defamiliarization is a tool used for critical reflection of the familiar, thus providing a new perspective, for example of the use of an artifact or a social situation [1]. In a similar way, our method aims to provide a fresh perspective of possible needs or interests and interaction that a specific technology could support.

![Figure 5. Transfer scenarios attempt to ground inventive ideas with empirical data.](image)

Lincoln and Cuba [18] coined the term *transferability* as the possibility to take findings from naturalistic inquiry conducted in one setting, to understand another specific setting. Transfer scenarios also investigates a possible match between settings, but has the intention of matching fundamentally different ones. Both approaches require that the involved contexts are understood enough to determine if a match between them is possible. This is prominent not only when matching a technology with a marginal practice, but also when the data has been collected and is transferred into the design. For this step it is important to have a feeling for *which* underlying needs that potentially could meet needs or interests among the intended users, which thus is yet another context to consider. This kind of matching is not trivial, demanding not only good imagination and design experience, but also faith in the resulting design.
Transfer scenarios should not only involve marginal practices, and involving potential users is crucial when doing detailed design. Getting input from different users at different points in the design process is already an accepted approach in HCI [17]. Furthermore, the design technique Personas makes use of data to give life to a “typical user” and to make this character credible, rather than to represent an existing user [17]. This is also how the technique is used when applied in transfer scenarios.

Finally, methods and techniques are only vehicles for developing the designer’s abilities, and can never be better than the capability of the people involved [21]. Thus, the choice of using transfer scenarios in the design process has to be made in consideration to the situation at hand.

Conclusions and Future Work

Transfer scenarios is a method that provides designers with a way to take advantage of both inquiry and innovation, to increase the possibility of a successful innovation. It takes advantage of the perspective provided by marginal practices to help the designer think outside the boundaries of technology. Similar kinds of design constraint are used in many idea generation techniques; the difference here is that this method supports a changed mindset through the entire design process, not just for a short brainstorm. With the design case of autonomous embodied agents we have showed that it is possible to sustain the changed mindset throughout the design process, and to produce novel design.

Transfer scenarios is not useful for every design problem; its current steps have been specifically designed to create innovations based on technological pre-requisites. However, we believe it could be modified to include other types of pre-conditions, using for example a certain location or activity as a starting point. For instance, when designing for urban commuting one might look into other ways of moving about, such as the Aboriginal Walkabout, which are journeys on foot that take place as much in the spiritual world as in the real. Such activities can generate new ways of seeing a familiar setting and increase the potential for innovation.

Our next step in this work is to involve external designers to try out the method, preferably for a variety of design cases and technologies. By doing this we hope to gain further insight into how the method may affect different design processes. We will also continue to develop and evaluate the design cases described in this paper. We will then use user-oriented techniques, such as placing the prototypes in the homes of users in a similar manner to technical probes, inviting focus groups for workshops to try out the technology, evaluate specific aspects of the interaction, etc. These results will then be fed back into new prototype designs which might – eventually, if we are lucky – turn into true innovations.
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