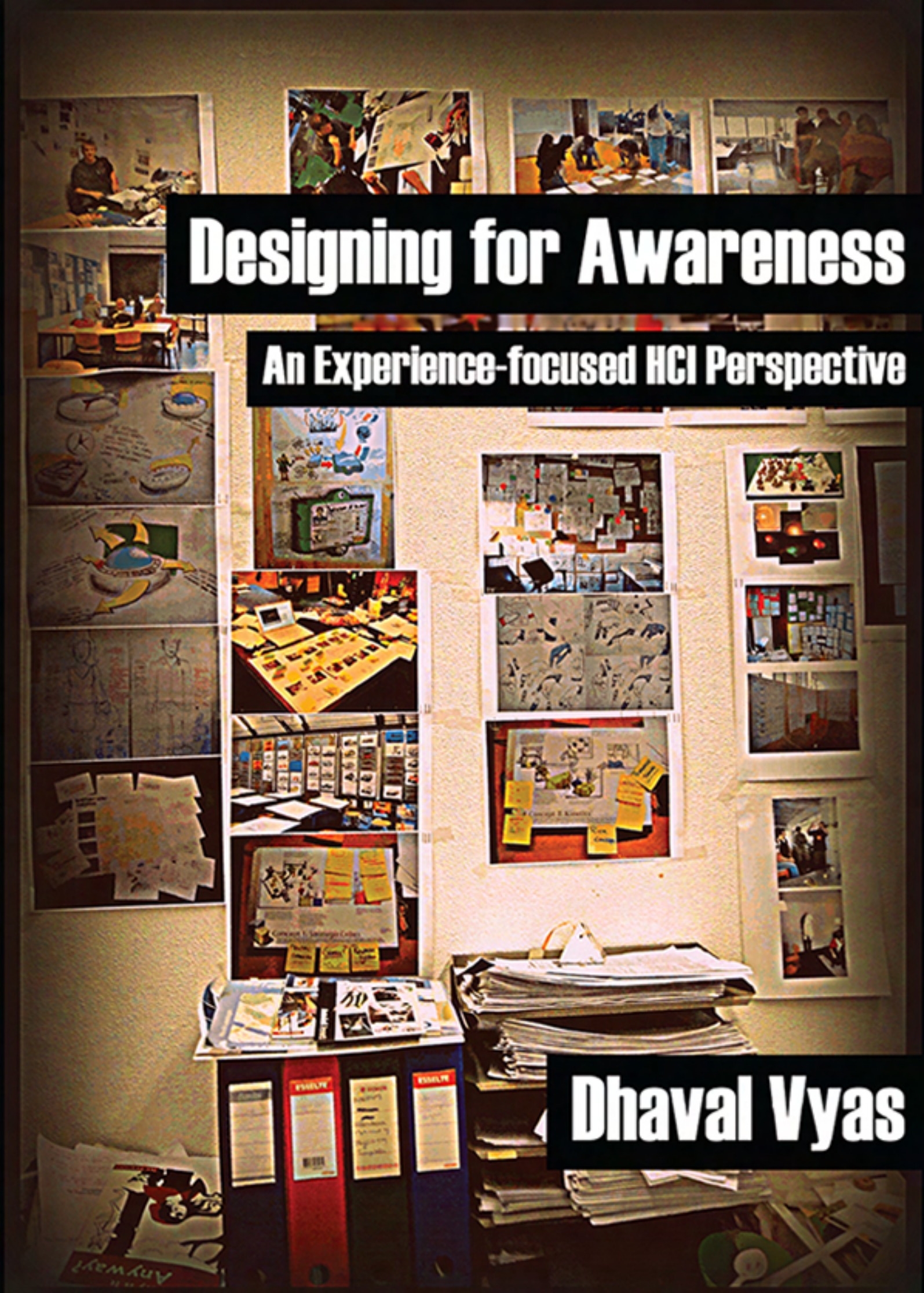
Designing for Awareness
An Experience-focused HCI Perspective
Dhaval Vyas

Designing for Awareness: An Experience-focused HCI Perspective

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મારા માતા-પિતા માટે...

To My Parents...

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Dhaval Vyas
Enschede, January 2011

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1

Introduction

The multidisciplinary field of Human-Computer Interaction (HCI) is experiencing a continuous change in its topic of study. One of the recent and arguably the most important topics of study has been the experience-focused perspective on HCI. As I shall elaborate on in this thesis, experience-focused HCI attempts to design technologies by taking a holistic view on understanding how people experience technology in their everyday environments. Secondly, it also aims to design for the wide-ranging, complex and situated experiences people have with technologies. As the title suggests, this thesis is about designing computer-based interactive systems that can support 'awareness' between people so that they can carry out their ongoing joint endeavors. The technologies that support awareness can be loosely termed as *awareness systems*. In my thesis, I will use two design cases to explore how one can design awareness systems using the experience-focused HCI perspective. In these two design cases, I investigate how early-technology ideas can be matched with people's experiences and their specific practices to inspire novel design. My thesis primarily focuses on workplace environments and looks at awareness as a situated and experiential phenomenon.

1.1 Awareness in HCI and CSCW

The notion of awareness has been central to Computer-Supported Cooperative Work (CSCW) research. It has its origins in workplace studies such as the London Underground study [106] and the air traffic control room study [100, 116, 219]. In its original conception, awareness was seen as a tool to understand how actors effortlessly pick up information about what is going on around them and make practical sense of it, and in turn, seamlessly adjust their activities [203]. In another study that motivated research on awareness, Kraut et al. [144] showed that people who are situated in close physical proximity are more likely to collaborate on projects simply because they are more easily able to engage in informal conversational encounters. Studies such as these encouraged researchers to develop technologies that can support 'informal awareness' between co-workers, especially when they are dispersed

over geographical locations. Hence, the issue of awareness became an important topic of research in the fields of HCI and CSCW – which, in the 80s and 90s, focused heavily on the applications and systems to support office work, organizations and aspects related to workplace collaboration. Here, awareness involved knowing who was around, what activities were occurring, who was talking with whom and focused on providing a view of one another in work environments. The assumption here was that awareness might lead to informal interactions, spontaneous connections, and the development of shared cultures [54] – all important aspects of maintaining working relationships which were denied to groups distributed across multiple sites.

The issue of supporting informal awareness in work environments paved the route for technologies such as media spaces [17] – a technology that supports audio-video links between two (or more) remote workplaces. Media spaces and other related technologies utilized the notion of informal awareness among remotely-located co-workers by placing such a technology in the common areas of their work environments, so that all sides can have a view from each other's respective common areas. Subsequently, the fields of HCI and CSCW saw a large number of software applications attempting to develop awareness systems that focused on conveying people's presence, activities, and availability of members of a community (read [94] and [193] for comprehensive reviews). Systems that attempt to convey awareness are called awareness systems. A recent text on awareness systems [163] defines them as: *"systems intended to help people construct and maintain awareness of each others' activities, context or status, even when the participants are not co-located."*

There are a large number of highly inter-related and overlapping notions of awareness, such as social awareness [22], situational awareness [60], workspace awareness [95] and contextual awareness [162], among others. In addition, a large number of awareness systems have been designed for differing and sometimes contradictory purposes. On the one hand applications such as TeamWorkStation [125] were built to support real-time, smooth collaboration with a remotely located co-worker. On the other hand, Nardi et al.'s [173] conception of awareness dealt with interrupting others by sending instant messages. The notion of awareness, which started from supporting informal communication in workplaces, has shifted to supporting interpersonal communication between friends and families, taking into account the non-work situations. HomeNote [215], Whereabouts Clock [28], ASTRA [164] and Family Portraits [170] are a few examples of awareness systems that have been developed for domestic environments to support interpersonal communications.

1.2 Experience-focused HCI

As the use of technology has extended beyond work environments, a need has arisen to take into account the cultural, emotional, interpersonal and other subjective aspects for designing new technologies. Since the late 90s, a growing body of work [185, 175, 131, 20, 167, 102, 132] within HCI has attempted to shift the focus from the task-based or functionalist view points to a more holistic view on how users experience technologies. Experience-focused HCI can be seen as an umbrella topic that keeps 'human experience' at the center of any type of HCI investigation. This reflects

a paradigm shift in the current HCI research from usability and task-based approaches to experience-focused perspectives. Buxton [35] argues the following: *"Ultimately, we are deluding ourselves if we think that the products that we design are the "things" that we sell, rather than the individual, social and cultural experience that they engender, and the value and impact that they have."* Experience-focused HCI aims to design for the multiple, complex and situated experiences people have with technologies.

The notion of experience has been a tricky topic in HCI and is yet to have a widely-accepted definition. Dewey [49] and McCarthy and Wright [167] describe experience as a totality of a human's interaction with an object. They conceptualize experience as a subjective, constructive, holistic and spatio-temporal phenomenon. It is important to recognize that experiences are situated and are formed in the course of a specific interaction and any representation of an experience is inherently incomplete. Hence, at times researchers [23] have termed experience as an ineffable phenomenon. It is something that may not be fully understandable, but its richness can be felt. McCarthy and Wright [167] discuss experience as the *"irreducible totality of people acting, sensing, thinking, feeling, and making meaning in a setting"* (p. 54). Even if human experience is subjective and situated in its nature [49], it can still be interpreted to inspire design. This perspective is also prominent among other researchers who investigate how experience-centered design activities can inform, inspire or understand HCI design beyond usability [167, 266, 218]. In the last 10 years, HCI researchers have developed conceptual frameworks to understand experience [77, 103, 167, 76]. The use of pragmatist philosophy [184] and phenomenology [52] has also informed how designers can incorporate experience-focused perspective into HCI. Although the authors did not label their work as experience-focused, the ethnographic fieldwork done in domestic environments such as the one by Taylor and Swan [233] can also be seen as an attempt to incorporate experiential aspects into design. In particular their focus on the peoples' situated actions in very particular places and situations is at the heart of experience-focused HCI. Role playing methods [29, 25, 128] have also emerged as important techniques to inspire experience in the design process. Such methods focus on innovating novel technological solutions by physically acting out potential problems and solutions. Additionally, probe-based methods have also gained prominence in HCI research to incorporate experience in the design process. Methods such as cultural probes [82] and technology probes [123] have provided a very useful way to support design explorations. Although not directly related to this thesis, some of my own work on experience such as developing a conceptual framework [260], an evaluation approach [261] and philosophical underpinnings of experience [247] has inspired me to use experience-focused HCI for designing new technologies.

As an important note, I would like to point out that this thesis does not attempt to explore the notions of *user-experience* nor does it focus on conceptualizing it. My sole focus here is to design technologies to support awareness. I do, however, use experience-focused perspective to do this. To read PhD theses focusing on user experience, I recommend the work of Battarbee [10], Kaye [132] and Karapanos [130].

1.3 The Thesis

Ever since the industrial revolution in the late 18th century, aspects such as efficiency, productivity, rationalism and so on have gained primacy and a higher level of interest in different 'work' domains over the subjective and experiential aspects such as fun, play and pleasure. This thesis extends the current notions of awareness systems – supporting task-based and instrumental aspects between co-workers – to supporting experience-focused interactions, in the context of work environments. Within HCI and CSCW research, one can find several examples of awareness systems that support emotional, playful and curious interactions. However, this has been mainly in the non-work domains such as domestic, leisure and gaming environments. The main research question this thesis attempts to address is:

RQ How can we design awareness systems for workplaces that incorporate an experience-focused HCI perspective?

To clarify this question, I do not intend to develop a 'methodology' of some sort to design awareness systems. On the contrary, my thesis explores this research question by means of two design cases where, using an ethnographic approach, I design two awareness systems and study their use in realistic settings. In both the design cases, I follow the complete design cycle – beginning from the problem definition and in-situ observations, through developing a working prototype to field trials of the prototype.

In the first design case, the aim was to develop an awareness system in an academic department setting that could playfully-mediate social awareness between co-workers. The focus here was on supporting non-work and pleasurable interactions between co-workers. I began by studying the everyday interactions of the staff members in the department using ethnographic methods and an inspirational technique called organizational probes [246] – a modified version of the cultural probes technique by Gaver et al. [82]. From the results of this six-month long field study, I developed important design implications for awareness systems and subsequently designed a situated display for the staff room in the department, called – Panorama [257]. Panorama is a large-screen, situated display which allows staff members to send their personalized digital contents such as holiday and conference pictures, personal comments and 'news of the day' quotes, personal achievements and announcements, and other socially-relevant information. Such contents are then played on the large screen of Panorama with a semi artistic representation. Secondly, Panorama, can stream images and videos in real-time from the public spaces of the department to create a curious environment in the staff room. Thus, Panorama supports user-initiated and system-initiated interactions to support casual and pleasurable social awareness in a playful manner. A two-week long field trial of Panorama was carried out in the department to observe how Panorama supported awareness in the department. Chapters 4 and 5 will provide detailed information on this design case.

In the second design case, the aim was to develop an awareness system that could support and enhance creative interaction between co-workers in a design studio setting. Unlike the first design case, this design case focused on supporting work practices of designers and supporting the collaborative practices of designers that support

creativity. So, supporting collaborative creativity was the 'experience' I intended to facilitate. With this aim in mind, I studied both academic and professional design studios to understand how designers work, how they collaborate with each other and in general how creativity is supported by the various practices that they follow. Following this eight-month long fieldwork in design studios, I developed important implications for designing an awareness system in the design studio environment. The Cooperative Artefact Memory (CAM) system was developed as a result of this investigation [255]. CAM is a mobile-tagging based messaging system. It allows designers to collaboratively store relevant information onto their physical design artefacts, such as sketches, collages, storyboards, and physical mock-ups in the form of messages, annotations and external web links. This way, CAM empowers designers to create a digital profile of their physical design artefacts that can be accessed by co-workers in a joint design project. CAM conveys the information of the ongoing projects through these tagged artefacts to make co-workers aware of each other's activities. I carried out a field trial of CAM in an academic design studio involving design students. The field trials of CAM shed light on how CAM facilitated expressions of design aesthetics, allowed designers to have playful interactions, supported the exploration of new design ideas, and supported designers' reflective practices. In general, our results show how CAM transformed mundane design artefacts into "living" artefacts that made the creative and playful side of cooperative design visible. Chapters 6 and 7 will provide detailed information on this design case.

By using these two design cases, my aim is to show two different viewpoints on awareness. In the first design case the focus is to support casual, pleasurable and non-work interactions between co-workers. Whereas in the second design case, the aim is to support work-oriented creative communications between designers in their design studios. Both design cases keep the notion of experience-focused HCI at the center of their design process. In other words, neither of the design cases focuses on the task-based, productivity and efficiency oriented aspects but employ 1) 'pleasurable social interactions' in the first design case and 2) 'creative communications' in the second design case, as their experiential aspects. In fact, the second design case is based on supporting work practices but I aim to go beyond the productivity and efficiency measures to elicit how creativity emerges in the collaborative processes of designers. I also believe that these two differing situations can make my quest for supporting experience-focused HCI much stronger. This is because, as mentioned before, the use of experience-focused HCI is often seen in the domain of domestic, public and other non-working social environments. In this thesis, using these two design cases, I show that the experience-focused HCI perspective can be applied in work domains, too.

1.3.1 Research Approach

In the literature, there are two general approaches for studying experience and designing technologies to support experience: 1) Reductionist and 2) Holistic. The reductionist approach [238, 104] has its roots in cognitive psychology which attempts to provide evaluative value to a product's experience. This approach serves to compare multiple designs, assess the value supported by a design or develop a theory and criteria to support evaluation [130]. On the other hand, the holistic approach has an

inspirational value. Holistic approaches used in [167, 82, 77, 76] are grounded in either John Dewey's [49] pragmatist philosophy or phenomenology and are qualitative in nature. Holistic approaches conceptualize experience as a coherent whole and attempt to view it in an irreducible totality.

In this thesis, I apply the holistic approach to supporting experience in awareness systems. By using ethnographic methods, this thesis addresses the research question (RQ) by understanding how we can design technology that fits within people's existing social and physical contexts. This means designing awareness systems that not only support the practices that people have developed in their routines over time, but enhancing these practices by designing technology that overcomes the challenges people may face.

1.3.1.1 A Qualitative Approach

My research follows a qualitative orientation to designing awareness systems. In both of the design cases, I begin my investigation using ethnomethodologically-informed ethnographic fieldwork to understand people's behaviors, practices, shared understanding, and use of artefacts in their natural settings. I use these understandings for developing 'implications for design' that are able to direct design. This way, my research is completely empirically-driven. The ethnomethodological orientation is well suited to a project such as this one, where the importance is not on validating frameworks or theories by using observed phenomena, rather, the aim here is to highlight emerging phenomena that can be further explored or re-used for designing technologies. The reason for selecting a qualitative approach as opposed to a quantitative approach was to gain an understanding of what sort of processes people employ and why they employ them, from their perspective, so that better design decisions can be made. This is precisely the goal of ethnomethological orientation. Additionally, the use of a qualitative approach can explain why particular processes are undertaken as opposed to others. To analyze qualitative data, I use widely accepted methods such as open coding [223] and affinity diagramming [110].

Qualitative approaches often run the risk of a lack of validation. I have taken this fact into account and dealt with this in three ways. 1) I have discussed my findings with several HCI experts during the course of my fieldwork in both the design cases. In design case I, another researcher provided extensive support in collecting and analyzing our fieldwork data. In this case, we corroborated our findings and avoided any individual biases. I also attempted to put my findings in comparison to the current research to understand how and why my findings validate, extend, or refute existing knowledge. 2) During my fieldwork, I tried to spend extensive time in the field to reflect on my findings. In design case 1, I spent six months in the field, observing, taking interviews with my subjects and using other techniques to gain an insight. Additionally, in design case 1, I was focusing on an academic environment that I was familiar with. Hence, this helped me in validating certain facts very easily. In design case 2, I spent nearly eight months in different academic and professional design studios. To 'get into the shoes' of the designers, I took a couple of design courses and became a resident design student for nearly a month. This gave me a lot of confidence in my findings. 3) In both of the design cases, I have used triangulation to generate

the results by employing a variety of methods and techniques. The majority of the results came from contextual interviews and naturalistic observations. However, in design case 1, a method inspired by the cultural probes study was used to get access to my subjects' inspirations, aspirations and experiences. On the other hand, in design case 2, during the trials of the prototype, I used the Repertory Grid Technique (RGD) in combination of semi-structured interviews. More detailed descriptions will be provided in the main chapters of my thesis.

1.3.1.2 The Process

In both of the design cases, a common process was used to design awareness systems. This process can be described by the following six steps:

1) Study cooperative (work) practices
2) Find out 'instances' and interesting patterns of interaction
3) Develop 'implications for design'
4) Create a design concept
5) Develop a working prototype
6) Trial the prototype in natural settings

These six steps make a full cycle for a complete design process. My investigation starts from studying the everyday practices of my subjects in their natural environments. As mentioned earlier, I use ethnomethodological orientation to understand how and why people do what they do, from their own perspective. I have used methods such as contextual interviews and naturalistic observation and in some cases used cultural probe-like methods and video recorded sessions of subjects' collaboration. Next, the large amount of multi-modal data (pictures, videos, field notes) was analyzed using open coding and affinity diagramming. Here the intention was to find specific patterns from subjects' interactions that are used to support awareness. Next, 'implications for design' – a complimentary step for ethnomethodologically-informed fieldwork, was generated. Here I sought to generate specific design features based on the empirical evidence. Next, a set of conceptual designs were generated in the form of sketches and other visual means. These conceptual designs were discussed extensively with colleagues and experts to make a feasibility comparison and fine-tune any specific design concept. Next, a final design concept was agreed upon and a working prototype of that concept was developed. In both of the design cases, the prototypes were intentionally made in such a way that they did not show a complete or a final product. This was done mainly to support an iterative design process. Finally, working prototypes were put to the test by carrying out trials in the natural settings of the subjects. The importance was given to the experience of using such a prototype and not to 'evaluating' them. I do not attempt to fully evaluate these prototypes mainly because, within the qualitative orientation, these prototypes were designed using experience-focused HCI perspective and the experience of using such prototypes is more central than the evaluation of how efficient and effective these prototypes are.

1.3.2 Research Context

This thesis contains several important facets that motivated me to carry out such a research project. I see this research as a combination of 1) workplace studies, 2) interaction design, 3) ubiquitous computing and 4) experience-focused HCI, as shown in figure 1.1.

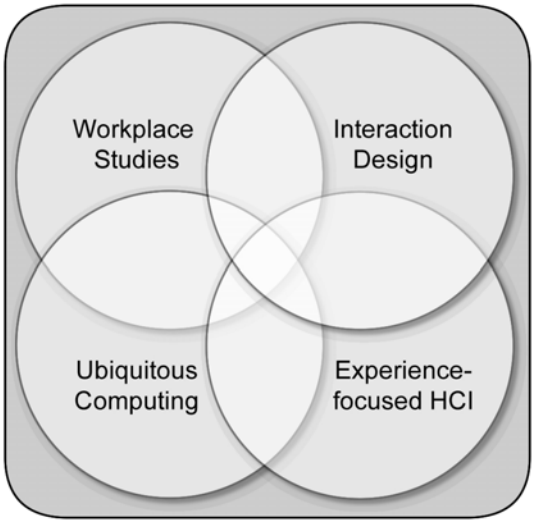


Figure 1.1: The four components of the thesis Designing for Awareness.

Designing awareness systems in workplace environments needs a thorough understanding of 'how work is being carried out' in the first place. In CSCW, workplace studies have played a major role in informing the design of computing systems in organizations [157]. In the context of this thesis, the workplace studies can provide plenty of useful information about co-workers' everyday routines, coordinative practices, their use of tools and artefacts and so on. Such an understanding of workplaces can inform us what awareness information is needed, to whom this information is conveyed and how, how awareness is maintained and, most importantly, how this information can be used for designing awareness systems. Workplace studies can elicit several complexities of work practices, especially when the notion of work is becoming more mobile and ubiquitous.

The second component, interaction design, poses specific challenges to explore the ways in which people can interact with awareness information. Hallnas and Redstrom [97] define interaction design: *"interaction design is designing the acts that define intended use"*. As some of the research on awareness (e.g. [106, 22]) has shown, co-workers make each other aware of their individual activities and status information through subtle and unobtrusive mechanisms. For designing technologies that can support awareness, a lot of emphasis has to be put on the way co-workers will interact with this awareness information and designing for awareness would mean designing interaction to support awareness.

The third component, ubiquitous computing, conveys a technology push that goes beyond the traditional desktop metaphors. Ever since Mark Weiser [264] coined the term, ubiquitous computing, a large number of technologies have been developed

to support people's wide-ranging interactions with everyday objects. Inspired by the notion of ubicomp (short for ubiquitous computing), my research has focused on developing awareness systems that go beyond the desktop and explored ways by which technology can be physically and socially embedded into people's practices. The two awareness systems that I have developed and described in this thesis are both examples of ubicomp.

The fourth component, experience-focused HCI, which is at the core of this research, delves into designing computing technology to support people's wide-ranging experiences. This perspective focuses not only on completing specific tasks with a technology but takes a holistic view of how people experience a technology taking emotional, pleasurable, playful and other ineffable aspects of using a technology into account. I believe that since technology is becoming part of people's everyday lives, designers need to ground the design of their technologies in this broad range of people's experiences.

1.4 Contributions

There are three main contributions that can be relevant to the HCI community: 1) Methodological, 2) Empirical and 3) Technological. I will describe these in the following.

The methodological contribution would show how one can design for awareness. The two design cases in this thesis deal with two different kinds of situations where the definition of awareness is different. In design case 1, I am interested in the non-work, interpersonal awareness between co-workers in an academic department. Whereas in design case 2, I focus on the collaborative practices of industrial designers that could convey awareness of creative work. This is reflected in the methodological focus of the two design cases. In design case 1, I use *situatedness* as a lens to understand how non-work, interpersonal awareness is practiced. In this case, I take into account the forms, activities, agents, places and contents of awareness. In design case 2, I use *physicality* [51] as a lens to understand how materiality of the design studio culture plays a role in supporting awareness. I take into account the material aspects such as the physical space, material design artefacts such as sketches, storyboards, and physical models. More importantly, I show how, in these two different situations, experience-focused HCI perspective can be applied.

The empirical contribution would provide new insights into collaborative practices, not studied extensively within the CSCW and HCI fields. Studying and designing for awareness means taking into account the salient and implicit practices of individuals. These practices may not be seen without a longitudinal exposure within the field of work. In the thesis, I will use examples from the field that will illustrate how such implicit and tacit practices are achieved by people. Additionally, this thesis will provide an alternative view on work organizations. As in the first design case, I look at the non-work, interpersonal and pleasurable practices of members in an academic department. In the second design case, I will provide empirical evidence of physicality of the design studio culture and show how designers' practices are inherently material in nature. A look into these aspects of work environments is not covered in

CSCW and HCI research, hence, this thesis will provide new empirical insights into such aspects of work environments.

The technological contributions of this thesis is minor compared to its methodological and empirical contributions. However, from an interaction design point of view the two technological prototypes that are described in this thesis show novel interaction possibilities. Panorama, which is the prototype developed in design case 1, is a large screen display that plays user-generated images and texts messages and system-generated live video streams in a continuous way using semi-artistic representation. CAM, which is the prototype developed in design case 2, is basically a combination of off-the-shelf tools that allows designers to store relevant information onto their physical design artefacts. Our field trials of these prototypes showed that the value of the technology was seen to be more important than the technology itself.

1.5 Thesis outline

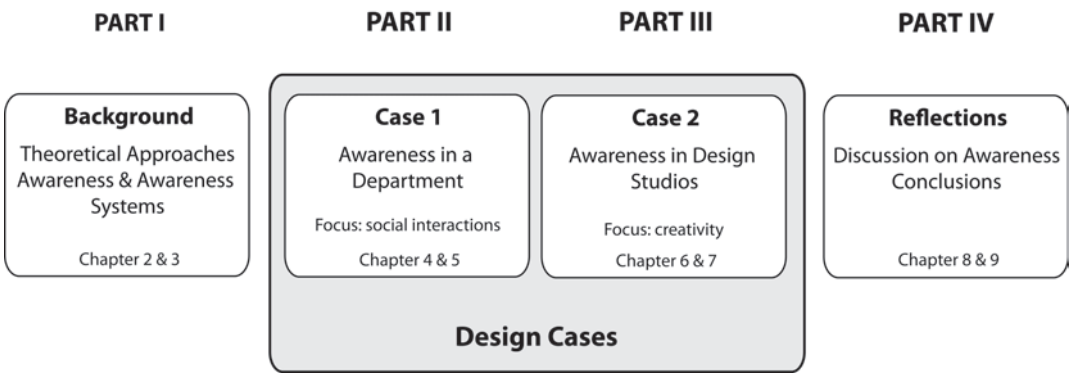


Figure 1.2: The thesis outline.

As I have attempted to establish in the earlier part of this chapter, the goal of this thesis is to explore how we, as HCI researchers, can apply an experience-focused perspective for designing awareness systems. I aim to do this using two design cases, where a complete design cycle is followed. The thesis is divided into four parts, and will be described in the following. Figure 1.2 provides a high-level schema of the structure of this thesis.

PART I: Background

In the first part, I attempt to lay a background for the thesis. I will review related literature from theoretical, conceptual and technological standpoints. **Chapter 2** provides a short account of awareness from the HCI and CSCW literature. Using its original conceptualization, I will identify important characteristics of awareness. Subsequently, I will also provide a view of awareness from an experience-focused HCI perspective. In the second part of Chapter 2, I will review some well-known examples of awareness systems, starting from Media Spaces to the current awareness systems. In particular, I will not provide an exhaustive all-inclusive review, rather, I aim to capture the diversity in the conceptualization and implementation of awareness systems.

Chapter 3 reviews some of the well-known theoretical frameworks to study group activities and collaboration. Since, studying group activities is imperative for understanding awareness in a given situation, a review of the existing frameworks can be very useful. I will review Activity Theory, Distributed Cognition, Grounded Theory, Actor-Network-Theory and Ethnomethodology (EM). I will not attempt to make a detailed comparative analysis of these frameworks.

The second and third parts will be about two cases, where, using an ethnographic approach, I designed technologies to support awareness in two different workplace scenarios: an academic department and a design studio.

PART II: Design Case 1 – Awareness in a Department

This part is dedicated to a case study of designing an awareness system in an academic department. Following the experience-focused HCI perspective, this case study aims to support playfully-mediated social awareness in the department. The focus here is not on the productive and task-based activities of the department, rather, the importance is given on the casual, non-work and pleasurable interactions between staff members. This case study is divided into two parts and will be described in the form of two chapters.

Chapter 4 describes ethnomethodologically-informed fieldwork in the department. Here, I will describe the interpersonal notion on awareness, the methods used in the fieldwork and the detailed results of the fieldwork. I will particularly focus on the awareness practices of staff members and describe the implications for designing a new technology to support interpersonal awareness between staff members.

Chapter 5 shows the subsequent parts of design case 1. Here, I will describe the prototype Panorama that was designed from results of the fieldwork in chapter 4. I will show the design logic of Panorama and its representational aspects. Next, a two-week long field trial of Panorama in the department will be described.

PART III: Design Case 2 – Awareness in Design Studios

This part is dedicated to a case study of designing an awareness system in the design studio culture. In this I will describe design case 2, where I will be focusing on the creative side of work practices. This will be done with the lens of physicality.

Chapter 6 will describe the longitudinal ethnomethodologically-informed fieldwork in different academic and professional design studios. I will describe the methods used in the fieldwork and describe its results in the form of themes of collaboration. As done in chapter 4, chapter 6 provides directions for designing an awareness system in the form of implications for design.

Chapter 7 will show the subsequent parts of design case 2. Here, I will describe the prototype CAM (Cooperative Artefact Memory) that was designed from results of the fieldwork in chapter 6. I will show the design logic and the architecture of CAM. Next, a set of field trials of CAM in a design studio is described. Here, I will show how designers used CAM in supporting their ongoing design projects and focus on the aspects that played a role in supporting design.

PART IV: Reflections

This part will provide a reflection on the work reported in the preceding parts of this thesis. **Chapter 8** provides a short discussion on awareness. I will summarize the important aspects that came out of the two design cases. The last chapter, **Chapter 9**, will conclude this thesis with final words on the contribution, methodology and future directions.

Part I

Background

2

Awareness and Awareness Systems

2.1 Introduction

The goal of this chapter is twofold. In the first part, I will provide a conceptualization of 'awareness', as it has been discussed within the HCI and CSCW fields. From the literature, I will extract the basic characteristics of the notion of awareness. Additionally, I will provide my own understanding of awareness from an experience-focused HCI perspective, that will be followed throughout this thesis. In the second part, I will review some of the existing awareness systems. This will not be an exhaustive review of awareness systems but I will describe a list of carefully selected awareness systems that are distinct in their functionality, goal and interactions.

2.2 Awareness

Research in CSCW, in general, focuses on exploring how computing technology can be designed to support people's cooperative activities to accomplish their work more efficiently and effectively [205]. Awareness is one of the central topics in the CSCW research. While people go about carrying out their everyday activities, they maintain awareness of things around them, which contributes to an understanding of what others are doing, where they are and what they say. This understanding can help people in making inferences regarding the intentions, actions or even emotions of others and can provide a context for their shared activities and social interactions [163]. It is believed that participants' being aware of each other's conduct and interaction has a great importance for the design and development of technologies to support collaborative work [106].

Schmidt [203] points out that the concept of awareness has provided a vehicle to address the complex processes of organizational interaction that enable actors to subtly and unobtrusively coordinate their actions and activities with each other. The seminal ethnographic studies of the London Underground control room by Heath and Luff [106] and air traffic control work by Lancaster University's CSCW group [100, 116] illustrated how actors 'pick up' cues, traces and signals about complex work related

activities from information rich environments and coordinate their ongoing joint efforts. Early technologies to support awareness – such as media spaces [17] – have often been specialized for mediating selective work related activities and relationships, through computationally integrated audio-video links between geographically dispersed co-workers [54, 85]. Here awareness is seen to be supported by facilitating informal chat and discussions between remotely located colleagues, providing an idea of what is going on at the other end and supporting other social interactions in an informal way. More recently, awareness technologies for work environments such as @Work [235], Kandinsky system [75], Hermes [38], Elvin [71], Ambient Agoras [224] have been developed to convey information about co-workers' presence, their on-going activities and their personalized messages. The scope of technology design is broadening with the growing interest and need to support personally meaningful, authentic, sociable and rich everyday experiences. The notion of mediated awareness has also evolved from the objectively observable aspects encompassing information about mainly the work-related and productive aspects of peripheral settings to conveying subjective aspects such as love and intimacy [40, 134, 243], playfulness [11, 81, 215] and other related issues.

In the context of collaborative work settings, the idea of awareness rests on the participants *abilities* to remain sensitive to each other's *conduct* while involved in their distinct individual activities [108]. The real challenge here is, as Schmidt [203] points out, to understand how co-workers effortlessly pick up these cues and signals about what is going on around them and make practical sense of it. In order to design a system that can support awareness amongst co-workers, we need to take into account diverse coordinative practices through which cooperative work is routinely and seamlessly integrated. These coordinative practices differ from domain to domain. A firm grounding into these practices, however, is essential to good technology design [157].

The words 'abilities' and 'conduct' are of a great importance to the understanding of awareness. The word 'abilities' describes that there is more than one way people can skillfully acquire knowledge about other people and their activities. And the word 'conduct' (which is meant in a plural sense) describes a large diversity of information pertaining to people's behaviors, activities and interactions that can be seen as important for supporting cooperative activities. I shall get back to these terminologies in the next section.

In the literature, there are two different ways awareness is conceptualized, relating to two different scenarios. One, where concerned participants are co-located and working towards achieving a common goal, for example in a control room or at a cubical office space. And second, where participants are remotely located and are attempting to collaborate via some kind of technological support (e.g. an audio-video linked communication setup). These two scenarios require different treatments of the term awareness. In the scenario of co-located settings, awareness is realized through unobtrusive practices (such as, *overhearing*) through which cooperative activities are somehow implicitly and unremarkably aligned and integrated into participants' ongoing activities [106]. In the scenario of remotely-located settings, certain activities are deliberately carried out (such as, typing an IM, or sending an SMS) that might interrupt another participant's flow of activities [173]. As Schmidt [203] remarks, the

notion of awareness, in this sense, is being used in increasingly contradictory ways. In my research, I am mainly looking at the co-located settings; hence, I conceptualize awareness as an implicit skillful practice that is aligned into the everyday work of participants.

2.2.1 Characteristics of Awareness

As Schmidt [202, 203] reported, there are several important characteristics of awareness. I summarize some of these in the following points.

1. *Awareness is implicit.* Awareness is not a deliberate act that people perform to find out, for example, where their colleagues are. It is also not a particular mental state or a type of activity, rather, it is an integrated aspect of people's practice. As researchers, we can only access awareness indirectly, through the analysis of space, mediators, and human conduct and culture [22]. In coordinative work scenarios, people become aware of each other's acts implicitly and without negotiation or other forms of focused interaction, that it is as if their distributed activities are 'seamlessly' integrated. As Heath and Luff [106] showed in their London Underground control room study that co-workers' 'overhearing' supported a kind of awareness between controller and divisional information assistants which lets them coordinate and control their ongoing work.

2. *Awareness is a skillful practice.* Even though awareness is an implicit phenomenon, it is not the product of passively acquired information. It is a class of highly active and highly skilled practices. Actors scan for certain cues and traces of the state of an ongoing work that could help them understand what is happening and inform their future activities. It is an attribute of observable action that is systematically accomplished during the course of actors' everyday activities. Actors apply skillful ways to design and produce actions to render features of their conduct selectively available to others. These actions may be intended for selected persons or for all the co-located people in general. The ways in which individuals accomplish awareness is inextricably embedded in the activities in which they are engaged, and the ways in which those activities necessarily entail particular practices and procedures.

3. *Awareness is about displaying and monitoring.* The ways in which cues, traces and indications of work-related activities are 'displayed' and 'monitored' are central to awareness. In fact, displaying and monitoring are complementary aspects of awareness. On the one hand, actors typically adjust and design their own activities in such a way that their co-workers and other relevant personnel are provided with cues, traces and other kinds of resources that may be relevant for ongoing activities. This particular attribute of their practice can be called 'displaying'. On the other hand, actors scan, observe, or listen to the activities of their colleagues to be able to determine the state, progress and direction of ongoing activities. This aspect of their practices can be called 'monitoring' Displaying and monitoring are thus complementary aspects of the same coordinative practices.

4. *Awareness is about 'exploiting what is already there'.* In supporting awareness about their co-workers and the status of an ongoing work, actors try and gather cues, traces and indications from established practices and the current state of their ongoing work. They do not put extended effort into exploring awareness related information, they try to infer from a giving status of the environment. This way awareness is 'ongoingly' achieved in collaboration with others. Awareness is awareness of actions and changes in the state of work (or any other situation).

5. *Work and workplace settings determine awareness.* When engaged in a cooperative effort, actors are objectively and materially interdependent. Their interdependence inescapably has causal aspects, and their actions and interactions are thus both intentional and material. The physical setting of a workplace and the nature of a particular work afford as well as constrain awareness. Workplace settings support awareness among a group of people via visual, audible and movement-based cues. Heath and Luff [108] utilized the notion of 'centers of coordination' (originally coined by Suchman [227]) to refer to specific work settings (E.g. control rooms) that have particular characteristics which make it necessary for individuals to ongoingly monitor each others' conduct whilst engaged in distinct but related activities. The nature of work itself also plays an important role in supporting or hindering awareness. The work of architects, engineers and designers would be represented externally in the form of artefacts such as sketches, drawings and 3D models, whereas the work of accountants and stockbrokers will be represented in the form of papers, excel sheets and in other digital forms. As Schmidt and Wagner [207] points out these artefacts play an important role in supporting awareness and coordination amongst a group of co-workers.

2.2.2 Awareness: An experience-focused perspective

Some of the early examples of awareness systems focused on conveying instrumental and productivity-oriented information such as co-workers' presence [54, 181], activity levels [187], their constant updates [235], availability [115] and privacy concerns [180]. In fact, Gross and colleagues' [94] comprehensive review on 'awareness in CSCW' focuses on the very productivity and task-based issues of work environment. So, how can we conceptualize awareness and awareness systems from an 'experience-focused HCI' perspective?

I believe that from an experience-focused HCI perspective awareness should be seen in a holistic sense and not limited to conveying utilitarian and practical information. By this I propose to look at the non-instrumental activities and practices that have 'value' for the overall experience in work environments. These non-instrumental issues can be about pleasure, enjoyment, playfulness, creativity and so on depending on the situation and field of work. While designing awareness systems, we need to take into account these non-instrumental aspects of people's everyday lives in addition to utilitarian and instrumental aspects of work. Secondly, awareness should not be seen in a pre-deterministic fashion. It should be seen as a situated prac-

tice that may differ depending on the environment. Importantly, people should be seen as entities that actively construct and maintain awareness information. Hence, an awareness system should be seen only as a mediator for people to support their awareness practices and not as the creator of awareness information. An awareness system should facilitate interpretive and usage flexibilities. By interpretive flexibility, I mean to suggest that an awareness system should leave room for people to interpret the awareness information and not make decisions for them. By usage flexibility, I mean to suggest that an awareness system should allow people to adapt the technology to support their individual uses. Thirdly, to be able to collect information about awareness activities, I believe that we need to develop the thick descriptions [86] of people's interactions with others, which should have detailed and rich description of the overall context in which the interaction takes place. In particular, specific attention should be given to the situated practices of people. The essence of situated action is that an experience is changed by the context in which it occurs.

This description on 'experience-focused HCI' to design awareness systems may not be seen as canonical. User experience has several connotations and I have tried to use my own understanding of user experience to design for awareness.

2.3 Awareness Systems

There has been a considerable amount of work done on developing technologies to support awareness between co-workers, family members and even friends. Gross et al. [94] and Rittenbruch and McEwan [193] have provided extensive commentaries and reviews of different types of technologies that have been developed to support awareness. I do not provide such an exhaustive review here. Instead, I have carefully selected specific examples that should provide a glance into the diversity of awareness systems. Within these examples, I will also provide an analysis of their focus on the notion of awareness. Since, both of my design cases are related to workplaces, my focus will be on the awareness-supporting technologies in work environments. However, since my focus is on designing awareness systems from an 'experience-focused HCI' perspective, I will also describe examples from non-work situations. From these examples, a shift from usability and productivity-focused awareness systems to 'experience-focused' awareness systems should be recognized.

2.3.1 Media Spaces

Media spaces (figure 2.1) are a set of technologies that use audio and video channels to connect distantly located sites and workplaces. The aim of media spaces is to provide an 'always-on' audio-video link between remote co-workers so that they can have 'informal' discussions and chats any time they want. Research into the media spaces was motivated towards supporting informal communication between geographically separated employees by providing an always-available view of their respective public areas. The basic motivation here was to create a feeling in employees as if they were all in the same area. Examples of such media space applications were seen in the form of systems such as Portholes [54], RAVE [85] and Kasmer [17] at Xerox's US and UK laboratories; VideoWindow [69] and Cruiser [70] at Bellcore; Montage [232] at Sun

Figure 2.1: Examples of the Media space application developed at the Xerox PARC (Source: [17]).

Microsystems, and CAVECAT system [161] at the University of Toronto, among other media space applications. This raft of media space applications with different audio-video communication setups suggests that visual access can provide for new forms of interaction and increase sense of presence between remote sites, which may eventually lead to positive and productive outcomes. Although the notion of awareness was not explicitly emphasized in earlier media space systems, the commentary of Bly et al. [17] suggests that supporting peripheral awareness was the most important use of media spaces.

The research in media spaces caught a lot of attention from the CSCW community and different adaptations on the original concept were developed. For example, in the RAVE [85] system each person was equipped with audio and video devices that connected him or her to other offices and common areas. In this case, users could select the area they wanted to have displayed on their monitor with a videophone connection that could be initiated by one user to connect with another users. The Montage [232] used the metaphor of hallway, where participants could navigate in the virtual hallway and glance into other's offices. This glance could provide a good impression of whether the other participant was approachable or not. Participants could also put signs at their doors to provide others an idea of their availability.

Researchers also pointed to several shortcomings of media space applications. Heath, Luff and Sellen [107] argued that in many instances what was required of a video link between spaces was not the talking heads communication link, that many of the media spaces supported, but also access to objects of interest. The same argument was also raised in Schmidt's [203] critique on the awareness research. Another shortcoming was that media space applications afforded interactions and working practices that were largely different from the natural and existing models of interaction and the comparison between the two was very difficult. Most importantly, Sellen and Harper [214] pointed out that media space applications were being deployed and assessed within the context of research laboratories of hi-tech companies. These applications were not deployed and assessed in actual everyday working environments.

Overall, the media space applications can be broadly considered as supporting informal awareness between a set of remotely-located participants. Informal awareness is the foundation for casual interaction, which in turn proves to be vital for support-

ing ongoing collaboration. This informal awareness can contain information of work colleagues, their presence, activity and availability.

2.3.2 TeamWorkStation

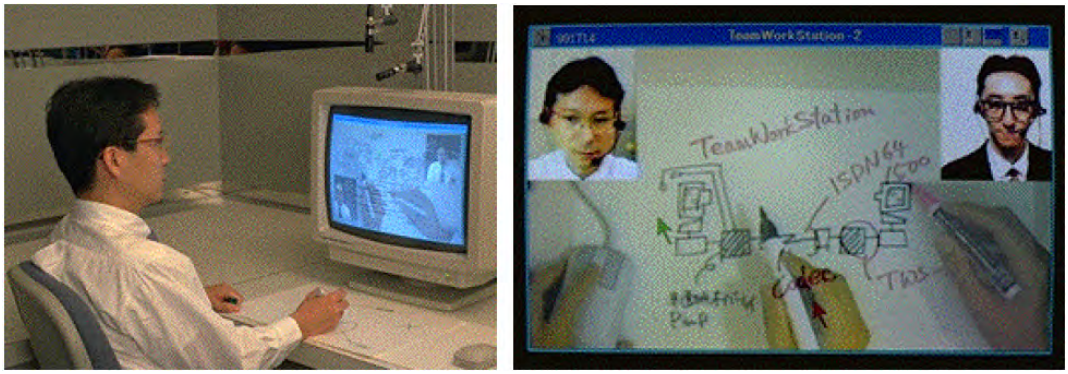


Figure 2.2: Setup of the TeamWorkStation 2. (Source: [126]).

One of the main criticisms of media space technologies was their lack of focus on artefacts or objects of discussion between the remotely located participants. TeamWorkStation (TWS) (figure 2.2) was one such application that particularly paid attention to supporting shared view on objects [126]. TWS belongs to a category of systems that support collaborative physical tasks between distant co-workers. A collaborative physical task involves two or more people working together on physical objects in the real-world [78]. Different applications have been developed using such an approach to support collaborative drawing and sketching [179], bicycle repair [145], product design [259] and so on. TWS supports collaborative drawing and sketching and discussions related to them. Figure 2.2 shows a version of TWS where a shared screen is used to represent the common artefact – a drawing sheet between the two participants. This shared screen was supported by an additional video channel that showed both participants' faces and an audio channel to complement these modalities to support synchronous communication. The key ideas of TWS were the overlay of individual workspace images in a virtual shared workspace and the creation of a shared drawing surface. TWS supports awareness through the image of hand and pen movements of drawing partners that is overlaid with the image of shared drawing papers. Although the actual drawing sheet is only available to one of the participants, the changes and annotations made on the sheet are equally visible to both the participants. Importantly, a remote participant (with no direct access to the drawing sheet) can point to specific portions of the drawing and make gestures and could also make annotations in a way that would not affect the drawing sheet but can still communicate certain ideas to the participant on the other end. For the remotely-located participants, the most valuable aspect of TWS's setup was being able to do things simultaneously.

One of the problems with TWS systems was that participants could not have a seamless gaze contact. In fact, they had to decide either to look down at the drawing sheet or to look at the computer screen to see the other participant's face. This defi-

ciency was later remedied by systems called ClearBoard-1 and ClearBoard-2. Details of the TWS and ClearBoard systems are described in detail in [126].

Overall, TWS (and other systems that focused on collaborative physical tasks) played an important role in supporting real-time awareness of co-workers' activities where the collaboration was centered around physical objects.

2.3.3 Informative Art

The previous two examples of awareness systems focused on supporting real-time and simultaneous awareness of co-workers activities by utilizing video and audio channels. Here, I will describe an awareness system that uses artistic visualization to support awareness. Informative Art (figure 2.3) is a set of artistic installations situated in the common area of a research institute [190]. These displays represent generic information related to the work organization such as email and web traffic, bus timetable, weather information and so on in an artistic and abstract manner that informs co-workers about the 'global' view of their institute. Figure 2.3 visualizes email traffic of individual workers in the institute using the Mondrian compositions as inspirations. The transformation from 2.3a and 2.3b shows the growth in the email traffic. Each colored field represents the e-mail traffic for one person in the group. The size of the square grows and shrinks with the aggregate amount of e-mail that a person has sent and received during the last few days.

Figure 2.3: Situated informative art displays installations. The email and web traffic to and from the organization is represented using a Mondrian composition. (b) shows the changes from the beginning stage of (a) (Source: [190]).

The Informative Art installations are developed using Mark Weiser's [264] notion of Calm Computing. The idea here is to create such information presentations that disappear into the background when they are not used and people should be able to perceive a greater amount of information available from the environment without overburdening their cognitive or other skills. Since, these displays visualize the current situation and ongoing activities in the organization, it helps members to *reflect*

on the environment. Unlike information that is visible (or 'publicly available' [106]) from the environment, communications by email exchange, web usage and so on are invisible to most the members in a group. By presenting cues for such information, the researchers here have aimed to complement the information that is already available. One of the advantages of using artistic and abstract representation to deal with awareness was its support for privacy issues. Since the information presented on the display has a global view about the environment and is presented using artistic patterns, it does not raise privacy concerns among members. There are other examples of such systems that use abstract representations to convey complex information for supporting awareness and better cognition. Pedersen and Sokoler's [181] AROMA is one such example.

2.3.4 Hello.Wall

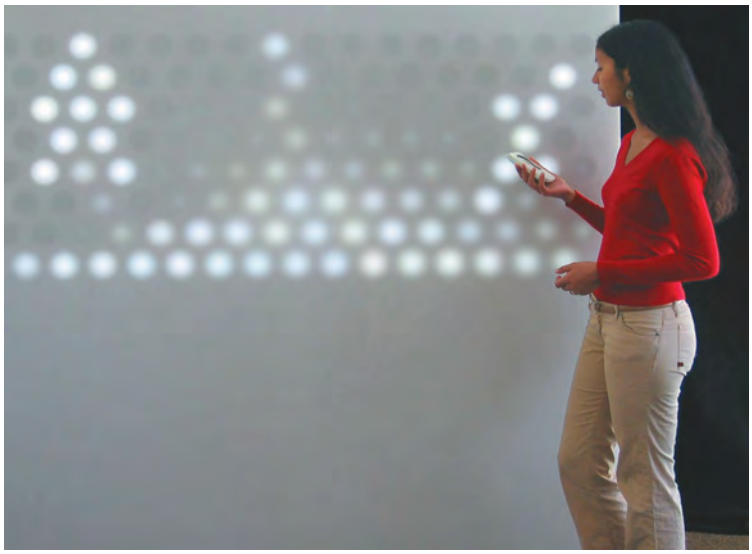


Figure 2.4: Display of the Hello.Wall system and a person interacting with it using a device called Viewport. (Source: [225])

In line with the previous example, Hello.Wall (figure 2.4) is also an ambient awareness display technology that uses abstract patterns to provide awareness of different activities between two remotely located work places [225]. It is a wall sized display that emits information via different light patterns. It works in two ways. It represents the organization-wide information publicly and information addressed to individuals privately to communicate detailed information with the use of a set of Viewport devices. The environmental information such as people's presence, activity levels, attitude, atmospheric information, and so on are mapped onto visual codes realized as light patterns which influence the atmosphere of a place and the social body around it. The patterns are distinguished from the following three categories:

1. ambient patterns representing general information such as mood and presence;

2. notification patterns handling individual or personalized messages; and

3. interaction patterns handling direct communication requests, such as a request for engaging in a spontaneous video communication with a remote team member.

The Hello.Wall display represents unobtrusive, calm computing technology that exploits people's ability to perceive information via codes that do not require the same level of explicit coding as with words. It can stay in the background, only perceived at the periphery of attention. In addition to its informative role, Hello.Wall also serves as an atmospheric decorative element, where visitors may enjoy its aesthetic quality. Since Hello.Wall abstracts information and has a separate level for private communications, it takes care of the privacy related concerns. One of the main differences between Hello.Wall and Informative Arts display is that the latter is meant for co-located environment with an aim to reflect on the ongoing activities. Whereas the former is meant to convey awareness of distantly located workplaces by providing a continuous exchange of information about the availability of people and to provide a starting point for initiating spontaneous video-based communication between the two remote sites.

Overall, Hello.Wall conveys awareness cues both as global and individual levels using light patterns. It creates a social architectural space using means beyond traditional architectural elements, furniture, or standard information technology. It introduces a level of social experience in work environments that has aspects such as play and curiosity.

2.3.5 Hermes

Figure 2.5: Hermes in an office corridor. (Photo courtesy of Alan Dix)

The Hermes system (figure 2.5) is a network of small interactive display units mounted outside different offices at the computing department of the Lancaster University, UK [39]. The office owners can leave messages for people visiting the office

and visitors can leave messages for the office owner. Messages can be in a textual or a graphic (picture or a note written via stylus) form and can be created on the display itself, via Hermes webpage, an email client or an SMS text message. This message is visible on the door display as its original form. Once entered onto the Hermes display, these messages are not made visible to other passers-by. In this case, Hermes only shows the last message from the owner on its screen. This way the visibility of the display is controlled to give priority to the owner's message that is meant for a wider audience. Additionally, it also serves for maintaining a level of privacy.

Researchers at Lancaster University carried out several field trials of Hermes and iteratively made improvements on the design of Hermes. Till date, Hermes has been used in home environments and public spaces such as community libraries with required adaptation, in addition to its original use in the workplaces. From a field trial [38] of Hermes in the office space, the researchers explored different ways office owners and visitors appropriated the use of Hermes to support awareness in their department. The common patterns of messages were about providing status updates of current activities in an attempt to maintain a sense of presence. One common use for messages set on Hermes door displays was to provide a sense of presence when away from the office:

—'Working at home today – reviewing papers.'

In other cases, Hermes was used to express the mood and current situation of a worker. This was mainly done by office owners to indirectly indicate their mood and mental situation. In some cases, members also left messages providing reasons for their absence from their offices so that others could adapt or reorganize meetings, for example.

Overall, Hermes provided asynchronous support for awareness information between workers in a co-located work environment. Importantly, it supported multiple sources such as the web, mobile phones, as well as physically being at the office door and writing messages.

2.3.6 Whereabouts Clock

Figure 2.6: The Whereabouts Clock (Source: [212, 28]).

The Whereabouts clock (WAC), figure 2.6, is a location-aware technology meant for domestic environments developed at Microsoft Research in Cambridge, UK [212].

The idea of this device was derived from the famous children's novel Harry Potter and The Chamber of Secrets by J.K. Rowling. Rather than telling the time, this clock indicates the locations of family members from a set of predefined locations: Home, School and Work. The information about location is tracked through the GPS signals of an individual's mobile phone and the family members are represented with a picture inside a small token on the LCD display of the clock (see figure 2.6). The change in a member's geographic location is also represented on the clock. The tokens in the center of the clock show that a person is currently in between locations. WAC is a situated display meant for a common area of a home such as the kitchen, where it can become a part of the routines of households. It is an 'always on' display, running in the periphery of vision just like a normal clock. WAC provides an interface that can inform where members of a family are located at a certain time by giving 'at a glance' information. A final feature of the Clock was the ability for family members to send text messages from their mobile phones to the Clock at home.

A set of field trials of the system were carried out in different households. In the most recent field trial [28], the researcher explored that by making the household aware of each other's locations, WAC helped them to coordinate different domestic activities. By conveying information about their location and activity to one another, users can make decisions and better plan their activities. WAC also supported aspects that were much more sentimental and experiential in the domestic lives. For example, the use of WAC revealed that it was seen as a device that provided social touch, reassurance of member's well being and safety and supported connectedness between family members.

Functionality wise, WAC is a simple application that shows, all the times, where different family members are located. But, as shown in the field trials of WAC, WAC showed a different facet of awareness in the domestic environment that was experiential and sentimental in nature.

2.3.7 Family Portraits

Family Portraits (figure 2.7) is a digital photo frame that allows adult children to monitor the activities of aging parents who are geographically separated [170]. The photo frame displays the state of the parent as abstracted icons surrounding a static photo of the parent in a frame, as shown in figure 2.7. Data related to the aging parent (such as health, activity, relationship, environment and event) is collected from his home and the 'qualitative' representation of this data is presented in the surrounding of the photo frame. This data is updated once a day. The idea behind this system is to notify the activity level of aging parents to their children, where inactivity may indicate health problems. The researchers conceptualized such a design for their display with an assumption that the distant person with an appropriate level of activity awareness that provides people with comfort without being privacy intrusive. Family portraits can be seen as a surrogate system in the form of mediated awareness support intended to ascertain certain aspects of the naturally occurring social encounters that are disrupted due to the geographic separation. The photo frame can be placed in any domestic location, where people may think about their loved ones, for example on a mantelpiece in the living room.

Figure 2.7: The digital family portrait application. (Source: [170]).

Overall, the Family Portrait application presents a lightweight approach to support awareness between family members. It provides a review of the day-by-day activities of an aging parent to her adult children in an abstract manner that could provide a 'peace of mind' for adult children.

2.4 Summary

The aim of this chapter was to provide a background on awareness research, by providing the conceptualization of awareness and reviewing the existing technologies that support awareness – the awareness systems. This is clearly not a complete and exhaustive review on the research of awareness. Importantly, from the small set of literature review given in this chapter, we can see several interesting patterns for designing awareness systems. Media space technologies utilized the 'always on' strategy to support and facilitate continuous, informal awareness between the remote participants. Ishii's TWS system showed a novel way to support real-time collaboration involving physical tasks. The strategy of image overlay provided a good support for collaborative task-based awareness. Informative Art and Hello.Wall technologies utilized abstract patterns to convey awareness in co-located and remote settings, respectively. In particular, Hello.Wall treated the use of the display as a decoration piece in the offices. This way, both technologies addressed privacy concerns. Hermes attempted to utilize both the co-located and remote awareness by using an asynchronous situated display technology. The Whereabouts Clock and the Family Portraits systems were designed to support domestic environments. Both systems showed emotional and sentimental values that were supported through awareness systems.

From this review, I have noted some important issues that should be considered for designing awareness systems that use experience-focused perspective. One has to take into account the 'larger effects' of situating an awareness system in a particular context and the 'value' it brings to its users. The examples of Whereabouts Clock and

Family Portraits showed that awareness systems did not only make their users aware of people's whereabouts and their presence, respectively. As the field trials of both these systems showed, these awareness systems supported emotional and sentimental issues such as reassurance, peace of mind, social connectedness and so on. The installations of Informative Art and Hello.Wall also hinted at the larger effects of experience of co-workers. Whereas the TWS system focused on supporting a particular task-based activity. One of the ways we can incorporate these larger effects and values is by taking into account the 'broader practices' of people who will use these awareness systems. So, not just focusing on supporting specific tasks but a larger spectrum of their everyday activities. The next issue is to provide an 'open ended support' to awareness systems and let people adapt and invent new ways of using them. For example, the field studies of Hermes showed that the technology was used in more than one way and people invented new ways of using such a technology. A trial of an experimental Media space application that I was involved in showed that people used personalized and animated gestures and external artefacts to support remote conversations [259]. A view such as this considers 'people as active participants' who can influence the use of the technology as much as the technology can influence the behaviors of people. I will carefully take these issues into account when designing awareness systems in parts II and III of this thesis.

3

Theoretical Frameworks for Understanding Group Work

3.1 Introduction

As technologies are becoming part of our everyday lives, the context in which these technologies are used become an important aspect in design. Over the last three decades, it has become a common practice to use approaches that provide an understanding of contexts to inform design of technologies. Since, my research focuses on workplace environments, the use of theoretical frameworks, to explore the relevance of these contextual issues and to understand group work, is going to be an integral part of my research. In this chapter, I will consider the major and most used conceptual and theoretical frameworks to understand and study the context – in which the systems to be designed are inhabited.

3.2 Theoretical Frameworks

Although it was made clear in the introduction that I will be using ethnomethodological orientation in my fieldwork, it would be important to review existing theoretical frameworks for studying context and group work. I will briefly describe the following frameworks and approaches. This is not a complete list of frameworks, but these are widely known and used within the fields of HCI and CSCW. These also come close to my research goals.

1. Activity Theory (AT)
2. Distributed Cognition (DCog)
3. Grounded Theory (GT)
4. Participatory Design (PD)
5. Ethnomethodology (EM)

3.2.1 Activity Theory (AT)

Activity theory was developed within the domain of psychology and education in the former Soviet Union [154]. It is a flexible conceptual framework, rather than a theory per se. The purpose of AT in its original Soviet context was to explain cultural practices (such as work or school) in the developmental, cultural and historical context in which they occur, by describing them in terms of 'activities'. Because of its flexible nature, AT has been adopted to investigate activity from a varied set of domains. These include studies of user interfaces for systems to be used in newspaper production [21] and medical care in hospitals [62] together with shaping the design of educational technology [12] and groupware [72].

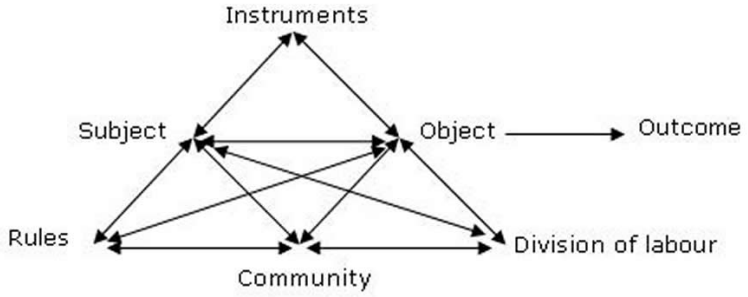


Figure 3.1: Activity System proposed by Engestrom [61].

AT was originally developed to account for individual cognitive activity. The work of Engestrom [61] shifted the focus to collaborative activities. Within this approach, the unit of analysis is the collaborative activity. Figure 3.1 shows the activity systems proposed by Engestrom [61]. Here, an activity is conceptualized as a system that comprises several elements: subject, object (or motive), rules, community, roles (division of work), tools and outcome. An activity is actually a systemic whole in the sense that all elements have a relationship to other elements. This systemic model, contains three mutual relationships between subject, object, and community. The relationship between subject and object is mediated by tools, the relationship between subject and community is mediated by rules, and the relationship between object and community is mediated by the division of labor. These three classes should be understood broadly. A tool can be anything used in the transformation process, including both material tools and tools for thinking. Rules cover both explicit and implicit norms, conventions, and social relations within a community. Division of labor refers to the explicit and implicit organization of a community as related to the transformation process of the object into the outcome. Each of the mediating terms is historically formed and open to further development.

The usefulness of AT for HCI was that it was considered a useful tool for designing user interfaces and computer systems based in the work settings in which they were to be used [21, 171]. Another assumption behind bringing AT to HCI was that the theory could provide the contextual background that would allow a technology to be designed and implemented that better suited workers in their work settings. In sum, the main role played by theory for AT is analytic, providing a set of interconnected

concepts that can be used to identify and explore interesting problems in field data.

3.2.2 Distributed Cognition (DCog)

The distributed cognition approach was developed by Hutchins [120] and his colleagues in the mid to late 80s and proposed as a radically new paradigm for rethinking all domains of cognition. A prominent follower of the DCog framework, Rogers [197], argued that what was problematic with the classical cognitive science approach was not its conceptual framework per se, but its exclusive focus on modeling the cognitive processes that occurred within one individual. DCog describes and explains group cognition with the goal of understanding how collaborative work is coordinated. DCog is thus a prominent candidate for providing core concepts in understanding and designing for collaborative (mediated) group-work.

An important aspect of the DCog framework is that cognition does not belong to the mind of people but it is socially distributed. In DCog, the unit of analysis is the cognitive system – formed by humans and artefacts together. This cognitive system is distributed between humans (internal representation in the minds of people) and artefacts (external representations). Both humans and artefacts are considered as agents within the cognitive system and they both have the same functions – representing and processing information. The framework conceptualizes cognition as an emergent phenomenon within the functional system. This means that cognition is a product of the interactions amongst agents of the system. Although the DCog framework acknowledges the role of individuals (e.g. humans), its focus is on the combined and cooperative effects of all of its entities. The extension of cognition from a single entity to a distributed system allows the researchers to study the individual in relation to its environment.

The distributed cognition approach has been used primarily by researchers to analyze a variety of cognitive systems, including airline cockpits [121, 122], air traffic control [98], call centers [3], software teams [74], and engineering practices [196]. One of the main outcomes of the distributed cognition approach is an explication of the complex interdependencies between people and artefacts in their work activities. An important part of the analysis is identifying the problems, breakdowns and the distributed problem solving processes that emerge to deal with them. In so doing, it provides multi-level accounts, weaving together *"the data, the actions, the interpretations (from the analyst), and the ethnographic grounding as they are needed"* [121, p.19].

One of the major criticisms of the DCog approach has been about its application in the real world settings. Nardi [172] has criticized DCog for its dependence on extensive fieldwork before being able to come to any conclusions or design decisions for a given work setting. Furthermore, she points out, that compared with AT, there is not a set of interlinked concepts that can be readily used to pull things out from the data. As such it can never be viewed as a 'quick and dirty' prescriptive method. The emphasis on doing (and interpreting) ethnographic fieldwork to understand a domain, means that at the very least, considerable time, effort and skill is required to carry out an analysis [197].

In sum, the DCog approach can inform design by allowing researchers to under-

stand how information represented in a variety of media might be transformed and how this might affect the work practices. The DCog approach is largely descriptive and less generative. It does provide detailed information about a cognitive system to be able to provide the basis for generating design solutions.

3.2.3 Grounded Theory (GT)

Grounded Theory is a research method that works almost in a reverse fashion to any other traditional approaches and may appear to be in contradiction of the scientific method. The basic premise of using GT is in the systematic generation of theory from data (often the field data) that contains both inductive and deductive thinking. The grounded theory approach, according to Strauss and Corbin [222], is a *"qualitative research method that uses a systematic set of procedures to develop an inductively derived grounded theory about a phenomenon."* The methodology is designed to help researchers to produce 'conceptually dense' theories that consist of relationships between concepts representing *"patterns of action and interaction between and among various types of social units"* [222].

Rather than beginning by researching and developing a hypothesis, a variety of data collection methods are the first step. Sources of data for developing grounded theory include interviews and field observations, documents, and videotapes [222]. From the data collected, the key aspects are marked with a set of codes, which are extracted from the text. The codes are then grouped into similar concepts, from which concepts categories are formed, which are then used as the basis for the creation of a theory. A unique aspect of grounded theory is the fact that data collection (or sampling) and data analysis are undertaken simultaneously, and not sequentially as in many traditional methods [200]. At the heart of the grounded theory methodology, are three coding procedures that Strauss and Corbin [223] refer to as open coding, axial coding, and selective coding. These codes are generated and validated using the constant comparative method, and coding, at each stage, terminates when theoretical saturation is achieved with no further codes or relationships among codes emerging from the data. GT emphasizes the need for the researchers to be immersed in data and the need to consciously guard against imposing a theory in a related substantive area that does not actually match the patterns in the data [89].

A growing importance of GT is seen in HCI [19, 192, 46]. One of the reasons for this is that GT can be quite valuable in exploring new domains or domains without any strong theories. And since HCI is incorporating new domains every year (e.g. human-food interaction [91]), GT can be an important approach for researchers. On the other hand, it is certainly not useful if one needs to test a hypothesis.

3.2.4 Ethnomethodology (EM)

Ethnomethodology is an analytic framework that was originally developed as a reaction against the traditional approaches in sociology, which were largely top-down theories geared towards identifying invariant structures [79, 80]. Its roots lie in a re-specification of the objectives of sociology. EM's primary claim is that individuals do not, in their day to day behavior, act according to the rules and relationships which

sociological theorizing lays down. The structures, regularities and patterns of action and behavior which sociology identifies emerge out of the ordinary, everyday actions of individuals, working according to their own common-sense understandings of the way the social world works. The analytical focus of EM is sensitive to the ordinary, practical commonsense reasoning procedures which make up people's understandings of social life, the resources they use to make sense of aspects of the social world.

Similar to the DCog approaches, EM has been used to explicate the details of various work practices through which actions and interactions are achieved. The EM approach has been used by a range of researchers studying work in collaborative settings such as stock trading rooms [105], print shops [26], and air traffic control rooms [116]. These accounts of work practices are presented largely as *thick descriptions* [86]. By this it is meant to produce extensive and very detailed accounts. The detailed accounts have proved to be very revealing, often exposing taken for granted working practices, which turn out to be central to the efficacy of how a technological system is being used. The exclusive focus on the actual situated order of the social world is the defining feature of EM. The exclusive emphasis on the unique features and lived sense of the activity define EM in a contrast to normal social science. Because the ethnographic stance stresses the importance of context or setting, and thus that there can be no theoretical perspective which can explain in advance what one is likely to see in a new setting, nor any data which constitute the 'right' data to be collecting, this raises a data collection and organization issue [189].

Like any type of ethnographic inquiry, EM-informed fieldwork seeks to study people and their work practices in their natural environments. However, EM represents a particular kind of ethnography with a specific focus. EM, as Button [33] puts it, *"shifts the emphasis away from the production of sociological accounts and theories of social doings to an emphasis upon the description of the accountable practices involved in the production of naturally organized phenomena".* EM is an analytical sensibility that helps in extracting everyday social issues from the point of view of the people who inhabit it. A distinctive feature of EM has been a focus to investigate, describe and understand how work (or any other type of specific practical interaction) is 'ordered', without using any theory, assumptions or preconceived notions. How the order or work is achieved and manifested is EM's primary subject matter for investigation. In particular, EM's analytic attention is directed towards the circumstances of action for evidence, where individuals used specific methods to achieve stable social order.

In sum, EM carries little or no theoretical baggage. It focuses on the mundane and practical ways in which people make sense of what they do. And it emphasizes the moment-by-moment, sequential organization of their activity.

3.2.5 Participatory Design (PD)

Participatory Design [90] is a design approach that actively involves all the stakeholders in the design process to ensure that the product designed meets the needs of its stakeholders. The stakeholder can be anyone who is going to be affected by this product, such as designers, engineers, end users, or government. PD is commonly associated to Scandinavia, even though it has been a widely used approach around many parts of the world. PD can be described in terms of a set of analytic

and constructive commitments to be able to reflect the general beliefs of the world. Blomberg and Kensing [137] point out that PD projects commonly have three facets: 1) a perspective on the politics of design; 2) participation; and 3) methods, tools, and techniques used.

PD recognizes the fact that in organizations the culture and work practices of people have been seen as deeply relevant to design, in particular in the western world. And people's 'resistance to change' is an important impediment to the systems implementation. There is also the aspect of 'unionism' by which the owners and proprietors of organizations are bound to take into account the discomfort of workers using technologies. PD solves this issue by involving participation from different stakeholders to have a consensus-led and inclusive approach to design. Using participation, PD solves several social problems such as improving the overall knowledge base in design, developing realistic expectations from a technology and increasing workplace democracy. Most importantly, as Randall et al. [189] claim, PD pushes ethnographers towards a more 'active subject' stance in ways which are analogous to sociological interests in a standpoint theory. In combination with establishing close understanding with participants, questionnaires and interviews also have been used to gain a view of the relations between technology and work across organizations. One of the most fascinating aspects of PD is that it allows a variety of methods, tools and techniques to be used. Prototyping methods [137] such as scenarios and mock-ups are common ways to apply PD. Importantly, these techniques allow workers and designers to more easily experiment with various design possibilities in cost effective ways.

In sum, PD, unlike the other approaches described here, is quite explicit about making changes. It is an interventionist approach that utilizes users and other stakeholders in the design process, up-front.

3.2.6 Summary

There are other well-known conceptual and theoretical frameworks and approaches such as external cognition [201], situated actions [229], ecological approaches [87] and actor-network theory [148, 36], which I did not report here because they share similar characteristics with the approaches that I have reported in this chapter. From the short review of the above theoretical frameworks, I would like to point out the three issues that are common to them:

1. Their focus is on context that goes beyond one user, but different conceptualizations of context.

2. Their focus on understanding mediated and cooperative work in its naturalistic setting.

3. Their commitments to the notion of 'situatedness' of human practices.

As Randall et al. [189] suggested in their book *Fieldwork for Design*, there cannot be a direct comparison of the EM approach with other frameworks and approaches. This is simply because EM is a theory-free approach and it cannot be compared to AT and DCog that have a very strong theoretical backing. Randall et al. stated that "*[EM]*

provides no alternative to the conceptual work that is done by theories such as activity theory or distributed cognition. It stands in no clear relation to problems of, for instance, grounded theory. Rather it consists, purely and simply, in a set of analytic choices."

For selecting an appropriate approach, I was keen on an approach that was theory free and flexible, since my research was exploratory and design-oriented than a purely sociological one. Secondly, I was interested in selecting an approach that could provide me with some kind of orientation or a 'way of looking' in the field, if you like. AT is certainly a rich approach and, as mentioned earlier, it is extensively used in HCI. However, it has a strong theoretical foundation, where the unit of analysis is an activity that should be seen and analyzed using some dimensions (figure 3.1). DCog has more of a 'problem finding' angle. It can provide a detailed analysis of, for example, office work and point to problems that might have affected people's working abilities. However, its main drawback is that one can only find these problems after having carried out an extensive fieldwork. PD is an umbrella approach which allows users' and other stakeholders' active involvement in the design of the technology. Crabtree [42] has elicited several similarities with EM and PD approaches. GT and EM come very close to my interest, since both are theory-free and have an exploratory nature. In other words, facts about a setting are explored during the course of the investigation. Both EM and GT follow a bottom-up approach, where the data generated from the field inform about the facts of a given setting. There is, however, a difference between these two – where EM rejects any preconceived notions about an environment or a setting, GT does not reject them completely.

The reason for selecting EM over GT was that GT lacks an orientation. An ethnographic study informed by EM can provide a focal point to the researcher, where they can understand practices of people from people's own perspective. EM can answer 'how do people do, what they do'. It provides a descriptive account of how people go about doing their everyday things. As an HCI practitioner, I consider these descriptive accounts of people's practices to be a valuable resource for design. Utilizing these detailed descriptions, I can develop quick-&-dirty design concepts. The underlying issue here would be that these design concepts will be based on the natural practices of the subjects that I study. GT lacks such an orientation.

The main criticism of EM approaches, by Rogers [197], is that results from an EM-informed study provides 'little more than a cursory set of tepid guidelines'. What Rogers hints at here is the failure of ethnomethodologists (who come from a social science background) to bridge that gap between field data and concrete design concepts. In general, this is a valid criticism and quite observable in CHI proceedings. In my case, however, since I come from a traditional HCI field, where design is the core of my expertise, Rogers's concerns become less important. As one will find in my thesis, following the EM orientation I have not only provided 'design implications' but also developed prototypes that were subsequently tested in real-world settings. Hence, in a way my EM orientation is clearly motivated towards finding design 'concerns'. Dourish [53] has suggested in his paper titled 'implications for design' that the quality of an ethnographic study may not be evaluated based on the design implications it generates. I do not disagree with Dourish's statement. However, if one chooses to use ethnography as a tool to inform design then results from ethnography

should, to some level, inform design. Since, my goal in this thesis is to design awareness systems, generating design implications and design ideas will be an important aspect of this work.

Part II

Design Case 1: Awareness in a Department

4

Fieldwork in an Academic Department[1]

4.1 Introduction

In large organizations, social awareness is sometimes neglected in the tension between heavy workloads, time clashes, a lack of social encounters between employees, and a lack of suitable platforms that allow one to construct and convey one's identity [22]. There is an ongoing effort to design tools to support social networking and facilitate connections between employees in large organizations. Companies such as IBM have attempted to explore this phenomenon using tools such as SocialBlue (formally IBM Beehive) [267] and Honeycomb [242] in their own organization. In addition, conceptualizing playful systems in work environments also seems to be desirable to support community building and group harmony. To Gaver [83], playfulness is about creating new perspectives, ideas, and goals, and exploring new ethical and aesthetic standpoints, and not only about entertainment or spending time. Playful systems allow users to artfully express their own creativity to establish curiosity, exploration and reflection as key values.

This chapter aims at exploring the awareness practices of staff members in an academic department. However, the focus is on the non-critical and the softer side of staff members' everyday interactions, going beyond the productivity and instrumentality of the academic profession. I believe that by collecting an account of how staff members become socially aware of each other can provide some useful understand-

[1]This chapter is based on the following published papers.

1. Vyas, D., van de Watering, M., Eliëns, A. and van der Veer, G.C. (2007) Being Social @ Work: Designing for Playfully Mediated Social Awareness in Work Environments. Book Chapter in "Home Informatics and Telematics: ICT for the Next Billion". **(HOIT '07)**, IFIP, Vol. 241, Venkatesh, A.; Gonzalves, T.; Monk, A.; Buckner, K. (Eds.) ISBN: 978-0-387-73696-9.

2. Vyas, D., Eliëns, A., van de Watering, M. and van der Veer, G.C. (2008) Organizational Probes: Exploring Playful Interactions in Work Environment. In Proceedings of 15th European Conference on Cognitive Ergonomics **(ECCE '08)**, Madeira, Portugal. ACM Press: NY. ISBN: 978-1-60558-399-0.

3. Vyas, D., Heylen, D., Eliëns, A. and Nijholt, A. (2007) Experiencing-in-the-World : Using Pragmatist Philosophy to Design for Aesthetic Experience. In Proceedings of the 2007 conference on Designing for User eXperiences **(DUX '07)**. ACM, New York, NY, USA, Article 8, 16 pages. ISBN: 978-1-60558-308-2.

ing about how we can support community building in work environments through technological means. Specifically, I seek to explore people's everyday interactions within an academic department to understand the role of playfulness in it. I attempt to understand the playful side of people's mundane activities and how playfulness constitutes their social practices – an issue that is central to Huizinga's [117] conceptualization in Homo Ludens. A main question that I answer in this chapter is how we as HCI researchers can design technologies for conveying non-work related, non-critical information about staff members to enhance social awareness in an academic department. I start with a naturalistic, in-situ exploration of an academic department, using methods such as contextual interviews, naturalistic observations and an adapted version of the cultural probes [82] to understand staff members' current and aspired practices of being socially aware of others and of the environment as a whole. My approach in the fieldwork is focused on understanding social interactions limited not only to work or routine activities but also sentimental, pleasure and play related acts.

The results of the six-month long field study show that staff members' natural and aspired practices to support social awareness can be seen in two broad themes: *Self Reflection* and *Casual Encounters*. Self reflections are a varied set of attempts from staff members to represent and reflect on themselves by letting others know about their choices, preferences, identity, and other more practical information by intentionally and unintentionally making their status information, personal details, announcements and expressions publicly available in the department. Casual encounters are different activities by which staff members, during their everyday activities, intentionally or unintentionally, interact with other members and objects within the surroundings that provide hints and cues of each other's social awareness. In this chapter, I elaborate on these two themes and provide examples from the field. I believe that for supporting playfully-mediated social awareness in work environments, designers need to take into account these two themes of interactions.

In the rest of the chapter, I first provide a short description of why 'play' as an everyday natural phenomenon should be considered for work organizations. Next, I outline the background work that enabled me to conceptualize social awareness and especially focus on awareness related to non-work activities. I then provide a brief description of the methods used in the field study and details of participants. I then provide the results focusing on the two themes of interaction for supporting social awareness in work environments: Self Reflection and Casual Encounters. I provide several examples from the field to provide different patterns within these themes. Finally, I discuss the results and provide implications for designing a technology for supporting playfully-mediated social awareness within large-sized work environments.

4.1.1 Play @ Work?

"Even in its simplest forms on animal level, play is more than a mere physiological phenomenon or a biological reflex. It goes beyond the confines of purely physical or purely biological activity. It has a significant function – that is to say, there is some sense to it. In play there is something at play which transcends the immediate needs of life and imparts meaning to the action. All play means something."

– Johan Huizinga [117, p.1]

Play undoubtedly is a multi-faceted phenomenon. We in our everyday lives intentionally or unintentionally convey playfulness or become part of playful acts. One cannot limit the idea of playfulness to specific aspects. Johan Huizinga [117] in his seminal text Homo Ludens argues that 'play is older than culture' – suggesting that play has been in the world even before humans and their civilizations. Playfulness can be observed in animals too and human civilization has added no significant features to the very idea of play. To Huizinga, play is a part 'of culture' rather than part 'in culture'. He extensively discusses the importance of play elements of culture and society and explores how far culture itself bears the character of play.

Since the industrial revolution, 'work' is seen as vastly different from 'play', as the praise for efficiency and rationalization has increased [268]. However, a recent article in Business Strategy Review suggests that a playful work environment can help in evolving the creativity and innovation processes of a company [158]. People not only like to play at work, but they also play in order to make sense of their time and space at work, to socialize with their peers and to construct an identity for themselves. Historically, the role of play in organizations has been evident. Successful companies such as Disney, Ferrari, Harley Davidson, Apple and many others were born not from sophisticated business plans but from the pure passion of play. With the growing business competition from others, companies such as Google, Gore and Motorola encourage their employees to use up to 20 % of their work time to play freely with new ideas.

The field of Human-Computer Interaction (HCI) has embraced playfulness in the last few years. In fact there are several concepts related to playfulness, such as computational humour [118], ludic design [83], funology [20], ambiguity [84], provocative and curious interactions [11]. Within HCI, Gaver [83] describes that playfulness is about creating new perspectives, ideas, and goals, and exploring new ethical and aesthetic standpoints, and is not limited to games, entertainment or spending time. Playful systems allow users to express their own creativity to establish curiosity, exploration and reflection as key values. By playfulness I do not mean winning or losing and turn-taking with a final result. Gaming systems such as PS-2, Xbox, Gameboy or PC games are already covering a huge portion of the entertainment industry's market. But in this case, I do not see entertainment or playfulness as being limited to dedicated devices. Following Gaver [83], I see users as active and creative beings for constructing their own entertainment.

4.2 Social Awareness

I already covered a background on awareness in Chapter 2. Here, I am going to reiterate some of it to build a platform for my aim to conceptualize non-work related, non-critical awareness within an academic environment. Schmidt [203] notes that the word 'awareness' is a highly elastic English word that can mean different things in different situations. The notion of awareness in HCI and CSCW research, however, is used in increasingly contradicting ways. Whereas the original notion of awareness [106, 100, 203] was seen as an unobtrusive, implicit and skillful act to coordinate

joint efforts, recent notions conceptualize awareness as intentional and intrusive acts for conveying information to other participants of joint efforts [173]. In this chapter, I will focus on the former conceptualization of awareness. In particular, I focus on understanding awareness between different people (office colleagues, family members, friends, and so on) – commonly known as social awareness. I will provide an overview of early work on social awareness and point to new developments of the concept in non-work related situations.

4.2.1 Early Work on Social Awareness

The earlier technologies such as the 'media spaces' were used to convey informal awareness through closely coupled audio-video links between distant offices [54, 17, 85]. The main expected benefit of using media spaces was to support productivity in work environments by creating possibilities to engage in informal or task-oriented conversations from a distance and, at the same time, to have a general orientation to the presence and activities of colleagues at the other end. Although, the claim here was to support the informal side of work activities, the outcomes of these technologies hardly yielded any experiential and pleasurable benefits for employees. Awareness from this perspective is defined as a purely functionalist view. Here is a famous definition of social awareness:

"Awareness involves knowing who is 'around', what activities are occurring, who is talking with whom; it provides a view of one another in the daily work environments. Awareness may lead to informal interactions, spontaneous connections, and the development of shared cultures all important aspects of maintaining working relationships which are denied to groups distributed across multiple sites."

– Dourish and Bly [54, p.541]

Through media spaces, it was assumed that geographically dispersed office members would work as if they were at the same place. Unfortunately, these assumptions never materialized [203]. Most awareness systems developed to support the work environments focused on the very aspect of productivity in users' everyday work life. For example, in some recent examples of awareness systems [166, 190, 235] awareness is supported through indications of the presence of colleagues, availability of their biography, their project descriptions, information about their daily schedules and office calendars.

4.2.2 Social Awareness beyond Work-Related Activities

With new business needs and the emergence of novel computing technologies such as ubiquitous computing [263] and ambient intelligence [1], the focus of technologically mediated awareness has shifted from only users' work environments to their everyday interactions. The scope of awareness has extended from merely supporting productivity and efficiency related issues to conveying users' emotions, love, social status and other broader social and cultural aspects. Gaver suggests that, as the context in which these (awareness) technologies are used changes, the form and ways to interact with these technologies should also change [81].

In domestic environments these technologies are used to convey, for example, emotional connections between distant lovers [40, 134, 226, 243], awareness within families [109, 123, 234] and ways to keep in touch with family from a distance [164, 170]. In public domains, these technologies are used to establish playfulness and evocations between strangers [11, 81], developing social and cultural respect within a large community [82], and many others. Even in office environments these technologies are deployed for exchanging information about the moods and attitudes between co-workers [217, 225]. All these systems embody certain assumptions about the basic objectives for conveying awareness, the information that should be conveyed and the media through which this might be conveyed.

4.2.3 Conceptualizing Social Awareness

Bødker and Christiansen [22] suggest that social awareness is a very subtle aspect of our overall awareness, which can be accessed only 'indirectly' through a granular understanding of space, tools, human conduct and culture. Social awareness can only be felt; it cannot be seen or measured in a precise manner. To be aware of somebody we need to feel his or her presence in a somewhat temporary and subtle way. Because if the presence is too apparent, we tend to take it for granted. These authors conceptualize social awareness as a conscious feeling of belonging, relatedness, and care, prompted by the environment.

Taking a sociological stand point, Glaser and Strauss [88] argue that the phenomenon of awareness is central to the study of interaction. They termed a notion of awareness context *"the total combination of what each interactant in a situation knows about the identity of the other and his own identity in the eyes of the other's"* [88]. They suggest that to understand the awareness phenomenon it is very important to see interactions in a broader context.

Glaser and Strauss's conceptualization leads to a reflective approach, which suggests that awareness technology should allow interactants to reflect on a threeway relationship of: *"how I see myself"*, *"how I see others"* and *"how others see me."* A similar position is also taken by Bødker and Christiansen.

"for social awareness to be prompted 'I' must have the opportunity to be reflected in my environment, and 'I' must be able to see how others are reflected, just as they must be able to see the reflections of 'me'."

– Bødker and Christiansen [22, p.10]

We conceptualize social awareness as reflections that are supported by 'cues' and 'traces' of different activities in a work environment. *"A trace of human activity is recognized as 'social' when it allows someone to acquaint themselves with others without receiving explicitly expressed information about them"* [22]. These cues and traces users leave in the environment make it compelling and emotionally valuable for the next person. When the next person chooses the same environment, he intentionally or unintentionally adds his own cues and traces to the same environment that would eventually turn the physical settings into a social world. Sometimes, these vague and

low-fidelity cues and traces might be valued more for community building than bold and high fidelity cues [83].

4.3 Studying Social Awareness in a Work Organization

To be able to understand how members support social awareness within an organization, I, with the help of a master's student – Marek van de Watering, studied an academic department at Vrije Universiteit Amsterdam for over six months [256, 246]. The department was divided over three floors, where in total 6 research groups were active when we carried out our investigation. The department inhabited around 200 employees, including professors, PhD students, researchers, programmers and administrative staff. Different facilities in the department such as post boxes, printing, meeting rooms, conference rooms, canteen were divided over these three floors, although over time we observed changes in the department.

As a first step towards exploring playfully-mediated social awareness in a co-located academic department, we sought to understand staff members' current and aspired practices of social awareness within the department. We carried out an ethnographic field study utilizing methods such as naturalistic observations, contextual interviews and organizational probes [246] – an adapted version of the cultural probes method by Gaver et al. [82] and informational probes approach [43]. There were two researchers actively involved in this field study and they often corroborated the process and results of the field study during and after the course of the field study.

In the following we provide details of the methods we used and participants of our study.

4.3.1 Ethnographic Field Study

As mentioned in the earlier parts of this thesis, our ethnographic field study was informed by ethnomethodological (EM) orientation [79]. Like any type of ethnographic inquiry, EM-informed fieldwork seeks to study people and their work practices in their natural environments. However, EM represents a particular kind of ethnography with a specific focus. EM is an analytical sensibility that helps in extracting everyday social issues from the point of view of the people who inhabit it. A distinctive feature of EM has been a focus to investigate, describe and understand how work (or any other type of specific practical interaction) is 'ordered', how people make sense of their everyday activities and what approaches and methods they use to achieve their goals. In particular, EM's analytic attention is directed towards the circumstances of action for evidence, where individuals used specific methods to achieve stable social order.

Using EM orientation, we started our fieldwork in the department using the lens of 'situatedness'. By this, we wanted to explore how non-work social awareness was practiced in the department and how the situated nature of social awareness was manifested in the department. In order to do this, we focused our exploration on the following awareness categories:

– Forms of awareness
– Activities of awareness

– Agents of awareness
– Places of awareness
– Contents of awareness

Forms of awareness describe different methods of communication that are used for mediating awareness information. These can be either synchronous (e.g. face-to-face, phone calls) or asynchronous (e.g. e-mail, instant messaging tools, post-it notes). The methods for communicating awareness information can be explicit, providing direct indications or implicit ones, leaving room for multiple interpretations.

Activities of awareness describe the type of activities within the environment that could mediate awareness information. These can be task-oriented (i.e. a routine work activity) or social in nature (i.e. lunch, coffee break). Often these activities overlap so it is important to take into account the possible relationships between different activities.

Agents of awareness are the people and the objects or artefacts within the environment that mediate awareness, directly or indirectly. People can be seen as individuals and also as constituting groups (e.g. research groups). In this case it is important to understand the roles that the ethical and political issues (e.g. position hierarchy) play in contributing to social awareness. We also need to take into account the role of students in forming social awareness within our educational environment.

Places of awareness, in a broad sense, describe the geographical as well as the 'social spaces' where interactions take place, including the hot spots of interaction. This can be seen as a multi-layered concept: personal vs. private spaces of staff members within an office, a floor, a building and the whole environment. Inherent to the observations made in this category of awareness is the question: "how does the spatial layout influence the structure of interaction?"

Contents of awareness refer to the actual information being mediated through different interactions. Contents of awareness can be staff members' activities, presence, social and political status, achievements, and so on. This can be explicit (i.e. a note saying that a person will be back at a certain time) and implicit (i.e. artefacts used as symbols or the information at a 'glance'). Both are open to different interpretations by different people, the implicit content being more so.

Using these categories as a base for our exploration, we used three methods: naturalistic observations, contextual interviews and organizational probes [246]. In the naturalistic observations, we used video and still cameras to capture staff members' activities in the staffroom, the printing-room, the canteen and other common areas where social communication happened. Marek van de Watering and I spent several hours during a week and noted staff members' everyday activities and their social encounters. Using a video camera, we also followed some of our colleagues to get insights into their everyday interactions, for example, walking to the canteen, to the printer room and to the staffroom. Next, we carried our contextual interviews and arranged a probing-based study inspired by the cultural probes [82] and informational probes approach [43] with 10 participants. Eight of the participants were the current staff members with a mixture of PhD students, senior academics, administrative and PR members. We also asked two bachelors students to participate in this study to get a broader perspective. These participants were selected based on their availability

and willingness to participate in a 6 week long study.

In the contextual inquiry, we asked questions regarding participants' social dynamics. For example: What type of information would the staff members in our department like to know about other members? What types of information would they be willing to share with others? What were their privacy concerns? What common areas in the department did they use often to gather information about others? What were the common tools of communication they used outside their offices? Especially in the staffroom, what were the most common activities performed by the members and how often? And lastly, how important was being socially aware of other members in the department? The information was recorded in an audio device and written notes were also taken.

4.3.2 Organizational Probes

In addition to the contextual interviews and naturalistic observations within different public spaces of our academic department, we also wanted to get an account of staff members' everyday experiences, the impact of their work environment on their social well-being and their emotional and subjective attachment with the department. Contextual interviews and naturalistic observations could only tell us about what people did and less about how they felt, hence, we developed a set of 'organizational probes' to understand staff members' everyday experiences – a technique inspired by the cultural probes method [82] and informational probes approach [43]. Cultural probes are a collection of specialized tools containing open-ended, provocative and oblique tasks to support participants' engagement with the design process. It is an interpretive approach to generate design inspirations rather than a data collection method [24]. Our goal to build on an approach like this was to explore playful practices of people in a work environment and to enable them to participate in the design process in a readily accessible way and reflexively trigger a design dialog that correlated with their everyday experiences and needs. However, our intention to use the cultural probes method was not only to gain inspirations from the cultural situation within the department. We also wanted to get a realistic account of their everyday experiences, routines and rhythms to inform our design, as done in the 'informational probes' approach [43]. Hence, we sensitized our 'organizational probes' method to suit academic organizations in order to explore current social practices and play aspects within this setting. Organizational probes are a set of participatory investigation tools that could provide useful information about staff members' everyday experiences within their work organizations. We applied our organizational probes over a period of three weeks, in an academic department.

The organizational probes package (figure 4.1) consisted of 1) My Blog and 2) My Logbook. The package also included tools such as a disposable photo camera, postcards, maps of the building, a set of grid paper, 5 colored pencils, glue and scissors and 3 popular magazines. Instructions were also provided about when they should use the camera or other materials. The My Blog assignments had pre-attached postcards, department maps and creative metaphors to gain insights into staff members' experiences within their work environment. The postcards were specifically selected to understand staff members' social status, impressions about the overall department,

Figure 4.1: Organizational Probes.

and their feelings about working in academia. Appendix 1 shows some example questions of organizational probes. Using these materials as stimuli, the staff members were asked specific questions to give an account of their everyday experiences and feelings in the department. The questions were formed intentionally to allow an active participation of our staff members. For example, staff members were asked to describe their typical day in 10 pictures. In this way, they were asked to keep the camera with them at all times. We also asked some informational questions relating to their privacy concerns, for example. Some of the questions were intentionally provocative in nature. For example, a question such as *"I feel lonely, when..."* and then hints about the use of camera and magazine clips were given to assist participants. The department maps were provided to understand what places were really lively, annoying and productive from a staff member's point of view, as well as to identify the most visited and least visited sites. The creative metaphors were used to understand staff members' conceptualization of their groups and their own position in it. In the "My Logbook" assignment, the staff members were asked to log their activities and feelings about these activities.

We selected 10 staff members from our own academic department and asked them to complete both assignments utilizing these tools. The staff members were given the organizational probes to be completed over a period of 3 weeks. The collected data was then analyzed to get an account of staff members' everyday experiences in the department and to generate design inspirations for a new technology.

4.3.3 Participants

We invited 10 participants (4 male, 6 female) from the department for our contextual inquiry and organizational probes study. The aim here was to get personal accounts of staff members' everyday social activities and their desired practices in the department. Table 4.1 shows the details of our participants.

No	Participants	M/F	Years in the department	Work dynamics
1	Associate Professor	M	15	A fulltime associate professor. Has a small research group. Teaches 3 courses in a year and works closely with master's students.
2	PhD Student	F	1	A recently-joined fulltime PhD student. Was a master's student earlier. Works on her individual research project.
3	Senior Lecturer	F	10	A fulltime lecturer. Mainly involved in teaching. Interacts with a lot of bachelor's and master's students everyday.
4	Professor	M	26	A fulltime professor. Teaches and supervises master's and PhD students, respectively. Has been in the department for a long time and knows many people in the department.
5	PhD Student	M	2	A fulltime PhD student. Works on a national project and collaborates with colleagues from another institute.
6	PhD Student	M	2	A fulltime PhD student. Works on a national project and collaborates with colleagues from another institute.
7	Personnel Advisor	F	2	A part-time personnel advisor. Works closely with the head of the department.
8	Department Secretary	F	15	One of the secretaries for the department. Looks after 3 research groups. Deals with several people everyday. Schedules and maintains everyday activities of staff members in her groups.
9	Visiting Researcher	F	3	A PhD student who works in two different institutes. Visits her supervisor one or twice a week. Knows very few people in the department.
10	Master's Student	F	N/A	A master's student, who has been working on her thesis for a last couple of months in the department.

Table 4.1: Participants of contextual inquiry and organizational probes study.

4.4 Results

We collected a large amount of data in the form of transcribed interviews, organizational probes material, and pictures and field notes from different public spaces of the department. These data were analyzed to explore important patterns and themes. Eight staff members out of ten returned the probes completing both assignments. The remaining two participants could only finish the probes assignment partially. We categorized all interview notes, observations and probes data and used open coding [223] to draw out the similarities and differences. In the following, we elicit the factors that played a role in staff members' practices for supporting social awareness within the department. We want to clarify that although we were interested in exploring how staff members support social awareness through playful means, our investigation was

not meant for exploring playfulness, per se.

In our investigation we found two broad themes of interaction for being socially aware of others: Self Reflections and Casual Encounters. In the following, I will provide the detailed results of our study. It is important to note that these two categories should not be seen as definitive and mutually exclusive but as broad concepts for informing design.

4.4.1 Self Reflections

In the fieldwork we observed a varied set of attempts from staff members to represent and reflect on themselves by letting others know about their choices, preferences, identity, and other more practical information by intentionally and unintentionally making their status information, personal details, announcements and expressions publicly available in the department. We term this broad theme of social awareness as – Self Reflections. Staff members utilized different publicly available tools, artefacts and devices as carriers for mediating information about self reflection. These artefacts and devices included notice boards, staffroom doors, the printing room door, post-it notes attached to one's office door and other artefacts available in common areas. The purpose of self reflection varied from supporting work-related to personal and even sentimental aspects. Using examples from the field, we will describe different rationales for supporting self reflections. The activity of self reflection was mainly found in the form of asynchronous interaction, in which senders could publish their information in a physical or digital form and receivers would come across these via their habitual activities at work.

4.4.1.1 Announcements

A most prominent pattern in the self reflection theme was making announcements. We observed that in several public places such as the staffroom, corridors, the printing room, and the canteen, staff members placed information pertaining to different activities, occasions, and news. The placement of these announcements were seen on notice boards, office doors, and on other 'place holders' found in public spaces of the department. For example, on the door of the staffroom (figure 4.2) a set of informative material was placed intentionally to make co-workers aware of certain information. In this particular example, one can see indications about a staff member's win in a local marathon, an announcement of a music concert in the city, evocative educational news clips from magazines, sharing some personal experiences via holiday postcards and announcing the birth of babies by attaching playful cards. In this way the surface of the staffroom door was used as a 'tool' to support social interactions with the department by announcements. Interestingly, the purposes of such announcements are not to support any work-related activities but to, for example, provoke staff members to a discussion regarding the article from the magazine, spread 'happy' news of a staff member giving birth, announce a personal achievement of winning in a city-wide marathon, and announcing an upcoming event of a music concert in the city. The point that I want to make here is that the aim of such announcements is not simply to communicate information to others but to evoke

emotions and social belonging by representing the information carefully, artfully and resourcefully.

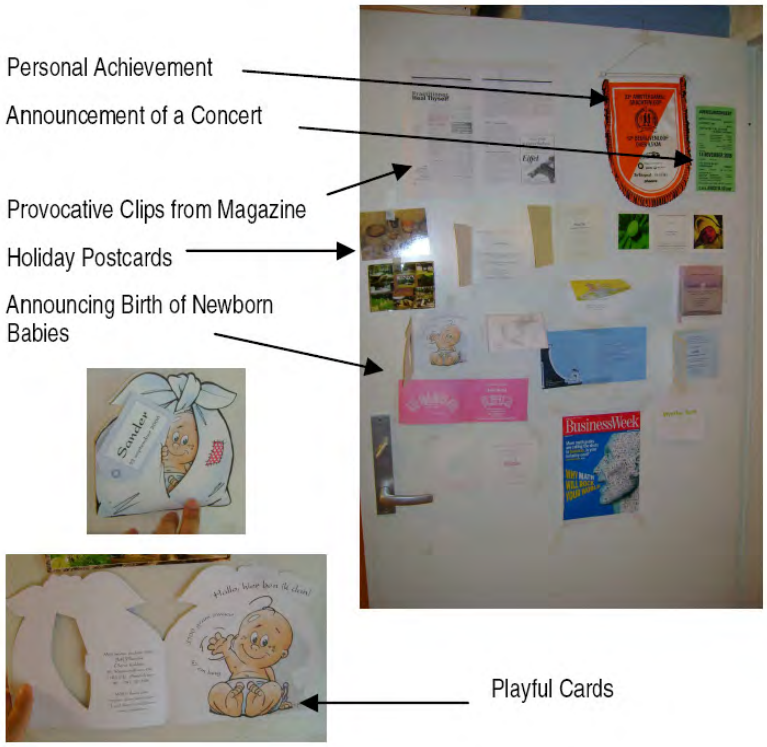


Figure 4.2: Self Refection objects found on the staffroom door.

The selection of the location, modality and representation of information, and cultural practices within the department were carefully considered by staff members before displaying such information. The staffroom was a frequently visited place within the department. In Crabtree and Rodden's [44] terms, the staffroom was a 'prime site' for supporting communications between staff members. It contained post boxes of all employees within the department, a fridge, a microwave oven, a fax machine, a small printer and of course a set of coffee machines. Hence, the staffroom had multiple facilities for the staff members. Hence, for several different reasons staff members visit the staffroom in a typical working day. Utilizing this 'multi-functional' character of the staffroom, staff members started using the entrance door of the room for placing important announcements for others. The attributes of a location affect both how suitable it is for information display and the kinds of information left or placed there. The modality and representation of announcements were also seen as compatible with the affordances of placeholders such as notice boards and office doors. The kind of informative artefacts that were seen on different placeholders had paper-like form that was easy to attach to the vertical surfaces. The portability of these artefacts was also relevant here. Although these artefacts were infrequently managed, some staff members did change and replace their announcements to make way for others or add a new artefact to the public space. The staffroom had a large physical space where some staff members come to chat while having a coffee break

or having lunch with others. It was also a common practice to go to the staffroom to celebrate birthdays or other occasions with fellow staff members. Hence, placement of announcements in such places would attract more attention. Staff members took into account the attributes of a location that would affect both how suitable it is for information display and the kinds of information left or placed there.

Overall, the staffroom door surface shows non-critical but evocative, affective and highly personal information pertaining to different staff members who chose to place this information in the public space. Some of these pieces of information were used as 'news' material and some were kept as infrequently updated information that certain staff members aimed to display in such a public location (accessible to all the employees), where it could attract attention and comments of other staff members and guests who might visit.

Figure 4.3: A notice board describing work activities and projects of a senior researcher, used for networking purposes (a), a door full of post-it notes used for notifications (b) and a message written on post-it (c).

Staff members' instrumental and work-related activities were also influenced by their everyday playful activities. We observed that announcements related to time-management, work notifications, appointment making, networking and other official announcements were done in a playful manner. Staff members advertised conference calls, research posters and group profiles in public spaces to initiate networking between different groups. In addition to utilizing the prime sites within the department, staff members also used their semi-private locations such as their office doors and notice boards close to their offices to announce different types of work-related as well as non-work information. Figure 4.3a shows an example of a notice board close to one of our participants' (an associate professor) office. He used this location to showcase the work of his research group with a large poster describing different projects he was running, his upcoming book, some announcements related to teaching and so on. Clearly, the intention for such a display is for a focused group of people, rather

than for all staff members.

The example in figure 4.3b shows an inside view of the office door of a department secretary. She managed three research groups within the department and was handling requests from several staff members at once. Professors and other staff members would come to her office for different reasons including for scheduling meetings, notifying updates and requests, and for other official and administrative purposes. On most occasions emails and phone calls were made to make requests, but several staff members (especially the ones who were at a closer proximity) would just come in to make requests in person. In a typical scenario, when she had to leave her room, she would use the relevant post-its from the inside of her office door (figure 4.3b) and stick them on her office door. As one can see in figure 4.3b, over a period, the secretary had collected a large number of post-its to be able to use them again. In most cases, a generic post-it note was placed, such as *"will be back in 1 hour"*. On certain occasion, post-its might be intended for specific people with important messages, such as *"Hans, your flight is booked.* Generally, post-it notes are less easy to pass off as obviously playful compared to other media. At times, reading these post-its intended for different people led to an understanding of her availability and presence but also gave indications about other people's activities, initiating curious reactions in people who visited her office.

The secretary's work practices were heavily influenced to be able to support awareness. The following is an account from her during the contextual interviews:

"I always work with the door open. It is as if I cannot work with the door closed, unless I am in a conversation that is very confidential or private. If staff members who frequently walk by my office saw that my door was shut, then they would think that I am not at work. So, I have to make sure that my door is always open to show to others that I am available. In other cases, I would just leave a post-it note on my door to let others know what I am up to."

Additionally, her office was situated at a place very close to the staffroom and rest rooms, so that staff members would routinely pass by her office and if they had some requests, they would just go to her office. Hence, she needed to always make sure to let others know about her status information. She used a set of pre-written post-it notes to manage her time and notify others about what she was doing and to provide her status information. Most common notes would look like the one shown in figure 4.3c, which states "Naar Hoofdgebouw" meaning "to main building". Both Dutch and English versions are written on the same note to inform local and international employees. At any time when she needed to leave her office she would look for a ready-made post-it with relevance and stick it on her office door.

In other cases, we observed that staff members also applied playful ways to remind others and inform colleagues about their work-related information, e.g. putting funny messages on post-it notes and placing them on the office door to playfully provide status information. We also found commercially available playful objects that could provide information about a staff member's status information (figure 4.4). This playful way of broadcasting information helped staff members to support their instrumental activities. While we noted that most announcements were not time critical such as for example alerts, they supported interactions related to social and work-related aware-

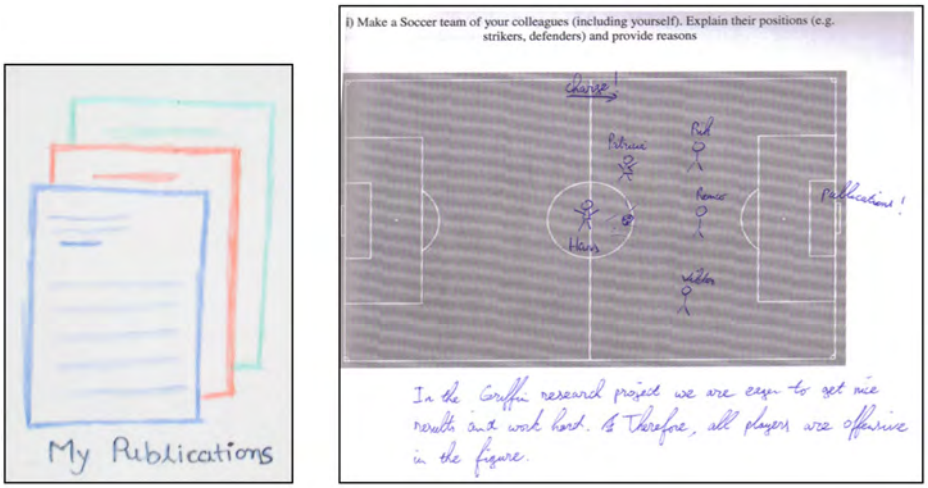
Figure 4.4: A playful object found on the door of a participant. The object is used to make visitors aware of the participant's current status.

ness. We found announcements to be an important tool for smoother functioning and micro-coordination of staff members. One of the flexibilities supported by self reflections was their reconfigurability. Staff members could, at anytime, publish their information in a place that was publicly reachable and in the same way could take the information back if they wanted.

4.4.1.2 Personal and Social Expressions

Since our investigation also aimed at exploring staff members' desired practices of being socially aware in the department, the organizational probes approach was formed to explore the aesthetics, expressive and emotional side of staff members' work practices. With our probes approach, we received a large amount of data expressing staff members' identity, social and emotional status, and their interpersonal relationships. Our probing approach provoked staff members to reflect on themselves in the department and reflect on other members and the department at large, following Bødker and Christiansen's [22] notion on understanding social awareness. In this section, we do not provide instances of staff members' social awareness practices but provide examples of their aspired and desired practices from our probes study.

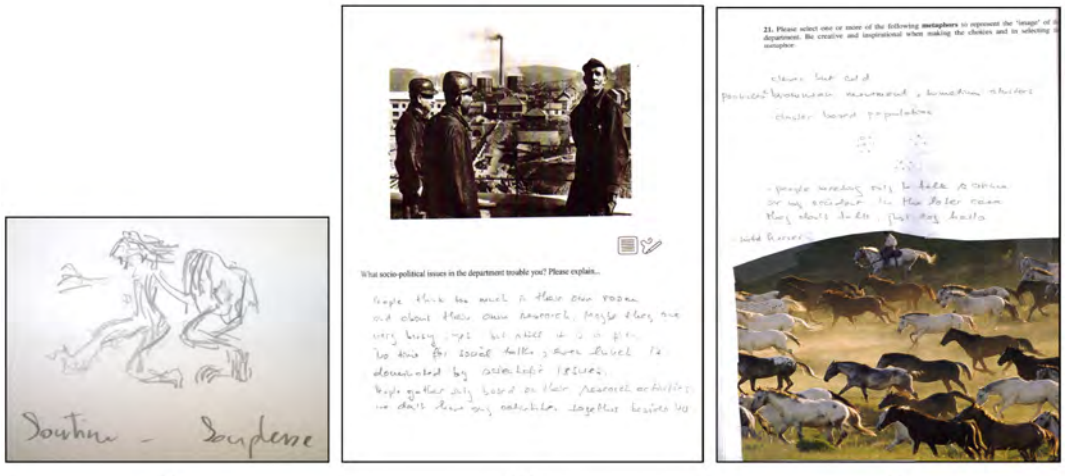
One of the most important aspects that came out of our organizational probe study was the fact that staff members did not see the department from a functional and utilitarian dimension but as a place where affect, pleasure and inspiration were interwoven with the utilitarian aspects of their everyday work. In particular, we observed several instances where staff members attempted to convey their identity either in the group or individually to reflect on themselves. In the organizational probes we asked questions such as: *"how would you like to be remembered in the department?", "how do you conceptualize your group to be?"* We also gave them different graphical metaphors (a tree, football pitch) and asked them to choose the most appropriate one and place their group members in it. Interestingly, we collected a lot of data representing the academic culture of the department. Figure 4.5a shows a doodle drawn by a participant representing his professional status as an author. Figure 4.5b shows another



(a) (b)

Figure 4.5: Expressions conveyed by staff members.

example of a PhD student who selected a football pitch metaphor to represent his group's work with the aim to score 'publications'. He placed his group members as fellow players who help each other to make these publications. The subtext reads as follows: *"In the Griffin research project we are eager to get nice results and work hard. Therefore, all players are in offensive positions in the figure."* These two examples represent how in academia scientific publications are important and how this fact shapes researchers' own identity and a perception of research in a group.



(a) (b) (c)

Figure 4.6: Personal expressions and thoughts conveyed through different means.

Our probes method also collected a lot of emotional aspects that bothered staff members. Figure 4.6a is a drawing made by one of the participants. It is a representation of a well-known art piece called, Souplesse, originally created by a French artist Chaim Soutine (1893-1943). This representation has a great personal value for

a senior researcher who came across it while he was a PhD student. The art piece represents a strong emotional sentiments and struggles he faced in the past. The examples in Figure 4.6b and 4.6c show a level of frustration expressed by one of our participants about the 'lack of social interactions' between the staff members. The notes on these two examples show how staff members are not able to interact with each other and express 'pity' that members mainly interact within specific boundaries. The example in figure 4.6c titles *"Clever but Cold"* In this case, the participant attached a magazine clip of running horses to express how members work and interact only in their own clusters.

4.4.1.3 Ownership

The notion of ownership of a resource is intimately connected and associated with its boundedness in space. Our field study was limited to the public spaces of the department, where most of the resources such as coffee machines, post boxes, prints, fridge and microwave oven were accessible to all the staff members freely. So, clearly there were no mechanisms by which staff members could claim ownership of these publicly available resources. However, we did observe several examples where ownership was conveyed. This can be seen as a particular type of self reflection by staff members. During our observations, we noted that staff members created and placed information and artefacts to make a reference to the ownership and identity of specific people in the department. Different approaches and representations were used to display who the information was from and who it was meant for. There was an observable level of 'directionality' attached to the information. There were different rationales used to convey ownership in the department.

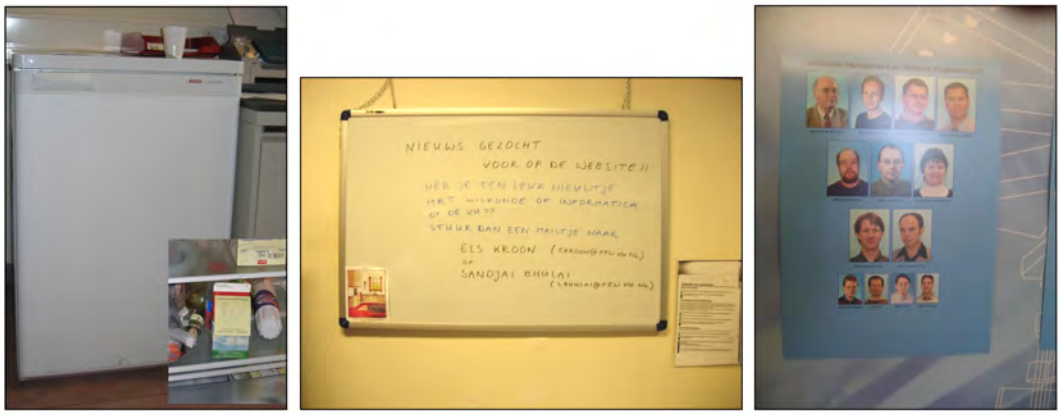


Figure 4.7: Examples of ownership. a) a milk carton with a post-it note in the staffroom fridge, b) A PR officer's announcement on the notice board in the staffroom: It says, roughly, "Please, send us 'nice' news to put into our website", and c) a hierarchical representation of staff members in a research group.

Figure 4.3a was an example where a senior staff member used a notice board outside of his office by placing and showcasing information about his work. Such placeholders can be considered as semi-public. More interestingly, such a way of pre-

senting information to others indicated a level of ownership too. Not the ownership of the notice board, but the ownership of the information – what it is about and for whom it is intended. The example in figure 4.7a shows a milk carton in a fridge with a post-it note with a shortened name of a person referring to the ownership of the carton. For a shared fridge in the department's staffroom, this was a practice not only to secure a food product but also indirectly and unintentionally provide cues for the owner's presence in the department. The example in figure 4.7b, shows a notice board kept in the staffroom by a PR officer asking for a specific information from the staff members. The notice board had a heading in Dutch "nieuws gezocht voor op de website", which literally translates as "looking for news items for the website". The PR officer, in this case, was looking for news items from the staff members that could be put on the department website. Information such as best paper award, project grant accepted, interviews and other kind news material. In this case, the notice board not only indicated the request made by a staff member but also her identity and activities by her. Generally, staff members would refrain from using this notice board, unless they had something very important to convey to others, as the notice board was at the center of the staffroom and would easily catch people's attention. The example showed a level of urgency and importance. The notice board, here, because of its situatedness, showed location-centric messaging. The location of the notice board determined what kind of messages could be placed there. Figure 4.7c shows a pictorial representation of members pertaining to a particular research group. Images such as these were placed on the corridors of the three floors of the department. It also showed a hierarchical representation of participants. This was commissioned by high level officials of the department and could be seen as a way for a new member to find out 'who's who' in the department. In particular, the way in which this legacy information was represented in the corridors of the department, would provide people walking by with the status of individual staff members in the department.

In the example of figure 4.3a, the information on the notice board, as a placeholder, was seen to be owned by a staff member. In figure 4.7a, we saw that ownership of a particular object was conveyed using a post-it in a publicly accessible fridge. And the examples in figure 4.7b and 4.7c showed how specific placeholders, due to their situatedness, determined what kind of information could be placed there, hence, in this case, the ownership of information and object was not as important as the value and meaningfulness of the location. In all these examples, we observed that, it was the location that determined what kind of information should be placed where and who the information should be directed to.

4.4.2 Casual Encounters

We found in our field study that most staff members had very limited time for explicit social interactions while working and that most encounters were initiated and defined by either some kind of routine activities or the "dynamics of the moment" (as one interviewee pointed out), thus by the context. Casual encounters were a kind of interaction, where staff members, during their everyday activities, intentionally or unintentionally, interacted with other members and objects within the surroundings that provided hints and cues of each other's social awareness. Casual encounters had both

direct and indirect forms. In the direct form of casual encounters, staff members could monitor and gather cues about different activities in the department through people themselves. Several examples of direct communication were seen, e.g. informal gatherings in the staffroom, casual staffroom chats, chatting while queuing in the canteen and the printing room. Through these verbal and visual encounters staff members received information about others. These communications included information about professional activities as well as personal and social activities. These were not well-planned, explicit acts of communicating with people but cues and traces about these actions were continuously monitored by the staff members. Whereas in the case of indirect encounters, staff members gathered cues from their physical surroundings and changes in the surroundings. Examples of indirect forms of casual encounters included getting cues from post boxes, print shelves and others. We will elaborate on this part in the coming sections. Figure 4.8 shows several instances of direct and indirect casual encounters that we noted during the naturalistic observations. In the following parts of this section, we will elaborate on casual encounters with some examples.

Figure 4.8: Everyday Casual Encounters. Direct and Indirect interaction with people and objects in the department.

4.4.2.1 Daily Routines

Through their everyday routines in a department, staff members implicitly select specific pathways and locations. These locations develop social meaning over time, and become a strong shared language in the department. Staff members rely on their knowledge of 'departmental routines' (their own and those of others) as well as the

placement of main traffic paths and common areas to find suitable places for information. These daily routines played an important role in allowing staff members to display and monitor cues, traces and signals around the department. Using maps and describing their everyday life in camera pictures, staff members reported several aspects of their playful practices where both 'space' and 'place' played an important role. Here space refers to the spatial and geographical locations and place refers to socially meaningful and experienced spaces. The staffroom was a common place for most social activities within the department, such as celebrations of different social events such as employees' birthdays and celebrating after getting funding for a new project. Normally, in this case the employee would use email to announce this amongst his group or friends. In some cases we observed play related activities. Some senior researchers liked playing cards with old friends to freshen their minds. The staffroom played an important role in establishing relationships between staff members. In summary, our staffroom played a role of social organizing.

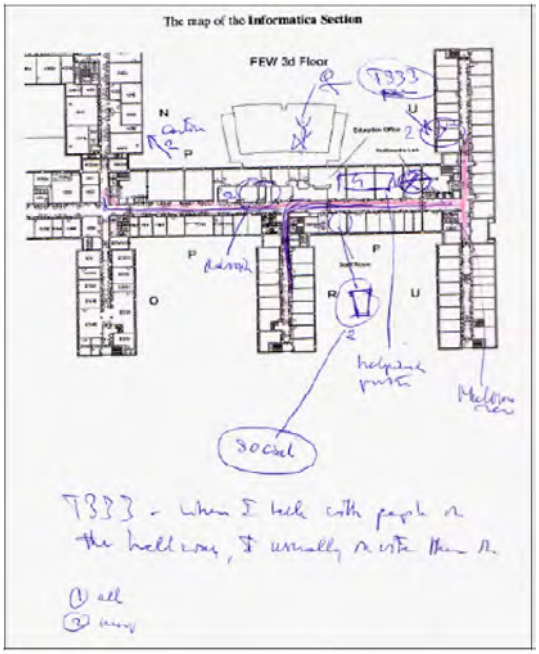


Figure 4.9: A staff members representation of daily activities in a geographical 'space'.

Staff members' daily routines in the department, their pathways and frequently visited places played an important role in having casual encounters with other members and objects in public spaces. The cues and traces pertaining to awareness information tended to group along the pathways and routines of staff members. When staff members know the routines of other members what are the most frequently visited places, where devices such as printer, fax machine, microwave and fridge are, staff members can use this knowledge in deciding where to leave and find cues and traces of other members. Tolmie et al. [236] found that *"routines are resources for action, and knowledge of others routines can be resources for interaction"*. To give an example, figure 4.9 illustrates an account of a staff member's routines in the department. Using the geographical map of the department (provided within the organizational

probes study) the staff member provided details of his everyday activities, routines, meeting spaces and frequently visited locations within the department. Amongst the most common was the staffroom, where important objects and media such as coffee machines, post boxes and fax machines were situated. In the figure, the word 'social' referring to the staffroom does suggest the importance of that place for having social interactions with other members.

Figure 4.10: The microwave oven in the coffee room (a) and, a scrap from a foreign employee (b).

The notion of space and place was observed to be multi-layered. In full, staff members identified several space and place aspects within an office, a floor, a building and the whole environment. Interestingly, a majority of staff members tied the notion of physical location to privacy issues. For example, staff members would typically make a strict distinction about where and what kind of messages and images to leave in the shared corridors, and what to keep within their own private or partially-shared office space.

To make our point about the importance of routines in displaying and monitoring the cues and signals about staff members' activities, we provide an example shown in figure 4.10a. Close to the microwave oven, which was frequently used by different members; informative artefacts such as research posters and calls for papers were placed in the knowledge that while waiting for the food to heat staff members could have a look these informative artefacts. As one participant said *"I might just have a look at these posters while I am waiting for my food."* In addition, media and technology such as the fax machine, and printer also attracted the placement of awareness-related information. Since these technologies are less portable, information typically comes to them. For example, as shown in figure 4.10b, some of the technologies become really important for staff members and their visits to these technologies become regular. Similarly, the fax and prints are kept close to the fax machine and printer shelves, respectively, so that members would come to these technologies, which would eventually increase the chances of casual encounters with other people.

There were several indications where the spatial layout of different work spaces influenced the structure of staff members' interaction. As one can see in figure 4.11 a picture taken by one of the participants as the part of the organizational probes study, a staff member's office could become a meeting 'place'. Here the physical space

Figure 4.11: The example of 'space' and 'place'.

was transformed into a place through social means. Space and place aspects also facilitated the 'forms' of interaction between the staff members. A physical location (space) and its situatedness (place) allowed members to interact with each other in an asynchronous way, where one could leave objects such as posters, conference calls, and post-it notes in a specific environment and interact with others in a physically-mediated way. Staff members also gave their accounts on playful incidents with other people in the department in places such as the coffee room, printing room and canteens. For example, one staff member described his card playing activity in the coffee room with other colleagues as an essential remedy to get rid of stressful situations.

4.4.2.2 Physical Markers

There were also several physical markers found in the public spaces that would indicate staff members' presence and activity level within the department. The example of a playful object situated at the office door of a staff member (figure 4.4), showed a direct and precise information about the member's presence at a particular time. However, there were several examples where physical markers helped members to gain information about other members' presence. During routine visits staff members were able to view the post boxes, print shelves, fax documents in their respective situational environments. By looking at these physical markers, staff members could guess or make inferences about other people. In some cases, the addresser or addressee might be an individual, a social group, contemporaries, successors, or combination. Two examples of physical markers can be seen in figure 4.12. The full post box of a staff member could mean that he or she has been away from work or too busy to pick up their post. And the empty post box may mean that the staff member has already collected their post. In either case, the physical markers can provide useful information about a staff member's presence and activity level in the department and allow others to coordinate their activities. This could mean that another member might not expect to speak with this person either because he or she is too busy or is not at work at the moment. Hence how the person can be approached can be determined by this. The example of print shelf also has a similar connotation. The prints are arranged based on the alphabetical order. A large number of prints of a staff member can mean that the member has a high activity load and is present at the

moment. The printer room was shared by members situated on three different floors. In some cases, we also saw that staff members would come to the printer room to guess if a person was at work or not. The cues of these physical markers cannot be seen as precise and staff members would have to guess in many cases.

Figure 4.12: Indirect mediation of awareness: staff post boxes and print shelves.

We observed that locations include meta-data for communication information by providing awareness information for staff members. Awareness information for department staff could be important to other members for scheduling and coordination work or other activities. The presence or absence of an object from its routine location could also provide information, especially awareness information. For instance, many of our staff members referred to knowing whether or not some of their colleagues were home or not by these physical markers.

4.5 Discussions and Implications

Supporting awareness in work environments through computational means has been an important topic of research in CSCW. The focus, however, has been on the productive, task-oriented and utilitarian aspects of work. In other words, researchers have utilized a functionalist approach to support social awareness in work environments. For example, awareness technologies in work environment such as @Work [235], Hermes [39], Elvin [71], and Ambient Agoras [225] have been developed to convey information about co-workers' presence, their on-going activities and individual messages. It is quite understandable that a functionalist approach should be used in work environments since productivity and efficiency are important goals of any work organizations. However, social and playful aspects related to work activities may not

be neglected as these have direct consequences on team and community building in organizations. In addition, in large organizations and companies social awareness is sometimes compromised in the heavy workloads, time clashes, a lack of social encounters between employees and flexibility and mobility employed in work practices. In their field studies in large organizations, Bødker and Christiansen [22] showed that in the 'new' work settings co-workers lack a sense of co-presence that tells them when their co-workers are available, and even where to leave a message if necessary.

Our field study in an academic environment provided empirical evidence on how staff members support social awareness in their daily work. Our results showed different practices staff members apply to be socially aware of their colleagues and the activities that they indulge in. It also showed that the notion of social awareness goes beyond supporting productive and task-related information and encompasses the playful, emotional, and other personal aspects of staff members' everyday lives. The two broad themes that we explored, namely self reflections and casual encounters, showed that awareness is conveyed through staff members' routine activities in an unobtrusive and implicit manner. The self reflection theme represented different patterns by which staff members represented and reflected upon themselves by providing cues and traces of their choices, status, preferences and achievements in public in a playful manner. We provided several examples of this theme where staff members artfully and resourcefully utilized important locations and informational artefacts to display information. Self reflection was seen to be supporting mainly the asynchronous and indirect way of social awareness. The casual encounters theme represented different patterns by which staff members, during their everyday activities, intentionally or unintentionally, interact with other members and objects within the surroundings that provided hints and cues of each other's social awareness. Casual encounters supported asynchronous and synchronous as well as direct and indirect awareness about staff members.

We believe that in order to design a technology for supporting social awareness amongst the staff members, we could not take the existing practices of staff members for granted. The EM-informed approach allowed us to collect a naturalistic account of staff members' everyday practices. In addition to knowing the current practices of staff members we also attempted to understand their aspired practices to explore their playful side. Hence, we utilized the organizational probes approach, a version of the cultural probes approach but adapted and sensitized for academic and organizational settings.

In the following, we first discuss the aspects of 'play' and 'place' from our results and provide implications for designing technology to support playfully-mediated social awareness.

4.5.1 On 'Play'

Although, as we mentioned earlier, we were interested in exploring how staff members supported social awareness through playful means, our investigation was not meant for exploring playfulness, per se. Additionally, from our results, it might not be easy to qualify the practices of the staff members as 'playful' or otherwise. This is simply because our intention in the investigation was to explore staff members'

observable and desirable practices about their social encounters and awareness practices. However, there were certain aspects of staff members' activities that we found playful.

The notion of play needs to be seen in the context of work environment. Perry and Rachovides [182] showed in their study of domestic environments that aspects such as 'making fun of others' or 'friendly bullying' amongst family members were seen to be important for evoking playful interactions. The work of Lindley et al. [155] showed that family members showed behaviors such as poking fun, displaying wit and self deprecation, amongst others, while being part of a field trial of a messaging technology called Wayve. We believe that such aspects of playfulness may not be relevant in the case of academic staff members, where professional and disciplined behavior is paramount. Play had a different definition in the case of the staff members, which involved, for example, keeping evocative, playful and personal objects on the office doors to draw other members attention or to initiate discussions.

Situated messages and artefacts played an important role in supporting playfulness. What we saw on the coffee room door example (figure 4.2) was an artful, imaginative and creative way to convey messages using playful cards, magazine clips, holiday pictures, and so on by staff members who engaged with their settings to create meaningful and useful displays. It was not always the case where display was playful in nature, for example the display in figure 4.3a. In the context of academic work environment, staff members seek to create practical yet evocative solutions for conveying information. In some cases, staff members learned that some of the spatial resources such as coffee room door (figure 4.2) and office room doors (figure 4.4) were more suitable for creation and display of playful objects and messages and for indulging into play itself, as opposed to a bit more stricter places such as the notice board in the coffee room (figure 4.7b). As echoed by Lindley et al. [155], play could emerge from the exploration of both "free movement" and the "rigid structure".

The use of organizational probes gave us useful indications about the playful side of staff members' everyday activities. As Gaver et al. [82] suggested, probes themselves are playful in nature. In our case, we utilized organizational probes, which had both inspirational and informative aspects that might be useful for understanding experiences of staff members. In the probes study, we provided tasks in a way that might evoke certain needs and desires staff members might have. One of the most apparent aspects of the data we collected from our organizational probes showed us a kind of craving for a sociable and playful work environment. For example, we asked about how they could describe their day. Some of them gave a visual representation by taking pictures of their daily activities and then writing stories about it, some drew their most important activities (figure 4.13), some simply wrote about their activities.

4.5.2 On 'Place'

Our results show that staff members, over a period, developed specific skills for social interaction and a diverse set of communicative ecology. In a hectic work environment, staff members established ways to support social awareness. The two generic themes of interactions, self reflections and casual encounters, that we explored from our fieldwork showed that staff members, through adaptation of their practices and use

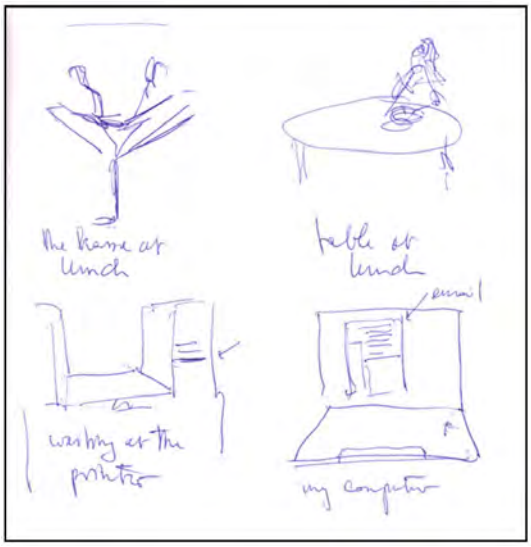


Figure 4.13: A staff member's representation of his typical day at work.

of spatial resources, devices and tools (such as notice boards, the staffroom door), conveyed their status, identity, behavior and activities in an implicit and unobtrusive but a skillful manner. We observed that in our results the notion of place was central in facilitating self reflections and casual encounters. Harrison and Dourish [101] made a distinction between the notions of 'place' and 'space'. Whereas space is limited to geographic and physical location, the notion of space is used to define the way space is used by people taking into account social norms and their everyday practices. Self reflection and casual encounters added new dimensions to the physical space of the department.

It was interesting to note how 'places' were created by staff members. In the coffee room, it was frequently observed that the space was used for informal chats between staff members, for celebrating members' birthdays and, on fewer occasions, playing cards or other playful activities with colleagues. As we noted earlier, the coffee room contained several important services and tools such as fridge, post boxes, fax machine, microwave oven, and a set of coffee machines. Staff members, during their routine activities, visited the coffee room for the purpose of using one of these services and tools and often had encounters with other members. Such casual encounters were not limited to only the coffee room but also in corridors, canteen and printing room. In this way 'meeting places' were created by staff members while practicing their routine activities. We found that the practices of self reflection also had social meanings. The coffee room door, which contained, many personalized objects (e.g. post cards, magazine clips), made it a place for conveying personal and sentimental messages. We believe that the activities of self reflections were rooted in staff members' understandings of the community which were constantly produced and reproduced by the group over time in response to events – such as a staff member giving birth.

We observed that the location of messages in the department was chosen by staff members to be able to convey the value and meaningfulness by providing productive as well as emotional and inspirational attributes. In some case, we saw that the mes-

sage was more valuable because of where it was. Staff members know how important and urgent a message is, who it is for and even what needs to be done with it by where it is placed or seen. As the example in figure 4.7b showed, the notice board at the centre of the coffee room was only used for very important and urgent matters, with a larger audience in mind. So, the meaningfulness was attached to these locations.

4.5.3 Implications for Design

For designing playfully-mediated social awareness we propose utilizing the two broader themes of interaction that we explored from our research, namely, Self Reflections and Casual Encounters. One can see several ways of implementing these two themes in an interactive technology to support and maintain social awareness in organizations. We briefly describe ways to apply these two themes.

SELF REFLECTIONS: From the fieldwork, we explored that artefacts and messages were attached on the coffee room door (figure 4.2), notice boards and so on to playfully-mediate personalized contents to make other members aware. For developing a new technology, self reflections can be seen as an explicit mechanism for user-driven interaction. For staff members this means that they can contribute towards the ongoing activities of the overall environment with their personal and non-critical information or data. The technology can serve as a tool that allows staff members to support their social needs, such as sharing non-work related news (announcing the birth of a child), personal achievements (e.g. best paper award) and personal interests (e.g. favorite books, favorite conferences). In this case, the technology need not be passively receiving feeds from users. It can, in fact, tweak, filter, alter contents and represent them in a comprehensible manner.

CASUAL ENCOUNTERS: From the fieldwork, we observed that staff members, in their routine activities, 'bumped into' each other and intentionally or unintentionally conveyed and collected information about their presence, status and activities. The concept of casual encounters can be realized when the technology proactively pushes information about the ongoing activities within the department and by offering resources of potential interest from the environment. This should definitely not interfere with staff members' routine activities nor should it mean that staff members need to reduce their public-view activities. On the contrary, casual encounters can provide an added value to the departmental social environment, especially, when during heavy workloads and frequent time-clashes physical interaction between members is not possible. The technology can serve as a mechanism by which staff members can be socially aware of each other by knowing their presence, social events and relevant non-critical activities within the department. In this case, even though users passively receive information from the technology, they can actively comprehend the implications of their action (either alone or in groups) on the technology.

In addition to these two major implications, we provide several sub-implications.

Awareness as reflections. A strategy that one might apply in designing a technology is to focus on aspects of people's everyday reflections. A technology should allow its users to reflect on themselves and on other members of the department. In order to support this, the technology needs to allow its users to explicitly and implicitly leave cues and traces of their activities and preferences. Through the mechanism of self

reflection, for example, members in the department could know each other's personal and professional interests and the things people are busy with. A technology should provide opportunities for viewing non-rational information that may trigger a commitment to reading and commenting on information that is related to the personal traces. It should provide a common virtual space that allows members to know about each other.

Awareness as belonging. A technology should be able to embody staff members, their artefacts and their activities in the sense that their presence is reflected on the environment. According to Fels [67] this type of embodiment can lead to an aesthetic feeling of belonging when users can relinquish the control over to the system. Embodying the presence of the staff member in a compelling way could lead to an emotional response of belonging to a community. In a big organization like an academic department, this could lead to social benefits even when it is difficult to establish face to face interactions with other members. This way a technology could serve as a platform to support awareness as a feeling of belonging.

Awareness as a choice. The use of an awareness system in the public domain may sometimes lead to privacy issues. Not all members may prefer a system that records their activities without notice. Organizational politics, organizational hierarchy and cultural diversity may even lead to the rejection of such an awareness system. A system should be able to utilize social awareness in an academic environment as an option or a choice and not as an obligation: a person is present only if 'he wants himself to be publicly known and present' [22]. As a mechanism to support self reflections, the members can add their views and their personal information to the system making their presence and their views available to the community.

Awareness in (playful) exploration. Unlike media spaces, where continuous, high quality video and audio links were provided to support awareness, a technology should be able to utilize unselective, random information in the form of casual encounters and self reflections. The two themes of interactions that we explored from our research can be utilized in a playful way by which staff members can intentionally leave cues and traces in the environment. This could lead to playful interactions between the staff members, which make the members explore possible facts hidden in the given information. Nevertheless, this unselective information could allow open and rich awareness amongst the staff members. Members can construct their own views and make their stories about the department based on the information provided by these cues and traces.

Non-critical & pleasurable awareness. Our focus has been on non-critical awareness. Our staffroom is used as a place to have a break from heavy workload, stress and obligatory tasks related to work. During the field study, we observed members chatting and playing cards. A technology should not impose information onto the staff members; rather, as suggested in the vision of 'calm computing', it should convey people's awareness in an enjoyable way that facilities people to reduce their stress. A technology should not focus on the precision of information but on how the information is experienced by the viewers through the traces it generates for supporting social awareness. Additionally, the information that is presented on the system should not require full attention from the users. It should be possible to ignore such information,

and the receiver may choose not to interpret the details of someone else's traces in great detail.

Awareness beyond intelligence. The notions of seamlessness, disappearance and intelligence as propagated in the vision of ubiquitous computing [263] and ambient intelligence [1, 56] are primarily based on technological intelligence. Their technology-oriented conceptualization of context is very limited and sometimes unachievable, especially when these approaches attempt to predict users' intentions and activities. Users' everyday encounters may involve interaction with many heterogeneous media and tools and users may adapt or interweave these to support their activities [37]. Additionally, viewing users as 'passive' receivers of information is an incomplete view. A technology should provide an opportunity for the staff members to be an active, playful and artful creator of their own environment. A technology should be able to utilize the intelligence aspect not to predict staff members' behaviors or activities but for depicting them in an artistic way to enhance social awareness within a work environment.

4.6 Summary

The need to support social awareness in large organizations cannot be emphasized enough. On the one hand, it can help in supporting and improving productivity and efficiency related issues in the environment. On the other hand, it can also be seen as a tool for community and team building and supporting personal and social communication between co-workers. Our fieldwork in an academic work environment showed that self reflections and casual encounters were two broader themes of interaction that helped staff members to be socially aware of their colleagues. We believe that these two themes are intertwined and cannot be seen in isolation. Our intention to carry out such an ethnographic fieldwork was to explore important implications for designing technology to support playfully-mediated awareness between staff members. Our work has provided several important implications that can be utilized by designers for such a purpose.

5

Panorama and its Field Trials[1]

5.1 Introduction

Awareness within work environments may not be seen limited to work-related information, activities and relationships. Mediating somewhat casual and engaging encounters related to non-work issues could also lead to meaningful, pleasurable and ultimately productive experiences. In particular, such a conceptualization of awareness in work environments could be much more valued, since, as Bødker and Christiansen [22] explain, social aspects of awareness are often neglected in heavy work loads, time clashes, and a lack of suitable platform to support informal communications. To make matters worse, work is increasingly becoming dynamic, where new people join groups or projects, companies hire, fire or close and work is carried out in a variety of settings such as offices, homes and even at airports. Within the CSCW field, and more recently in the ubiquitous computing area, a considerable amount of work is done on developing technologies to support social awareness and informal communication between co-located members in work organizations. Recent technologies such as Informative Art [190], Hermes [39] and Dynamo [127] are different forms of situated awareness displays that attempt to mix both the productive as well as the creative and lighter side of work activities. In this chapter, I go a step further and design an awareness display called Panorama that attempts to mediate non-critical and social aspects of people's everyday lives in a playful manner.

Our fieldwork in an academic department (Chapter 4) showed that social awareness in work environments has several facets that go beyond the productivity and efficiency-related aspects of everyday work. The fieldwork led to developing several important design implications, the two major implications being allowing people to

[1] This chapter is based on the following published papers.

1. Vyas, D., van de Watering, M., Eliëns, A. and van der Veer, G.C. (2007) Engineering Social Awareness in Work Environments. Universal Access in Human-Computer Interaction, **(HCII '07)**, LNCS 4555, Springer-Heidelberg. pp. 254-263. ISBN 978-3-540-73280-8.

2. Eliëns, A. and Vyas, D. (2007) Panorama Explorations in the Aesthetics of Social Awareness. In Proceedings of The European Simulation and AI in Games Conference **(GAME-ON '07)**, Nov 20-22, University of Bologna, Marco Roccetti (ed.), pp. 71-75, EUROSIS-ETI Publication, ISBN 9789077381373.

support *self reflections* and *casual encounters*. This chapter is divided into two parts. In the first part, I will describe the design of an awareness system called Panorama that was developed using the two design implications from our fieldwork. In the second part, I will provide results of a two-week long field trial of Panorama in our own academic department.

Panorama is a large screen display that was situated in a publicly accessible area of the department – the staffroom. Panorama attempts to mediate cues of social awareness through visual information. It is meant to enhance social awareness in a playful way by displaying non-critical and non-work related information about co-workers. As I mentioned earlier, Panorama utilizes the two 'design implications' developed from our fieldwork: self reflections and casual encounters. These two implications are supported by the following means, respectively. 1) Staff members can send images, video and text messages pertaining to their personal, social or work-related activities to the system, and these are displayed in a semi-artistic fashion on the large screen of Panorama. This way Panorama allows members to express their interests, thoughts and sentiments. 2) Panorama also collects information from the department using cameras – distributed around the public areas of the department and represents this information on its screen in the form of live video streams and images. In this way, it captures casual encounters from the physical environment of the department and presents them on the large screen. Panorama was conceived as a 'calm technology' [264]. At times, Panorama became the center of attention and a topic of discussion (at least, in terms of its contents) and, at times, it just ran in the background of staff members' periphery and attention. In the latter case, staff members could go on chatting and eating their lunch without being bothered by Panorama.

In the field trial of Panorama, with the help of a bachelor's student – Edwin Keijl, we placed a large screen display, running the Panorama application, in our department's staffroom for two weeks. We used observations, interviews and the Repertory Grid Technique (RGT) to get an insight into staff members' interactions with Panorama. The RGT is an evaluation method that produces qualitative as well as quantitative results by eliciting interesting aspects of a system from its users. We combined this technique with observations and interviews, to understand the playful side of social awareness and get a comprehensive view of the staff members' experience while interacting with Panorama. This was of course central to my approach to apply experience-focused perspective. We did not intend to *measure* social awareness within our department. Instead, we were more interested in understanding the effects of Panorama on staff members' workaday experiences. Hence, the field trial reported here takes a somewhat different direction in focusing on how staff members might connect with their colleagues and the department in general through an awareness device. Additionally, we focused on the use of social awareness cues in the form of images, videos and textual messages of staff members as a way to do so. Using this approach, we aimed to deepen our understanding of the potential of Panorama to support social awareness and how this is transformed and used within the academic work environment. Thus one goal of this research was to build on previous work in awareness systems to further define what supporting social awareness might mean for work life and to open up new kinds of technical possibilities as a result.

Most research on awareness systems in work environments has focused on how technologies can be used for the communication of location and activity or supporting coordination within social groups. Since, Panorama did not intend to support productive and other work-related activities, the results shed new insights into the social and playful side of work environments. The results of our field trial showed that Panorama stimulated curiosity, initiated conversations and activities during lunch hours in the staffroom. Staff members also gained knowledge about their colleagues and departmental activities and were able to cherish old memories from previous group outings and social gatherings.

In the following sections of this chapter, I will first introduce our prototype of the Panorama system, its design rationale and our initial design iteration. Next, I will provide details of our field trial, including the setting in which the trial took place, its participants and methods used in the field trial. I will then provide the results of our field trial, focusing on the important characteristics of Panorama. In the end, I will discuss our approach and results.

5.2 Panorama: Supporting Playfully-mediated Social Awareness

For designing playfully-mediated social awareness, I treated the two design implications – self reflections and casual encounters, from the earlier fieldwork, as the design ideas. This meant that the technology that I designed should incorporate these two design ideas. To apply the notion of playfulness in design, I wanted to provide an opportunity for the staff members to artfully and creatively contribute to the departmental settings. It was evident from the ethnographic fieldwork that the staffroom in our department was the center for most of the social and informal activities. I intended to put a large screen display in our staffroom that would allow staff members to receive socially meaningful information from the environment and to publish relevant information onto the display. Figure 5.1 shows a prototype version of the Panorama application.

For designing Panorama, I utilized an existing technology called Virtual Poetry (ViP), which was originally developed for creating an augmented reality theater production [59]. ViP was developed by one of our colleagues – Anton Eliëns, who also participated in the design process. ViP is a complex representation system based on DirectX9. It allows projection of live video feeds, digital video clips, texts and sequences of images on an immersive 3D space. The ViP system also allows a variety of visual effects, including texture mapping of image feeds on 3D objects, overlays of multiple image textures, as well as particle systems with streaming image feeds projected on sprites. ViP can be seen as an umbrella platform for representing different visual information, where representation style can be adapted to suit a particular need. For conceptualizing the Panorama interface, we adapted the representation of ViP to show a *continuous* and *always on* interaction. As figure 5.1 shows, there are two planes of the Panorama interface, both presenting visual information floating in opposite directions – providing a feeling of *walking through a corridor*. Panorama can take inputs from nine different channels, which are shown at the bottom of the Panorama interface. This, in a way, informs the staff members what to expect on the

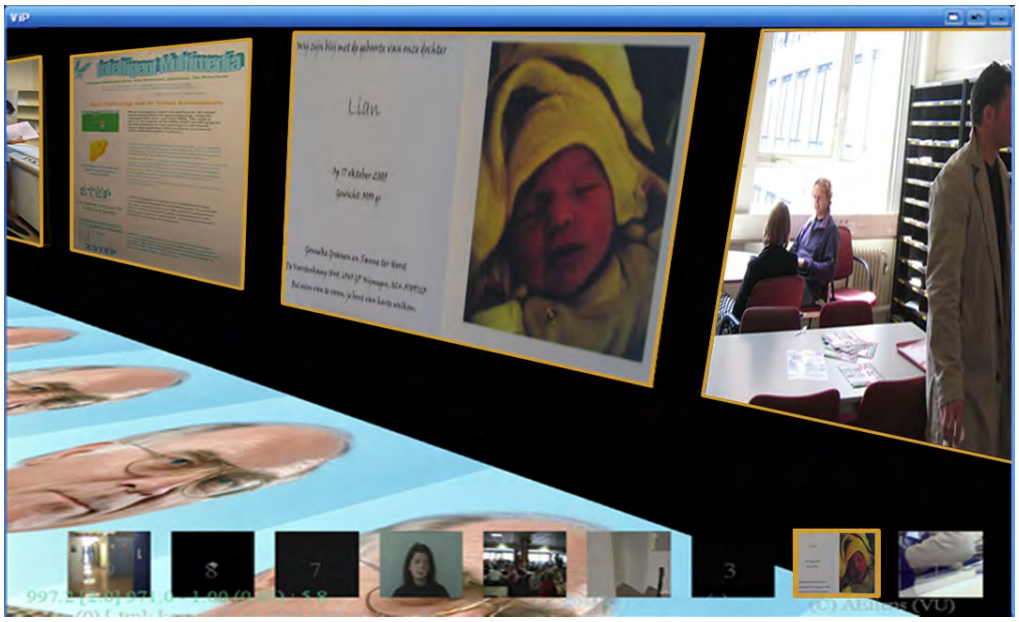


Figure 5.1: A screenshot of the Panorama prototype. A video of Panorama installation can be seen on this link: `http://www.youtube.com/watch?v=i8hR2V5Voak`

vertical plane of the Panorama screen. The speed of flotation of the images is adapted from the sensor information in real time. When cameras in the public area detect increase in people's movements, then the speed of visuals on Panorama increases. This particular functionality is devised to indirectly inform staff members about the activity level in the department. I will elaborate on this issue in the following parts of this chapter.

The goal of the Panorama system is to enhance social awareness by providing interpersonal and rich information related to staff members and their everyday interactions in the department. Panorama provides a facility to support staff members' creativity and playfulness and should not be seen as a tool that attempts to support work-related activities. I wanted to explore if Panorama in the staffroom could allow different users to speculate about what was happening in the department. This non-selective information could allow affective, engaging and reflective interactions between the staff members. Panorama utilizes information about self reflections and casual encounters in the following ways:

– *Self Reflections* are explicit user initiated interactions. Staff members can contribute towards the ongoing activities of the overall environment with their personal and non-critical information or data. Here, Panorama serves as a tool that allows staff members to support their social needs, such as sharing non-work related but highly sentimental news (e.g. announcing the birth of a child), personal achievements, and personal interests (e.g. concert visits, favorite books). In this case, Panorama does not passively receive feeds from members. It represents it in a manner that conveys the liveliness of the environment.

– *Casual Encounters* are implicit system initiated interactions. In this case, Panorama proactively collects information about the ongoing activities within the department

and offers resources of potential interest from the environment. Panorama serves as a mechanism by which staff members can be socially aware by knowing each other's presence, social events and other relevant non-critical activities within the department. In this case, even though members passively receive information from the technology, they can actively comprehend the implications of their action (either alone or in groups) on Panorama.

Broadly speaking, Panorama receives both explicit and implicit awareness information about the staff members and their activities and represents this onto its display. The Panorama interface is like a virtual gallery, where on the wall and on the floor information about social awareness is presented. Figure 5.1 represents the 'idle' environment when the activity level is minimal. As activity level increases it transforms the representation first into the 'live' environment (representing the normal activity level) and then into 'chaotic' environments (representing hectic activity level). We used motion and noise sensors to detect the activity levels in the common spaces like the staffroom, the printing room and the main corridor. In both cases the activity level within the department is represented by the change of speed, color, abstractions (e.g. using shader) and overlays of 3D objects and particles.

5.2.1 Representation

By conceptualizing social awareness as reflections of cues and traces, it was important for us to consider the meaning that we were embedding in Panorama. Our decision for creating such a representation for Panorama was based on the available resources and on a number of assumptions that we made regarding the ways in which this representation could facilitate social awareness.

The self reflections (such as objects of personal interests) are represented as a flow of images using particle systems. Since these are used to form a sense of belonging and recognition, these are presented without any form of modification of the actual content. To add the artistic flavor, different particle flows are used to focus viewers' attention. The objects of self reflections are seen as clues and traces, when interpreted within the departmental context can aid to support social awareness.

The casual encounters are represented as still images or videos generated through sensor-triggered cameras in the corridors and printer rooms. To emphasize the fact that casual encounters are important and not necessarily the people involved in them, Panorama uses different levels of abstractions to emphasize the peripheral nature of social awareness. This also takes into account the privacy issues that may arise when monitoring people in real-time. The videos streaming by Panorama are represented in abstract forms using shader and particle overlay effects.

The overall mood and activity level in the department is captured using different movement and sound sensors. Inspired by [190], the overall activity level is represented using different visual effects and by adjusting the speed with which the information is presented. Panorama uses sensor-triggered, transparent particle effects that can be shown at any layer of the Panorama interface. Increased activity level, for example, could generate more particle effects and abstraction and a higher speed of representation. We chose particle effects for their aesthetic richness to stimulate curiosity and to decrease predictability that might evolve into boredom.

5.2.2 Two Levels of Communication

Panorama establishes two levels of communication between the co-workers. This results from our two-fold aim of combining specific information with overall impression to support social awareness within the department.

Panorama provides concrete building blocks of information by providing the precise information such as an individual's announcements, achievements and so on in the form of unaltered images, texts and video streams. This way, self reflections are mediated as a direct representation of reality, establishing detailed communication of information through the system. The movement and placement of the representation in turn are used to focus co-workers' attention. Although abstracted in part using shader techniques and other visual effects due to privacy concerns and to stimulate curiosity, casual encounters are also examples of this type of explicit communication of information. Both mechanisms aid co-workers for extracting the information about social awareness directly from what they see on the screen.

On the other hand, Panorama provides an impression about the overall environment by representing different sets of information in certain ways to indicate the activity level within the department. Panorama uses real-time sensor input to gather information regarding overall activity in the department and based on this Panorama changes its representation. As the activity level increases, the speed, overlays and abstractions of different moving objects also increase. This sort of indications of increased activity level is generated through different social acts of the co-workers. Interestingly, for co-workers Panorama provides an indirect way of controlling its representations. This way Panorama may influence co-workers' working practices. For example, workers can adjust their ways of working after receiving indications about the overall activity level of the department.

5.2.3 Early Assessments of Panorama

Before Panorama can be deployed in a real-world setting, we wanted to gain some insights into how it might be valued and experienced by its potential users. For this, we devised a small scale assessment for Panorama. We took into account the fact that methods for assessing technological, productive and instrumental aspects of a system may be impractical or unsatisfactory when evaluating systems that are meant to support subjective and interpersonal aspects. Social awareness is one such aspect. Previous research [111, 165, 218] has shown that mixed-reality and artistic interfaces can be better evaluated using a combination of argumentation ('art criticism'), using multiple interpretations, and informal conversation with users. To validate our understandings of social awareness and to assess the effectiveness of Panorama for our department, we organized our assessment in two phases.

In the first phase, we invited eight employees of our department to a laboratory-like room. Without providing explicit information about Panorama, we demonstrated three different scenarios of Panorama, representing different environments in the department: Idle, Live and Chaotic. During the session we first asked them to individually write down: what Panorama represents, the difference between the three scenarios and the system's suitability in the department. After this we introduced

Figure 5.2: Phase 1 of Panorama assessment (in a Laboratory).

some discussion points to get an account of their social meaning construction about the system. See figure 5.2. The discussions were recorded in an audio device and the transcripts of their written answers were also collected for further analysis of our design.

In the second phase, using a projector, we placed the Panorama system in the staffroom (see figure 5.3). The main purpose for this assessment was to observe the behaviors and reactions of staff members towards Panorama and check its effects in a natural environment. We asked questions similar to those in the lab assessment, but the whole exercise was left open, in the sense that the passers-by could comment on almost anything. We took notes of their comments and noted their behaviors.

Figure 5.3: Phase 2 of Panorama assessment (in the Staffroom).

5.2.4 Results of Early Assessments

The lab assessment led to some interesting perspectives on Panorama. It was clear to all participants what Panorama was about. Some described it as, *"it reflects the dynamics of our department", "it demonstrates what's the department in a virtual way", "a lazy way to get information about the department"*, and so on. Most participants could easily recognize the objects presented on the Panorama: posters, announcements, events, images of staff members, but it was difficult for them to make clear narratives of the sequence of the presentation. The presentation of Panorama was appreciated by most participants. Some said, *"it could also be used as a PR resource to attract new students to the University."* The three different scenarios of Panorama were also easily distinguishable into idle, live and chaotic environments. The difference between information and impression was observed. Some participants (mainly students) appreciated the dynamic visuals, overlapping images and fast flow of information in scenario 3 (chaotic environment); compared to others (mainly senior staff members) who appreciated the slow but comprehensible flow of information in scenario 1 (idle environment). Scenario 2 (live environment) was considered to be the best by all the participants as it was a combination of a nice representation of the dynamic side of the department while still being informative.

In the staffroom assessment, we noted that a main aspect of the Panorama system was curiosity. We did not explicitly invite anybody for this assessment. All participants came to the staffroom to do their routine activities or take a short break from work. We observed that many of the viewers were curious to see their pictures on Panorama. Interestingly, privacy did not seem to be an important issue. There were two reasons for this: first, Panorama provided non-critical information about staff members and mainly the information that was in fact published by the staff members themselves; and second, staff members (like other academics) were interested in conveying their status and identity. One of the viewers waited for some time to see himself on the big screen. Others commented,

— *"I would like to see myself on the screen."*

In such a small scale assessment, we found that Panorama certainly increased curiosity and provided pleasant experiences between the participants, and to a certain extent improved their knowledge about the social environment. We believe that the social benefit offered by Panorama was a result of mainly the social and personal nature of the content and partly due to the dynamic representation and its placement in the staffroom. When installed in the staffroom, we observed that Panorama provided a reason for members to communicate about different ongoing activities in the department. E.g. a conversation:

— *"Whose trophy is this?"*

— *"I think its Jan's."*

An interesting thing about this example was that the same announcement of this person's achievement of 'winning in a city marathon' was already published on our staffroom door (shown in figure 4.2 in the previous chapter) but very few people knew it. When presented on Panorama it became a point of talk among the viewers. In this particular case, we observed that the viewers started talking about other aspects

related to this instance.

5.3 Field Trial of Panorama

Learning from the early assessments of Panorama, I planned to carry out a more realistic and a longer term field trial of our system. I again would like to emphasize that it was not my aim to evaluate the technology, but observe and understand the effects of the technology on staff members' behaviors, interactions and interpretations. Boehner [23] argues that a technology is bound by the ineffable – the aspects that cannot be fully known or understood through explanation or measurements but must be experienced. As Bødker and Christiansen [22] argued, social awareness cannot be measured precisely as it is a subtle and implicit aspect and does not meet the eye. Hence, in this case, assessing the effects of Panorama on the staff members would be to explore their experiences of being socially aware, being able to interpret (or even speculate) other staff members' social activities, and subsequent interaction that is triggered by panorama.

In the following, I provide the details of the field trial including its setup and methods used to collect data from the field.

5.3.1 The Setup

It was clear from our fieldwork (chapter 4) that the staffroom was an important place that staff members visit during their everyday activities and routines. For the longer term field trial, we chose to deploy Panorama in the Human Media Interaction (HMI) research group, at the University of Twente. This is a different work environment from the one which was studied in the previous chapter. We believed that by choosing a different work environment to study the use of Panorama would make it easier to justify our design of Panorama.

HMI had 48 employees, 8 of them working part-time. HMI had its own staffroom which was colloquially referred to as *Rappa* within the group. This room was often visited for routine activities, such as collecting mail or using the photocopier. In addition, staff members commonly met in the Rappa for social activities such as eating lunch and having informal chats with co-workers or celebrating staff members' birthdays. We deployed a large screen display in the Rappa, running our Panorama application for two weeks. For studying the use of Panorama, participation of staff members was absolutely necessary. We invited members to submit the images, videos and text messages that they wanted to show to their colleagues. We also created a Facebook group where they could store images, videos and write status messages that they want to display on the screen on Panorama. During the early discussions with the staff members we found out that they showed a reluctance to having camera-based sensors in Panorama's installation. Hence, we decided not to include wireless camera in the public areas of the research group. Only one camera was placed in the Rappa. Figure 5.4 shows the setup of Panorama in the Rappa. The display was placed in one of the corners of the Rappa to allow unobtrusive interactions.

Figure 5.4: The Panorama system and its setup in the Rappa.

5.3.2 Methods

We attempted to collect data from multiple sources using different methods. We used three main methods: 1) observations, 2) Repertory Grid Technique (RGT) and 3) semi-structured interviews. Two researchers worked on this field trial, collected data separately and then corroborated data at the end of the trial. In the following, we provide details of our methods and participants.

5.3.2.1 Observations

Knowing the 'peak hours' of activity in the Rappa, observations were performed around the lunch hours. The system ran in a corner of the room while staff members from the HMI group could walk in and leave whenever they wanted, as they would usually do. On the opposite side of the room, behind a filing cabinet and some large sight-blocking panels a place was created to observe activities in the Rappa while Panorama was running. An observer sat quietly at the back of the room with just enough space to view the people in the room and the system, but obscured enough not to disturb the activities in the room. A sound recorder was connected to the laptop of the observer, to ensure that interesting details of the interaction between people were not left out. Furthermore, notes were taken at the same time to note the number

of members in the room and of the interesting interaction between Panorama and the members in the room.

The HMI staff members were encouraged to send in photos and videos through Facebook and email. This could be anything from past HMI events to more personal contents, such as, holiday pictures and everything else they wanted to share with others. The sequence of the series of photos was randomized and distributed over the nine available sliding containers in Panorama. Observations were performed over a total of eight days, spread out over two weeks. An estimated total of 30 members visited the Rappa while Panorama was active, consisting of HMI employees and visitors from outside the department. On average, 10 members were present at the same time in the Rappa, each day at the 'peak hour' during the lunch breaks. Their reactions to the Panorama system, interactions and conversations served as input for the observations.

5.3.2.2 Drop box

During the observations, a cardboard box (seen in figure 5.4) was placed in front of the Panorama system with a pile of paper and a pen on top of it. The idea here was to allow staff members to leave comments about Panorama whenever they felt like it. An open question was at the top of each comment form, to encourage the users to express their feelings about the system.

5.3.2.3 Repertory Grid Technique and Interviews

The Repertory Grid Technique (RGT) is a technique for eliciting and evaluating people's subjective experiences of interacting with technology, through the individual way they construe the meanings for a set of artefacts under investigation. RGT is based on Kelly's [136] 'personal construct' theory, a theory from the psychological research field. Kelly explains that people make sense of the environment around them by forming personal constructs that are bipolar in nature. This means that while assessing a technology, a user can describe the technology in his own personal words, sparked directly by his experience. These bipolar constructs can in turn be used to determine how a single element of a technology relates to them on a certain scale. To apply RGT, researchers normally select a set of related technologies with the technology in question [66]. Test users are then confronted by these systems and are asked to construct their experiences. After collecting users' qualitative constructs, the users are asked to rate the degree to which each element in the study relates to each bipolar construct according to some scale (typically a binary or Likert-type scale). The main idea of RGT is not to create a comparative analysis between the selected technologies, but to explore users' experiences with relation to individual technologies. Overall, the use of RGT means that the qualitative constructs and elements of the technology together can produce quantitative results. Together they represent the experience of users.

Our aim behind using RGT was to learn more about the staff members' experiences while interacting with the Panorama system. We invited 15 members of HMI who were seen to be often present in the Rappa while the field trial of Panorama took place. Table 5.1 provides the details of our participants. Out of the 15 participants, 9

were male and 6 were female. The majority of the participants experienced Panorama for more than three or four days during their lunch break.

No	Position	M/F	Age group	Years in the department
1	PhD Student	M	20-29	Recently started
2	PhD Student	F	20-29	Recently started
3	Post Doc	M	20-29	5
4	Post Doc	M	30-39	5
5	PhD Student	M	20-29	3
6	Researcher	M	20-29	6
7	PhD Student	F	20-29	4
8	PhD Student	M	20-29	1.5
9	PhD Student	F	30-39	4
10	Secretary	F	50-59	10
11	Secretariat	F	40-49	18
12	PhD Student	M	20-29	1
13	PhD Student	M	20-29	3
14	Senior Lecturer	F	50-59	14
15	Technician	M	40-49	13

Table 5.1: Details of participants.

To apply the RGT, the participants were presented with five different systems: Panorama (coded as D1, for device number one), television (D2), Nintendo Wii (D3), digital camera (D4) and mobile phone (D5). Appendix 2 shows the cards used during the study. These devices were chosen for the fact that all of them are electronic devices with a screen display, with an assumption that most people would be familiar with. Each of the participants was shown six different combinations of three of these systems and was asked to think of a construct for each of these groups. Only triads that contain the Panorama system are used, because eliciting six constructs already requires a lot of time and effort from the user [64] and asking more would not be suited for a research of this size. After construct elicitation, the participants were asked to rate all five systems on a seven-point scale.

After the RGT session, the same participants were asked a few open questions in a semi-structured interview session. Appendix 2 shows some of these questions. The interviews were audio recorded. They were asked about any new information or knowledge they gained from using the system, how they thought Panorama supported social awareness and so on.

5.4 Results

For this section, the voice recorded data from the interviews and observations was combined together to form a large pile of information that contains all the reactions from the employees of the HMI department. The next task was to order, categorize and analyze all these statements and conversations. The second part will describe the results from the RGT sessions.

5.4.1 Observations and interviews

The qualities and interesting aspects of Panorama can be described in a few categories that will be explained below with a great number of examples. A lot of quotes from the observations and interviews are directly cited as examples of these categories.

5.4.1.1 How Panorama was perceived

Figure 5.5: Panorama in use during observations.

As a part of their daily routine, staff members would come to Rappa to, either, collect their prints, check their post, have lunch on the sofa, use the microwave oven, have informal meetings with colleagues or use stationery – that were stored in a cupboard in the Rappa. The placement of Panorama in the Rappa meant that it was going to be seen (or interacted with) only when staff members would enter Rappa. In our two-week long field trial, we observed that Panorama in the form of a large screen display was overall appreciated by all the staff members.

In the beginning, the novelty aspect of Panorama played an important role in staff members visits to the systems and paying a focused attention. Panorama itself is not a system that allows staff members to directly interact with it. Hence, after looking at some of the pictures, videos and reading news items, staff members just continued

their everyday activities. However, there were occasions where several of staff members would stay in the Rappa for a longer period of time. One of the examples of such an activity was during the lunch hours. Some of the staff members routinely had lunch in the Rappa. The deployment of Panorama added a new dimension to their lunch activities. In this case, Panorama was conceived as a *'calm technology'* [264]. At times, Panorama became the center of attention and a topic of discussion (at least its contents) and, at times, it just ran in the background of staff members' periphery and attention. In the later case, staff members went on chatting and eating their lunch without being bothered by Panorama. It was in fact an intentional design strategy that we considered for conceptualizing the design of Panorama that the system should not be intrusive in staff members' everyday activities. Figure 5.5 shows a typical lunch gathering in the Rappa. In this figure, one can see how some of the staff members have rearranged their chairs and their sitting positions to be able to see the contents running on Panorama. Here, the novelty and curiosity aspects of Panorama played an important role in staff members' interest and behaviors. Here is a comment from a staff member who was present during the lunchtime and had sufficient exposure to Panorama: *"It stays on the background, because it's only visually active. Today we had some long discussions and that thing was just running on the background, so we didn't even discuss it. That would probably be related to the news value as well. You're watching it now and then, but not constantly. So if you put in some new pictures it might lead the conversation a bit. But then it has to draw attention a bit. I did notice that pictures draw more attention than the text, because that was always the same."*

5.4.1.2 Types of information sent

Figure 5.6: Example images sent by staff members to the Panorama system.

Although, we left it completely to our staff members to send any type of visual information that they thought appropriate to Panorama, we did find some patterns in their sent images and texts. The images sent to Panorama can be generally categorized into staff members' conference and other official visits; the group's outings to different places; individual staff member's personal life, interest and trips; some funny pictures of the staff members and images from the old time (80s and 90s). The number of submitted pictures ranged from about 30 on the first day to 300 at the end of the field trial. Figure 5.6 shows a few examples, where 5.6a shows picture from a conference where a demonstration was being carried out, 5.6b shows the group's outing to a nearby historical town, 5.6c is a wedding picture of a member, 5.6d shows two members posing a funny shot and 5.6e shows an image from the late 80s. Apart from these, some members sent pictures of their children and pets, funny magazine clips (e.g. PhD comics) and their hobbies. In particular, images pertaining to a mem-

ber's hobby were frequently seen on Panorama. For example, images pertaining to staff members playing musical instruments, ballroom dancing, sports activities were often seen. A motivation behind such a pattern was to explore common interest in their colleagues.

There were a very few examples of videos being sent to Panorama. These were mainly from different social gatherings and staff members' vacation time. The textual messages were, surprisingly, about work related and official announcements. Staff members sent messages about new developments in their research, new project proposals and the like.

In the following, we will provide details of our results focusing on four important characteristics of Panorama: 1) stimulating curiosity, 2) learning new things, 3) initiating interactions and 4) cherishing old memories.

5.4.1.3 Stimulating curiosity

One of the interesting aspects that came out of our field trials was the way Panorama initiated curiosity among staff members. Panorama promoted a level of curiosity that went beyond its novelty aspect and was observed throughout the two weeks of our field trial. We observed that often staff members got curious by the content they saw on Panorama, and they started asking questions, which eventually led to discussions The usual reactions of the staff members included sentences such as 'where was this picture taken?' and 'who is that person?' In the following, we provide an excerpt of a conversation that took place during a lunch session in the Rappa that will illustrate the curiosity aspect of Panorama.

Staff member #: "Whose photos are these? Did you send photos?"

Staff member #: "No"

Staff member #: "There are some photos I don't have, these I don't have. It's from the spring school"

Staff member #: "Some from when we went to the Mexican restaurant, I think Christian sent them"

Staff member #: "Look, this is from the spring school" (people pointing at the screen)

The above excerpt shows discussions about two separate events from the pictures that were shown on the Panorama screen. One of them is about a group of people who went to a Mexican restaurant and another one is about a spring school in which some of the staff members (mainly PhD students) participated. Not all members knew about such activities and these images provided a level of curiosity among staff members to discuss these events while have lunch. The simple fact that images are moving on the screen and keep getting interchanged with other pictures draws a lot of attention from the users. But Panorama does not completely pull them from their daily routines to forcibly look at the system. So it does draw the attention, but it is not too distracting. Also, Panorama had a continuous representation, new images passing through the screen would not be easily recognizable to the staff members

and this was an aspect that initiated curiosity. At times, staff members sent pictures that where unknown to some of the members. For some people this supports their curiosity while watching Panorama, because *"if you see only a few pictures you don't know, the urge to ask other people about it would be bigger than when you don't know anything about most of the content"*. So it can be stated that there has to be a balance between content that the user knows something about and content that is completely new to him. If he knows everything, there is no reason to keep watching.

Here is another example of a one-to-one conversation during the lunch hours.

Staff member #: "Who is this girl?"

Staff member #: "She's a colleague"

Staff member #: "Is she married?"

Staff member #: "Didn't you know?"

Staff member #: "No"

Staff member #: "Like ten years ago? Not last week."

This conversation is mainly initiated from some pictures a staff member sent to Panorama. She worked in the department for a few years on a part time basis. Other members did not know much about her. When she sent the pictures of her marriage to the Panorama system, it initiated lot of curiosity among staff members. In particular, the fact that she had been married for almost 10 years and no one knew about it was very surprising for most of her colleagues. When these pictures were shown during the first few days of our field trial, it received a lot questions from the other members in the lunchroom. Also during the interview session, the example of this particular staff member was mentioned again and again. One staff member commented: *"Of some pictures I do wonder where they are from, who took them and who are on them, because I don't know them. There's a great difference between pictures of events that you did attend to and those that you didn't. For example, the pictures of Hannah's wedding were nice to see, because I didn't know about it and she's not here that often."*

In the interviews, staff members indicated that they also got curious and interested by the content they saw on the Panorama screen. The most logical explanation for this was that members had some point of recognition when they saw a picture that involved a colleague or a familiar setting. Sometimes, staff members saw pictures of themselves that they never knew existed. On other occasions, staff members could recognize pictures they took themselves on the Panorama screen, even when they did not intend to send to Panorama. This frequently happened because multiple copies were spread across the department, at a particular time of an event. They also might want to see the reactions of others on their content. Other examples were those where the Panorama user was present at the concerning event, but might just not know that any pictures were taken that day. In that case the user could ask others to exchange these pictures. A common response in the interview was that a person's attention was drawn by things that were moving on the screen and *"my own content. Not the*

things that I see myself, but the things I made myself. I know I've made them myself, so if someone takes them from somewhere I recognize them easily."

The level of curiosity was maintained by Panorama throughout the two weeks. This was mainly due to the fact that staff members did send their pictures, videos and text messages almost everyday. Staff members noticed changes in the content of Panorama and this led to a motivation to check Panorama out everyday. Here is a comment that we received during our observation session: *"Now all the wedding pictures of Hannah are out, that we saw yesterday all the time. Maybe they get changed every day."* For staff members it was hard to predict the exact sequence of images being presented on Panorama and hence they kept looking for new content. This randomness of Panorama supported the curiosity in staff members throughout two weeks: *"Maybe because the content drops in randomly, you have to keep looking if something new is happening."*

5.4.1.4 Learning new things

Staff members developed knowledge about new things regarding the department as well as about their colleagues by looking at Panorama. Some of the staff members used Panorama to inform about the ongoing and new activities the group is involved in. A week before our field trial, the group had an official photo session to place pictures on the group's website. A technician who was the first to have these pictures sent them on Panorama to allow others to see these pictures. This way he used Panorama to announce the arrival of these new pictures. During a lunch session in the Rappa, this initiated a lot of pleasant reactions and talks between staff members. The following are some examples:

Staff member #: "Hey, wow, our group photos "

Staff member #: "How come these are on Panorama?"

In another case, a senior member in the group posted two messages to Panorama, announcing some collaborative activities with another institute.

—"HMI to collaborate with the University of Trento on a joint Master's degree."
—"HMI involved in a proposal for an Erasmus Mundus European Master's degree."

This kind of announcements initiated a lot of interest in other staff members and led to conversations and discussions during lunch hours. In some cases, members asked the senior researcher to elaborate on such news. The following are some reactions:

Staff member #: "What's with Trento on a joint master's degree?"

Staff member #: "something HMI is working on?"

The project manager in the group also used Panorama to make an announcement related to her work. She normally, kept track of staff members working hours on different national and international projects. She sent a text message stating: *"Please fill the time sheet till week 22nd and may be some English biscuits will appear."*

In addition to the work-related announcements, we also observed that staff members gained knowledge about their colleagues while viewing Panorama. In nearly every interview we did, the example of the female colleague, who worked part time, was mentioned. In this case, several of the staff members in the group did not know the fact that she was married. One of the members commented, *"If you see different sides of people, it helps a lot, normally you only work with them and now you see their holiday pictures, wedding pictures and such. So you know more about their personal things, such as their partners and hobbies."*

Panorama was of some interest to PhD students who were new to the HMI department. Panorama provided especially for them as an extra opportunity to learn about other people. The following except shows a conversation between two colleagues, one of them recently started working in the group. In this case, a very strange picture of a girl having a snake around her neck appeared on Panorama. This obviously, made other members curios.

Staff member #: "Who's the girl holding that snake?"

Staff member #: "No one knows, it's a secret" (laughs)

Staff member #: "It's your girlfriend, isn't it?"

Staff member #: "Yes, so now it's not so secret anymore"

A lot of content that was sent in by the HMI employees featured trips to cities and other events, such as conferences or celebrations. Some examples of the specific topics that people learned about were holidays and events that people of the HMI group attended to: *"It's fun to see old pictures of trips and to see the differences of people who were there and who are still at the department."* In a different example, during a lunch hour, several pictures of different animals and wildlife appeared. This was clearly very unusual from other pictures; hence it initiated discussions about these pictures. The following is an excerpt from a conversation, which led to the information that a staff member went to Kenya and had done safari there during his holiday.

Staff member #: "What's with the giraffe on there all the time?"

Staff member #: "Because someone went to Kenya"

Staff member #: "Ooh, so we want to show off"

5.4.1.5 Initiating interaction

The images staff members saw on Panorama triggered new conversation points, funny comments and behaviors in staff members. At a certain time it also evoked certain expectations among the staff members. While looking at Panorama during lunch hours, a conversation might be started out of curiosity, which often led to new knowledge for staff members. This category is closely related to the previous two categories about stimulating curiosity and learning new things.

It was quite frequently observed that the presence of Panorama in the Rappa initiated conversations. One of the main reasons for this, we believe, was because of the lack of context provided in the pictures. As one of the staff members suggested, *"You do miss context a bit, if you don't know where the pictures are from. During a lunch time, by looking at Panorama, someone asked 'why is there a picture of a giraffe' and then someone starts explaining about it."* This shows that certain aspects needed more explanation and there was always somebody who could provide this missing context to provide a complete story behind such an image. We also found that some of the contents of the Panorama initiated conversation about common interests between a group of staff members. In one case, a member suggested that he would send his pictures of his ballroom dancing classes. Subsequently, a colleague responded by acknowledging similar interests, which then lead to a longer conversation between these two members. In another case, by looking at a picture from an academic conference, staff members started discussing how the conference was and about a member's research interest. The following is an example where an image taken during a group outing led to talks about football.

Staff member #: "That's pictures of our trip to Deventer"

Staff member #: "Deventer got a beating by Ajax the other day"

Although interaction with the Panorama system itself is minimal, it did create some playful situations during the observations. The lack of context from some of the images also led to hilarious comments and poking of fun at each other. A web cam was connected to the Panorama system that showed a live video stream (recorded in the same room) on the screen. At first, people did not like the fact that a camera was pointed at them. But already the first day people started moving around the camera and eventually it pointed at a piece of paper with *"Frans is gek"* (Frans is crazy) written on it, as a practical joke. Some technical issues caused the video stream to pop up more than usual on Panorama. This joke kept getting repeated a few days in a row with new comments everyday. In some cases, staff members made fun of some images. The following is an excerpt of a conversation take took place during lunch time in the Rappa. By looking at a funny behavior of a colleague, staff members present in the Rappa started speculating about him.

Staff member #: "That's one drugged picture, he doesn't look fresh"

Staff member #: "No that's normal style" (sarcastically suggested)

Staff member #: "Looking drunk with ice-tea" (laughs)

Staff member #: "but you don't know that it is ice-tea"

Staff member #: "a big bowl of whiskey"

In other cases, images on Panorama evoked funny comments from staff members. The following comment was given by a staff member, while looking at a picture of a colleague wearing a strange costume:

— "I didn't know we had an astronaut in our group."

Our observations also found that with the presence of Panorama in the department, some staff members built 'expectations'. Some of these expectations were motivated towards getting comments from other staff members and inviting members to talk about it. At a certain moment during observations, people came in to look at the specific pictures they sent to Panorama. One person invited a guest to show him the pictures she sent in. People sat in direction of the screen, so they could watch Panorama while they were eating. The following example shows a conversation excerpt, where a staff members expresses her expectation about talking about herself.

Staff member #: "Everyone is ignoring me a bit today"

Staff member #: "That's the only thing that we can't do because of this screen" (laughs)

Staff member #: "Well, normally nobody looks at me"

Staff member #: "But I said 'Hello' to you the other day at the bar"

The excerpt shows how some staff members built expectations to be commented upon when their images are shown in the Panorama.

5.4.1.6 Cherishing old memories

In the department, the permanent staff members had been working together for a long time. On the other hand, PhD and Post-Doc researchers were temporary employees. Over the years the department saw people coming and leaving, with a lot of reminiscence. Staff members sent several images pertaining to different events, celebrations and social gatherings at conferences from the past. While coming across Panorama, and especially during lunch sessions, staff members talked about past memories and some funny moments with their previous and current colleagues. In the following we provide some examples.

Staff member #: "That's us in Deventer"

Staff member #: "I also want this picture. I saw it several times this week. But I don't have it."

The above excerpt of a short conversation happened when some staff members saw a picture taken during the group's outing to a historical city called Deventer in the Netherlands. The group spent a whole day together exploring the city. A staff member commented, *"It is fun to see old pictures of trips and see the differences of people who were there and who are still at the department. Then you would like to see more content. But a good thing is that there is always somebody explaining the picture if they recognize it. Like the thing where Henry fell and broke his wrist while ice-skating."*

Staff member #: "Hey, who's that to the left of me?"

Staff member #: "Andreea?"

(a) (b)

Figure 5.7: Some of the images pertaining to the group's outing represented on Panorama.

Staff member #: "It's on her goodbye party"

Staff member #: "That's Andreea before she left; she arranged a dinner and some of us went there"

Staff member #: "Aow, quite an old picture"

The above excerpt is another example of reminiscing of events of social gathering when one of the staff members' was leaving the group. These conversations did not last long as the continuous representation of Panorama meant that there would be a new image in a few seconds. Additionally, the secretariats had a huge collection of pictures from the previous 20 years. During our field trials, they sent these images to Panorama, which led to interesting discussions between staff members, especially the new members. For example, figure 5.7b shows a picture of an outing in the early 90s. Some of the new members were pleasantly surprised by seeing old pictures. Some members had very funny reactions on looking at different pictures. Following are some examples of these reactions:

— "Did Anton have black hair?"
— "Ohh yeh, this looks like Dirk."

5.4.2 RGT

As described in the methodology, each of the 15 participants of the RGT sessions was asked to elicit six constructs and rate all five systems (represented on cards) on a scale from one to seven. This section will describe how to interpret and analyze the data that is produced by this method. RGT results can be explained by representing the

data from individual users or by combining all results from all the 15 users. Figure 5.8 show combined results of all the 15 participants.

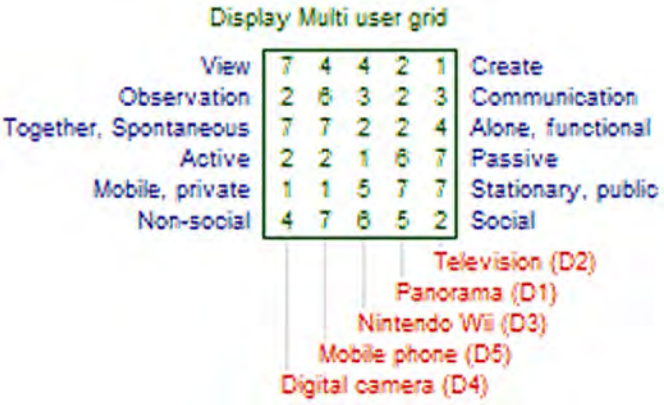


Figure 5.8: Multi user repertory grid.

To get a better overview of the data, the WebGrid V software (`www.repgrid.com`) was used to produce a graphical representation of the user data. WebGrid is a tool that can be used for collecting and visualizing repertory grid data [64]. As shown in figure 5.8, the result of an RGT session consists of a table containing the five devices (D1 to D5) as columns and the user-generated constructs as rows. Each cell contains the rating of a device, with respect to two bi-polar constructs or keywords. A low rating (1 out of 7) means that the device is associated with the keyword on the left, a high rating (7 out of 7) with the keyword on the right. For example, in figure 5.8, the Nintendo Wii is rated 1 to represent a highly “active” device.

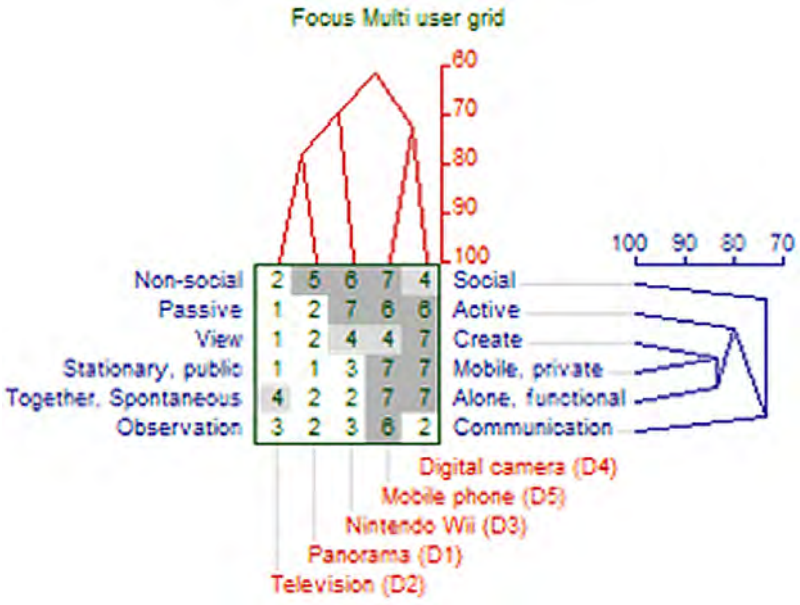


Figure 5.9: Multi user FOCUS grid

One of the graphs WebGrid V can produce is the FOCUS grid (see figure 5.9). The

table here contains the same data as figure 5.8, but all the rows and columns are shuffled and reordered so that similar devices and constructs are grouped together. Two devices are grouped if they have similar ratings for each of the constructs; two constructs are related if they hold similar ratings for each of the devices. At the top of the table, a dendogram (an acyclic graph) is shown in red, that indicates how related the ratings of the elements are, the numbers along the graph show relation in percentage terms. A dendogram for the relation between constructs is shown as well in blue. With this grid, only relationships between elements or constructs based on ratings can be revealed. Fallman and Waterworth [66] suggest that two constructs or elements that are similar in rating could also hold a semantic similarity. This way, relations concerning the meaning of elements can be uncovered, that might not be noticed when one would only have the data as presented in figure 5.9.

We collected 90 user-generated constructs (6 each from 15 participants) from the RGT, which were inputted into the WebGrid V software to produce a large structured grid containing all data. Fallman [64] suggests the formation of clusters of constructs where ratings of for this group are mathematically close to each other. The idea behind this is that such coherence in rating could imply a similarity in their meanings as well. A group of ratings can have a specific dimension of meaning in relation to the chosen systems. The large FOCUS grid is used to find these groups of constructs. Constructs belong to a cluster if their ratings are 90% similar, as can be read from the dendogram. If this percentage is too high, no constructs would be regarded as similar to another. Likewise, if the percentage is too low, the clusters would become so large that the meaning of the cluster regarding the elements might disappear. A cluster consists of at least four constructs. A second round of FOCUS analysis with a threshold of 85% is performed to see which groups are formed around the existing clusters. Some new clusters are created as well.

This method leads us to 7 groups, consisting of 4 to 23 constructs each. Each group consisted of constructs where ratings grouped them together. From each group, one or two labels were chosen by interpretations that are representative for each one. These can be regarded as new constructs for these groups. One group that had no obvious coherence in meaning was left out. The constructs in this group were: (Common place – New); (User in full control – User has no control); (Usable – Not usable); (Warm – Cold). Next, a rating for every group was formed by calculating the mean of all ratings in a group. What is left of the large and unstructured 90 construct user grid is a new grid containing the six most significant meanings that represent how the user experiences these systems. These constructs and their calculated ratings are shown in the grids in Figure 5.8 and 5.9. Each of these unique dimensions will be introduced, analyzed, and discussed both in terms of their origins, their relations to the chosen systems and specifically their relation to Panorama.

In the following, I will briefly analyze the results focusing on the 6 categories of user-generated constructs.

5.4.2.1 “View” – “Create”

This construct originated from a group which described what the users saw as the purpose of the five systems. It included constructs such as *watch, consume, output* and

show versus *create, produce, input* and *capture*. The overall trend was that Panorama and television were seen to be similar devices, used for viewing data and digital camera was purely for creating things. Mobile phone and Nintendo Wii were somewhere in between. Our intention as the developers of Panorama was to create a device to stimulate the social interaction between co-workers of the HMI group. The idea was to achieve this through user initiated interaction as well as system initiated interaction. The current version of Panorama used for this evaluation only allowed for minimal interaction with the system itself, for example, the webcam that was connected to Panorama during the first few days of the observation sessions. Hence, we saw "viewing" as a characteristic of Panorama rather than "creating".

5.4.2.2 "Observation" – "Communication"

The constructs of this group point at the aspect of communication. This was different from the previous construct, because (View – Create) explains how much interaction between the user and the system was possible. This construct tells us something about the way a system can convey a message from one user to another or just from the system to the user.

The mobile phone was the only system that was rated as truly meant for communication, which could logically be explained from its function. Panorama was rated as the most observation related system, together with digital camera. The reason for this was mostly the same as the previous construct: this prototype of Panorama was used for observation rather than active communication through the system. Though this construct alone would not tell us anything about communication between users.

5.4.2.3 "Together, Spontaneous" – "Alone, Functional"

This group was a mixture of a few different constructs. The majority pointed at the social aspect of experiencing a system together with other people versus the individual use. Other constructs included *spontaneous, long time of use, social* and *fun*, versus *planned, short time of use, individual* and *not funny*. The overall impression was that elements on the left hand side of the grid 5.8 were devices that were used in a group for a long amount of time, meant for fun and socializing. On the other side were functional devices that were used individually, where usage was short and planned.

Panorama could be placed in the former category together with Nintendo Wii. Mobile phone and digital camera belong to the latter. Television was right in between. Thus, users experienced Panorama as a device that was supposed to be used in a group, for example, in the Rappa during the observations. Furthermore, it was described as a fun, social and spontaneous device, which corresponded to what was intended by the developers of Panorama.

5.4.2.4 "Active" – "Passive"

With 23 constructs, this was the largest cluster that clearly described the contradiction between active and passive systems. Every one of the fifteen participants came up with this construct, or some variation to it. The most striking thing here was the fact that nearly all users rated the systems equally on this construct. Panorama and

television were on the passive side of the grid, but in general, users indicated that Panorama was a little more active than television. From the interviews after the RGT sessions, participants explained that experience with Panorama led to more interaction between the staff members and therefore was a bit more active. The other three systems were on the active side of the grid, because they required physical effort to control them.

5.4.2.5 "Mobile, private" – "Stationary, public"

This construct explains how the HMI employees understood the use of devices and their functions. Mobile phone and digital camera were regarded as the more task-oriented, mobile and personal devices, whereas Panorama and television and were on the opposite side and Nintendo Wii was somewhere in between.

It was logical that participants found Panorama to be concerned with stationary and public, because this was the way it was presented to them during the observations. The interesting thing was that they saw it as public, in the sense of sharing the personal things with others, contrary to a mobile phone, which was regarded as private.

5.4.2.6 "Non-social" – "Social"

This was perhaps the most interesting cluster, where the participants implied about the aspects of social awareness. This category represented the devices that were considered for the purpose of socializing with others. Here, television was regarded as the least social device, and Nintendo Wii and mobile phone as the most. This gave us a point of reference view the Panorama system, which was rated a bit less social than the Wii and mobile phone, but more than television and digital camera. This was mainly because since Panorama triggered conversations and interactions that were social in nature.

5.5 Discussion

Ubiquitous computing researchers have spent many years augmenting workplace organizations with technology in the quest to create smart workplaces [265, 225, 2]. However, as I mentioned in the introduction of this chapter, non-critical and non-work aspects of workplaces could also lead to more pleasurable, sociable and playful experiences. In this case study, I used a notion of awareness that focuses on the non-critical aspects of work environments including playfulness, experiential and other social aspects. I have described Panorama – a large screen display that playfully mediates cues to support social awareness in an academic work organization. Panorama allowed staff members to send their interpersonal information in the form of images, videos and text messages, which were randomly presented on the large screen in a semi-artistic fashion. Staff members could use such a mechanism to support a broad range of activities from making announcements of personal or academic achievements, through showing holiday or conference pictures to displaying funny or expressive images to evoke certain experiences in each other. At the same time,

Panorama can also capture images and videos from the public spaces of a department and represent them in an abstract way by making sure it does not invade staff members' privacy.

Although the kind of interaction that was supported by Panorama was mainly one-sided – mainly from the technology to staff members, Panorama attempted to provide support for reflecting on staff members' lives, both individually and as colleagues. The design of Panorama was intentionally sensitive to make visible the social and experiential aspects of staff members' activities in the department as well as outside the department. This brought the normal background of staff members' social lives to the foreground, and pushed task focused activities of everyday work to the background [170]. Instead of focusing on tasks, we created a system that functions as a social entity in the workplace and as an alternative view of work life. Panorama strives to create a curious and experiential environment by providing a semi-artistic and engaging window into the social life of staff members. In that sense, it attempts to create a sense of continuous presence of staff members and becomes a resource for conversation and contemplation on the rhythms and routines of the workplace.

Our two-week long field trial of Panorama showed how it stimulated curiosity, initiated conversations and activities during lunch hours in the staffroom. Staff members also gained knowledge about their colleagues and ongoing departmental activities and were able to cherish old memories from previous group outings and social gatherings. Reactions of the staff members of the department about Panorama were overall positive. People enjoyed seeing both current and former colleagues at events organized by the department, and personal content such as holiday, hobby and marriage pictures, as well. It proved to be a great source of new knowledge about colleagues for both newcomers and people who were well-known to the department. The placement of Panorama allowed staff members to carry out their routine activities unobtrusively. During lunch hours, when a few staff members sat down in the Rappa for lunch, Panorama became a source and a trigger for conversations. And at times, it was not in staff members' focus. I believe that this really added value to the quality of Panorama. The serendipity of images and videos and the variety of topics that were covered by them played an important role in supporting staff members' conversations during lunch hours. It also provided an interpretive flexibility during the interactions with Panorama. Recently, the field of HCI has witnessed evaluation approaches that use users' interpretations as the basis (e.g. [218, 111, 261, 133]). During our field trial of Panorama, we collected a large set of staff members' interpretations about their colleagues, their social status, their non-work activities, among other things. Complementing the field trial, we used RGT to gain further insight into staff members' everyday experiences. The main quality of RGT was that it used user-generated constructs to describe different aspects and characteristics of Panorama.

A kind of play that was initiated by Panorama is also worth a discussion. The way Panorama represented information in a random and continuous fashion added to staff members' entertainment and enjoyment. Additionally, the contents of the Panorama became a trigger for poking fun at each other. As we saw in one of the examples, pictures of an unusual pose from a staff member (referred to as 'drugged') initiated funny conversations between staff members. Similarly, staff members were also able

to reminisce about their colleagues and past activities by viewing the contents of Panorama. Playfulness and affectivity were important properties of Panorama that supported social awareness among staff members.

5.6 Summary

Rogers [198] notes, *"we should also be designing* [technology] *to be exciting, stimulating and even provocative causing us to reflect upon and think about our interactions with them."* My work has contributed to an emerging domain for awareness technology, designed for the deeply experiential parts of human life, and not just for a particular task. Panorama is a large screen display that was situated in a publicly accessible area of the department – staffroom. It attempts to mediate cues of social awareness through visual information. It is meant to enhance social awareness in a playful way by displaying non-critical and non-work related information related to co-workers. Panorama provides a window into the unexamined background of sociality of workplaces, and novel perspectives on workplace rhythms and tasks. The field trials of Panorama showed how it generated curiosity in staff members, helped members learn new things about their department and colleagues, initiated new conversations, and allowed members to cherish old memories.

Part III

Design Case 2: Awareness in Design Studios

6

Fieldwork in Design Studios[1]

6.1 Introduction

In part II of this thesis, I showed how technology for supporting non-work and pleasurable social awareness can be designed. In this part, I will describe the design of an awareness system for product design studios. In particular, I will focus on designing an awareness system that can support creativity in designers' workplace activities. In this chapter, I will describe fieldwork in the design studio culture and provide important implications for designing an awareness system. In the next chapter (chapter 7), I will describe the design on an awareness system and its field trials in a product design studio.

This design case differs from the previous one in three ways. 1) Approach-wise, in design case 1, I focused specifically on studying awareness practices of staff members in their department and took into account the forms, activities, agents, place and contents of social awareness. In this design case, I do not focus on studying awareness practices of product designers. I take a broader approach by studying designers' collaborative and coordinative practices in their natural settings. I believe that an

[1]This chapter is based on the following published papers.

1. Vyas, D., Heylen, D., and Nijholt, A. (2008) Physicality and Cooperative Design. In Proceedings of 5th Joint Workshop on Machine Learning and Multimodal Interaction. **(MLMI' 08)**, Lecture Notes in Computer Science, Springer-Verlag. 325-337. ISBN: 978-3-540-85852-2.

2. Vyas, D. (2009) Artful Surfaces in Design Practices. In CHI '09 Extended Abstracts on Human Factors in Computing Systems. **(CHI '09)**, ACM, New York, NY, 2691-2694. ISBN: 978-1-60558-247-4.

3. Vyas, D., Heylen, D., Nijholt, A. and van der Veer, G. (2009) Experiential Role of Artefacts in Cooperative Design. In Proceedings of the fourth international conference on Communities and technologies **(C&T '09)**. ACM, New York, NY, USA, 105-114. ISBN: 978-1-60558-713-4.

4. Vyas, D., Heylen, D., Nijholt, A. and van der Veer, G. (2009) Collaborative Practices that Support Creativity in Design. In: ECSCW 2009: 11th European Conference on Computer Supported Cooperative Work, **(ECSCW '09)** I. Wagner, H. Tellioglu, E. Balka, C. Simone and L. Ciolfi (Eds.), Vienna, Austria, September 7-11, 2009, Springer, London, 151-170. ISBN: 978-1-84882-853-7.

5. Vyas, D., van der Veer, G., Heylen, D. and Nijholt, A. (2009) Space as a Resource in Creative Design Practices.In Proceedings of the 12th IFIP TC 13 International Conference on Human-Computer Interaction: Part II **(INTERACT '09)**, Gross, T. et al. (Eds.). Springer-Verlag, Berlin, Heidelberg, 169-172. ISBN: 978-3-642-03657-6.

understanding of a larger set of collaborative and coordinative practices can provide some useful information about how creativity in design studios is supported, which in turn can be used to inform the design of an awareness system. 2) From an experience-focused perspective, in the previous design case, I focused on playful and pleasurable social interactions as an experiential aspect. In this design case, I will focus on *creativity* as an experiential aspect. This design case is certainly not about supporting task-based aspects of design studios, rather, the focus here is on understanding and designing to support creative communications between co-designers. 3) In the previous design case, I used 'situatedness' as a lens to study people's interactions. Here, I will use 'physicality' [51, 248]as an analytical lens to study and understand creative aspects in the design studio culture. By this I will focus on the material and physical aspects of design studios that play a role in supporting creativity in the design studio culture. Based on the results I will elicit important implications for designing an awareness system that can support and enhance designers' creativity.

My motivation to do this kind of research is multifaceted. First, although research in HCI and CSCW has increasingly started focusing on the design of interactive and collaborative technologies, 'design as a profession' is largely untouched as a subject of empirical study, with a few exceptions such as [124, 207, 194] and a CSCW journal special issue edited by Eckert and Boujut [57]. Secondly, as a part of the creative industry, design cannot be easily formalized or rationalized to a specific set of activities, tasks or other kind of stereotypes. For example, traditional ways of communicating and collaborating may not be so important for the design profession (as we will see later). Additionally, as Lawson [152] puts it, designers use 'synthesis' when it comes to problem-solving, whereas traditional scientists use 'analysis'. Designers' way of thinking focuses on quickly developing a set of satisfactory solutions, rather than, producing prolonged analysis of a problem [45]. Hence, there is a need to understand how designers differ from other knowledge workers in terms of their working practices. Thirdly, I believe that in order to better support designers' work and to develop new technologies (e.g. awareness systems), we need to understand how collaborative practices of designers enable creativity in their everyday work. Mark Weiser's [263] vision on ubiquitous computing projects a world where computation would be embedded into our everyday objects – not just physically but also socially and procedurally. I believe that to be able to support this vision in the design studio culture, we need to study the everyday practices of designers, the tools and artefacts they use and their social interactions. An empirical investigation is required that specifically looks into the ubiquitous, collaborative and material nature of design practices.

In this chapter, I provide details of a longitudinal ethnographic fieldwork in academic and professional design studios. Parts of this fieldwork, focusing on different issues, have been published elsewhere [244, 249, 250, 258, 248, 251]. The aim of this fieldwork was to explore and collect a set of important implications for designing a ubiquitous computing system that can support 'awareness' amongst co-designers. The fieldwork included both academic design studios and professional design studios, involving participants from master's level to experienced designers. I studied two academic industrial design departments and a set of design companies over a period of eight months. Using examples from the fieldwork, I develop the results

around three broad themes by which design professionals support creativity: 1) use of artefacts, 2) use of space, and 3) designerly practices. The theme, *use of artefacts*, represents a set of practices which involve the use of physical design artefacts (such as sketches, storyboards, mock-ups) in order to support creative communication amongst a group of designers. The theme, *use of space*, refers to a collection of ways designers utilize their physical space within design studios to support creativity. The theme, *designerly practice*, refers to a collection of practices, which are very specific to the design studio culture, that help to support designers' communication and collaboration. These broader themes encompass functionalist and instrumental aspects related to design activities as well as inspirational, aesthetic and experiential dimensions that are important to aid creativity in the design profession. These themes are not mutually exclusive; on the contrary, their combinations are frequently used and they are frequently complemented by the other generic ways of communicating, such as, talking, looking, overhearing and so on.

6.1.1 The design studio culture

The concept of studio-based work has been central to practices as well as education within design disciplines such as architecture and industrial design for over a century [65, 16]. A typical design studio (figure 6.1) has a high visual and material character – in a sense that it is full of material objects and design artefacts; studio walls and other less permanent vertical surfaces are full of post-it notes, sketches, posters and magazine clips for sharing ideas and inspiration; physical models and prototypes lying on the desks, amongst other things. Many of the objects in a design studio may have seemingly little to do with the projects at hand, but in fact serve to challenge and inspire new ideas, to create cross-contextual reminders that lead to breakthrough thinking and conceptualization [15].

The role of collaboration between co-designers is critical to a design studio's creativity. As Engestrom [63] explains, the source of creativity is not inside a person's head, but it emerges in the interaction between a person's thoughts and his sociocultural context. In design studios, communication and coordination between co-designers rely as much on different visual and physical aspects as they do on verbal aspects. Additionally, designers do not work in a stereotypical or mechanical fashion when designing interactive products. Designers tend to be innovative, creative and often playful in order to collaborate and successfully meet the demands of building new products and services. Keeping this in mind, the design community has been working on developing tools (e.g. Electronic Cocktail Napkin [93]) that do not demand great effort, commitment or precision and allow quicker production of their design ideas. Instead of using optimization in their work, designers use methods by which they can produce a set of results, all of which might be satisfying a given problem or a problematic situation. As a result, designers frequently use and produce a relatively high number of representations such as, design sketches, drawing, storyboards, and collages, amongst other things. Moreover, methods frequently used by designers such as role playing [25], body storming and design choreography [143] are not limited to problem solving but also include understanding interactional, aesthetic and experiential qualities in designing interactive products. A much more detailed account of

designer's work practices is provided in Nigel Cross's [45] seminal text – *Designerly ways of knowing*.

Figure 6.1: A typical studio workspace.

The physical surroundings of a design studio and the persistence with which different material artefacts are arranged and represented are important to the design activity and serve as organizational memory [3] and distributed cognition [120] for design teams. This ecological richness of design studios stimulates creativity in a manner that is useful and relevant to the ongoing design tasks. The studio space is important for supporting and inviting design critiques [240] and the strongly ingrained designerly practice of showing work and eliciting feedback early and often [45]. Such practice encourages discourse and reflection during the design process [209]. Moreover, in design studios much of the design work is collaborative and group-oriented and the physical nature of design studios can easily afford group-orientation and collaborations. Overall, I believe that the physical setting of the design studio is typically meant to emphasize and stimulate communication, collaboration, and sharing. The spatial aspects of design studios promote a style of learning that is based on continuous dialog, conversation and critiquing on each other's work.

6.2 Related Work – Studying Design Practices

Our everyday communications and coordination acts go beyond linguistic signals and involve the use of material artefacts, locations and physical spaces [41]. In fact, CSCW studies have increasingly shown the importance of material artefacts in coordinating distributed and co-located work [120, 207, 216]. Several authors (e.g., [138, 140] discuss how individuals intelligently make use of physical space and its affordances, in order to establish communication within a group. In the following, I provide a short review from the literature of design studies focusing on the importance of 1) design studio space, 2) material design artefacts and 3) bodily conducts.

1) European projects such as DESARTE [31, 32, 147] and ATELIER [124, 14, 207, 58] have primarily focused on understanding and designing computational tools for design and architecture studios. The DESARTE project aimed at studying the spatial dimension of design studio settings and on its influence on the practice of the design community, as well as on the way people interact within and across project teams and with external visitors and customers. Their ethnographic studies explored that the sense of 'place' is not directly related to the perception of its spatial dimension, but rather to its capacity of bringing forth its main features from the practice point of view [47]. Results of their ethnographic studies have provided useful insights into the 'customizability' of physical workspaces. These studies focusing on architectural design studios refer to the 'communicational' role of space in design studios. The results of their ethnographic studies were used to design Wunderkammer and Manufaktur – a set of 3D environments to provide digitally-enhanced design settings [30]. The ATELIER project had an aim to design ubiquitous computing tools in architectural design studios to enhance learning and design practices, in general. The ethnographic studies of Jacucci and Wagner [124], within the ATELIER project, focused on integrating ubiquitous computing technologies to support students' embodied interaction and to contextualize these technologies to architectural design situations. Their ethnographic research illustrated the importance of material richness and diversity of material artefacts. They also registered the distributed character of architecture learning and the use of space as a resource for collaborative interactions.

Allen [4] studied the effects of physical layout on the probability of interaction in research laboratories and product development firms. His results showed that the relationship between the probability of two people interacting and the physical distance between them was strongly negative ($r = 0.84$). In some cases, research has also illustrated that ill-considered construction of design studio space could lead to a negative impact on designers' creativity [153]. As John Seiler points out, *"buildings influence behavior by structuring relationships among members of the organization. They encourage some communication patterns and discourage others. They assign positions of importance to units of the organization. They have effects on behavior, planned or not."* [211]. Agility and flexibility in design studios are also found to be important in some of the studies. The book by Horgen, Joroff, Porter and Schon [112] refers to the flexibility in design studios as 'workplace making'. The authors suggest that workplace making is a continuing effort of improving and changing basic assumptions about work practices and physical workspace to suit the current needs of design projects. They call for design studios that are much more flexible and adaptive to designers' needs. Agility is another aspect that is seen as designers' ability to quickly respond and effectively make rapid changes in an uncertain situation. In the design studio context the readiness-to-change physical settings is seen to be imperative. Exploring the success of a well-known design company called IDEO, Kelley and Littman [135] suggest that despite the fact that all IDEO offices have a similar feeling and layout, *"one can easy tell it's an IDEO office, each office creates and enacts a distinctive environment. The team dynamics change with projects, and thus, there is a continuing rearrangement of teams, project spaces and neighborhoods."* To the authors the flexibility of these spaces is enough to support IDEO creative practices. Kuhn [146]

suggests that physical space of architectural studios should be arranged in a way so that designers can 1) deal with open-ended problems, 2) carry out rapid design iterations, 3) use heterogeneous media, 4) support formal and informal critiques, and 5) making creative use of constraints. Schon's [209] seminal work conceptualizes designing as a kind of experimentation that consists in reflective conversation with the materials of a design situation. He suggests that this reflective practice involves a continuous process of seeing-moving-seeing [210]. Schon's work does not explicitly make a case for the importance of physical space of studios but a certain organization and arrangement of design studio spaces can greatly support reflective practices.

2) The study of Sachs [199] suggests that in traditional practices of architectural and design students the emphasis in the studio is placed on progress in the creation of the design artefacts and the required representations of it. Hence, progress is expected to be visible as a sequence of design artefacts such as drawings, sketches, storyboards and models – each expanding upon the information in its predecessors. Design artefacts often used and produced during design practices such as paper drawings, physical or graphical models can serve as representations of cooperative work. Once design artefacts are attached to the space, the materiality, stigmergy, public availability and knowledge landmarks of these artefacts help in supporting communication and coordination amongst design teams. Schmidt and Wagner [207], in the context of architectural design studios, developed the notion of coordinative artefacts by illustrating how coordinative nature and resourceful materiality of artefacts such as architectural maps, 3D models and CAD plans make design artefacts amenable to coordination. Work of Perry and Sanderson [183] in two different engineering design companies showed that the design process was tightly bound up with the creation and modification of a variety of design artefacts. In particular, the authors show that the 'public' representation of these artefacts played an important role in supporting intra-group communications. Interestingly, Robertson [195] has specifically focused on the role of 'public availability' of artefacts from Merleau-Ponty's phenomenological viewpoint and attempted to establish relationship between awareness, perception and public availability of artefacts. The materiality of design artefacts can greatly support collaborative creativity in design studios [129]. The communicative, engaging, perceptual capabilities of material artefacts make them richer not just from an informational viewpoint but also experientially and aesthetically. Material artefacts let designers experience through seeing, touching, smelling and using other motor skills. The analysis of Jacucci and Wagner [129] shows that materiality supports intuitive and simultaneous manipulation, mobilizing our tacit knowledge and enabling participation. Focusing on the work practices of graphics designers, O'Neill and colleagues' [177] ethnographic results revealed that designers build up practical, tangible, visual understandings of color and suggested that such an understanding of color schemes are not supported by the current technologies. They claimed that current technologies required designers to deal with color in an abstract manner. They provided several important directions for developing color management work flows for graphics designers.

3) Amongst the empirical work on understanding design practices, Tang's [231] classic study focuses specifically on collaborative drawing, using observational video-

tapes of three to four people collaborating at a table. Tang identifies several features of collaborative work activity that should be taken into account when designing collaborative technologies. These are: 1) the importance of gestures, 2) drawing space as a resource for collaboration, 3) the importance of the process of collaborative drawing itself (instead of the final result), 4) recognizing the mix of simultaneous activities, and 5) the spatial orientation of collaborative workers. Focusing on distributed design projects in industrial settings, Robertson [194] develops a taxonomy of embodied actions of designers. She suggests that the public availability of different artefacts and embodied actions of distributed participants in a cooperative process could support communicative functions. She also argues that flexible and mobile access to the publicly visible information could improve coordination. Hornecker [113] uses an experimental setup where a group of co-located participants uses an assembly of three-dimensional objects in order to carry out paper prototyping as a design activity. Generating implications from a set of video recorded paper-prototyping sessions, her goal is to develop a graspable interface using table-top display technologies in order to support co-located design work. She focuses on the role of embodied actions such as use of gestures, parallel activities of participants and alignment of gestures with design artefacts and talks.

6.3 Study Methods

To be able to explore the the collaborative practices that support creativity in design studios, I aimed to get a naturalistic view on how design is practiced in design studios, using EM orientation. Here, as mentioned in the introduction of this chapter, I did not attempt to study awareness per se, but get a larger account on designers' collaborative and coordinative practices, from a physicality point of view. I studied industrial design departments at two technical universities and a set of design companies in the Netherlands. My access to the design studios in companies had some time-bound limitations, whereas the access in academic design studios was open and prolonged. This has been reflected in the methods, observations and the data that were collected. See table 6.1.

In my investigation, I studied designers and design researchers as well as students who were involved in master's programs. The ethnographic fieldwork lasted approximately eight months, with nearly 250 hours spent in the field. I used three methods for studying designers' everyday practices: naturalistic observations, contextual interviews and video recorded collaborative design sessions of designers and design students. In the naturalistic observations, I studied the collaborative aspects of the design studios. My goal here was to understand the natural circumstances of designers' collaboration, the tools and methods they use, and how the creative process of design is achieved. In this case, I spent several hours observing designers' work and their collaborative design sessions, by taking notes and pictures. In the contextual interviews, I asked 10 master's students of industrial design and 5 designers / design researchers to participate in the study. I asked questions on individual ways of designing and on how designers understood creative ways of working. I asked how

Setting	Methods		
Academic	Contextual Interview	**Participants**	**Work Dynamics**
		1. Design Researcher	Design researchers from a technical university were asked questions about their ongoing design projects.
		3. Design Researcher	
		3. Master's Student	At industrial design departments of two technical universities, we invited eight master's students to give an account of their everyday design activities. All the students worked on collaborative projects with other students throughout their academic studies. All were based in studio-based working environment at their respective universities.
		4. Master's Student	
		5. Master's Student	
		6. Master's Student	
		7. Master's Student	
		8. Master's Student	
		9. Master's Student	
		10. Master's Student	
	Naturalistic Observations	Over a period of 6 months, we visited industrial design departments at two technical universities. We spent hours observing and understanding students' interaction with each others. At one university, one of the authors participated in several week-long design courses to get a thorough account of student design practices	
	Live Design Meeting/Sessions	We recorded design sessions of four design projects. 1) A project about designing a set top box for elderly house holds for supporting their medication 2) A project of collaborative sketching. 3) A project on designing a product to support remote communication between family and friends. 4) A project of designing interactive toy for children. We invited these groups for a final interview, where they gave us an account on their design process.	
Professio-nal	Contextual Interview	**Participants**	**Work Dynamics**
		11. Head of a design company	Ran a 30-people design company that focused on engineering design products.
		12. Designer / Lecturer	Partnered a small design company with a colleague. Worked on a large variety of projects varying from designing a postcard to creating exhibitions.
		13. Junior designer	A recent University pass-out who started his own design company that focused on graphics design.
		14. Senior designer	A designer with 30 years experience in four different design companies.
		15. Senior design researcher	A designer at a large design company that focused on developing a variety of products and technologies.
	Naturalistic Observations	We carried out naturalistic observations for a week at an ICT design and research company working in the social and cultural domain. The company had around 50 designers and design researchers working on different projects and was spread across two locations in a city. The company's major focuses were designing ICT products in the area of healthcare, arts and culture, e-society and education. The company had several studio-based design facilities and had multi-disciplinary approach to design. During the observations, we unobtrusively observed their work practices, creative design sessions, and communication styles, among other things.	
	Live Design Meeting/Sessions	At the above mentioned design company, we observed and video tapped designers' collaborative discussion sessions. In some cases, we left our video cameras at with the designers who later on returned these cameras at the end of their recorded design sessions. In most cases, we jumped into the ongoing projects, in which the designers had to explain their previous design activities for our records.	

Table 6.1: Information about setting, participants and methods.

they brainstormed, what methods they used to come up with a design concept, how they conveyed ideas to each other, their preferred tools for designing, the perceived advantages of using such tools, and so on. I took opportunities to record design sessions of groups of student designers. In some cases, I was the participant observer collaborating with design students and recording their design proceedings. I was also allowed to record live design sessions in a design company.

All interview and observation notes were reviewed and video recordings were analyzed to explore important patterns. I categorized all interview notes and observations and used open coding [223] to draw out the similarities and differences between designers' creative practices. That is, for each unique observation I coded it with a descriptive stylized label. I then compared subsequent observations with the coded ones, where I marked recurring similar observations with the best matching code. Observations that did not fit were given a new code. I then used the coding and categorizations along with affinity diagramming [110] to reveal key themes within the data.

6.4 Results – Practices that Support Creativity

Using physicality as a lens, I explored different practices that I have categorized in the following three generic themes: 1) Use of artefacts, 2) Use of space and 3) Designerly practices.

6.4.1 Use of Artefacts

Material design artefacts such as sketches, drawings, storyboards, collages, cardboard, clay or foam-models, physical prototypes and their different manifestations during a design process play an important role in supporting communication and coordination of ongoing work between co-workers. In general, use of artefacts can be seen as externalization of thoughts, ideas and concepts on a range of physical media. Designers' externalizing practices vary over time (at different stages of design), in modality (from paper sketches to physical models), in purpose (exploratory or definitive), and are subject to individual preferences. In a single design project, design practitioners produce and use a plethora of design artefacts to support their work. Within the context of industrial design, a design artefact can be seen as a 'mediator' as well as a 'product' of cooperative design. When I talk about artefacts, in the rest of this chapter, I mainly refer to physical artefacts with three-dimensional shape and material qualities. Schmidt and Wagner [207] argued that in CSCW research the term 'artefact' is used also in mentalist and cognitivist sense, which may be confusing when understanding the actual material practices. Hence, when I talk about artefacts, these are material artefacts.

6.4.1.1 Artefacts in the design cycle

Design practitioners use and produce a plethora of material design artefacts to support their work. In the case of product designers, these design artefacts can vary in representation and modality and range from paper sketches, drawings, storyboards,

foam and cardboard models and so on. An analysis of design artefacts produced during a collaborative product design project can lead to useful information for understanding the coordinative practices of designers. As such, the use and manipulation of these artefacts is not a given, neither do these artefacts exist objectively in designers' everyday practices, but they are constructed in and through the process of design. Additionally, artefacts can be seen in two different ways: artefact as a tool to support work and, artefact as a representation of work. Artefacts such as a drawing board, ruler, pencil and others are used as tools to support designers' work. Whereas artefacts such as a design sketch, clay or 3D model can be considered as representations of the design process.

A design cycle cannot be strictly defined but it is a process, often iterative, that habitually starts from defining a problem or brainstorming and ends at a point where a final working prototype is produced. The observations of different collaborative design projects showed that during design cycles design artefacts play a pivotal role in supporting communication and coordination between co-designers. In the following, I will 1) use a design project that I observed as an example to describe the way design artefacts help in supporting coordination, and 2) describe how, in a design cycle, the role of these design artefacts go beyond supporting productive and task-based activities and encompass the 'experiential' aspects of design.

1) I will provide details of a collaborative design project carried out by four master's students working towards developing a health-care technology for the elderly population. The project was a 4-month assignment, as a part of students' academic degree, where they had to design a working prototype of a technology that helps elderly people with their medication intakes. I followed the students' collaborative design sessions and also took into account their individual activities. At the end of the project, I collected a large number of design artefacts produced during this project. In the following I provide my analysis depicting the importance of design artefacts.

Figure 6.2 shows a few examples of design artefacts pertaining to the collaborative design project. As can be seen here, the design artefacts varied in their modality, scale and materiality. Figure 6.2a shows four different versions of the software interface which needs to be manipulated by a remote control, figure 6.2b shows a technical drawing of the remote control, figure 6.2c shows physical models of the system and figure 6.2d shows a software prototype being tested in the field. The following is an excerpt from the final group interview. It shows the primacy of design artefacts in supporting decision making and coordination.

During an interview session, one of the participants of this project gave the following account: *"We started off with brainstorming and then made some sketches about different ideas. We had a list of requirements and we then tried to match these with different design sketches we had. So, we laid out the sketches on a table to be able to discuss and select one that fits the requirements and is doable. We also made digital sketches with AutoCAD and Visio. However, for discussions we preferred the physical sketches to provide critique on each other's work. We made several different foam models of the remote control. We took them to the elderly people to get their informal feedback during the design process."*

These design artefacts also served as representations of different cooperative ac-

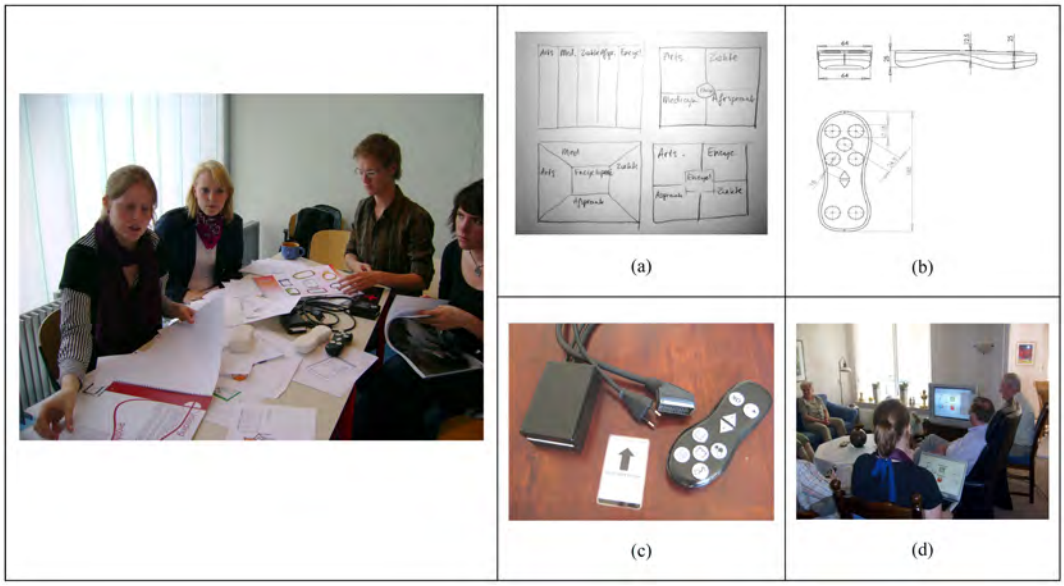


Figure 6.2: Final interview with the design group, where participants gave an account on their design process. Examples of different kinds of design representations: (a) brainstorming ideas using different versions of the interface on a paper sketch, (b) technical design of the remote control, (c) physical models of the system and d) software being tested during a field trial of the prototype.

tivities. For example, some of the sketches (figure 6.2a) described the brainstorming process that was used by the group. Additionally, these representations, in the form of a design sketch or a detailed design, carry a great number of conventions, notations and layers that can be very useful when designers collaborate with each other and allow them to extract the information they need. Designers can also extract the details of notation, format, and syntax underlying their form and use, such as the specific techniques involved in working with maps, charts or matrices. The important issue here is that the materiality of different design representations can afford and trigger different collaborative actions in the design team. In Bruno Latour's [149] terms, these representations have the characteristics of immutability and mobility. In other words, these artefacts can work as a persistent form of information as well as a carrier for information that can be moved in or out of the work space in order to support efficient collaboration between different co-workers. The immutability and mobility of artefacts, designed or used during a design process, allow co-workers to collaborate and coordinate work amongst themselves.

Another use of design representation is to establish communication amongst peers. The sketches and models that designers develop serve as a communication tool in the design team. Also, because a part of what I studied was an academic environment, it was very important for the design students to showcase their thoughts and ideas and make them visual, not only for themselves but also for other people to show what they were doing. Some of these students did work with external clients and for them it was very important to be able to communicate their design ideas. One of the students commented, *"an advantage of sketching is that if I am in a meeting with a client*

and I can quickly show my ideas to them then, so it is very powerful in communication." Besides just using words, physical models help designers to quickly show their clients the prototypes and models and issues that are very specific to actions and interaction. And the more examples of these external representations they have, the more useful it would be for communication with the clients. One of the virtues of these tangible artefacts (within a space that itself has material qualities) is their engaging capacity. They ask us to experience through seeing, touching, smelling, maybe also gesturing, heaving and moving. Involving all the senses is to do with richness of 'informational cues'.

The multi-modality supported by these design artefacts provided an understanding of the design practice that might not be conveyed through sequential text or speech. Considering different stages of any design process, designers routinely produce different models of the product they are trying to build. This could range from a conceptual stage in a sketch, to a cardboard model, to a full prototype. Figure 6.2 can also be seen as examples that provides different levels of multi-modality of the design artefacts. As can be seen in the figure, the multi-modality of these artefacts involves two-dimensional handmade drawings (6.2a), three-dimensional physical object (6.2c) and a software-based representation (6.2d). It is important to note that these variations influence the properties of a representation and suggest or enable different usages, interaction styles and variations in meaning, even when they represent the same object, idea or concept. Each of these models can be seen as having a specific 'mode' of expression, when put together these model form a multi-modal representation of the design concept. The materiality of these artefacts connote a variety of qualities that are connected to the designers' senses (vision, sound, smell or touch) and vary with parameters such as weight, thickness, transparency, and so on. It is this multi-modality that turns the materiality of an artefact into a source of multiple channels of interactions that could lead to rich experiences.

During the course of a design process, artefacts go through many changes. The temporality of different material artefacts could help in establishing an understanding of the process that is used in the cooperative design work. Because of the iterative nature of a design process, temporality becomes especially relevant since there will be a need to understand, explain and mediate the design activities involved in it. The materiality of these representational artefacts could provide a great deal of information about the way they are created, used and manipulated, conveying the process that is applied in designing. Importantly, the temporality serves not only as indicative of different stages of a design process, it also serves for accountability (planning, managing, budgeting, and so on) of the design work. A thorough insight into different artefacts produced during a design process could lead to some indication about change of plan, change of methods or any other deviations during the cooperative work. Especially in the collaborative design processes, these artefacts provide cues and signals for the co-workers to appreciate the intention of colleagues and the challenges and problems that are faced by the others. The temporality is indicative of the design-in-progress which is of a great importance in cooperative work.

2) My observations in design studios showed that the role of design artefacts goes beyond communicating and coordinating task-based and productive information and

encompasses experiential aspects of design. During the fieldwork with designers, researchers and design students, I found that it was important to understand the experiential nature of artefacts at three levels of a typical design cycle(figure 6.3): exploration, communication and use [250]. Exploration level refers to an early stage of design where designers or design researchers use different methods to understand the problem and the situation that they are designing for. Communication level refers to the phase where designers collaboratively develop ideas and concepts using different methods and techniques. Use level refers to the phase where designers try to evaluate and test their ideas and concepts amongst themselves and with prospective users. There are blurred boundaries between these design levels and it is only in order to associate different artefacts with these design phases that I apply this kind of classification.

As can be seen in the figure, there is a list of material artefacts associated with these three phases of design. There are mainly two types of artefacts, those that are already in the environment and those that are created by designers. I take both into account in my analysis. I believe that an understanding of the experiential role of material artefacts could lead to a detailed analysis of designers' practices. In the following, I will discuss the three levels.

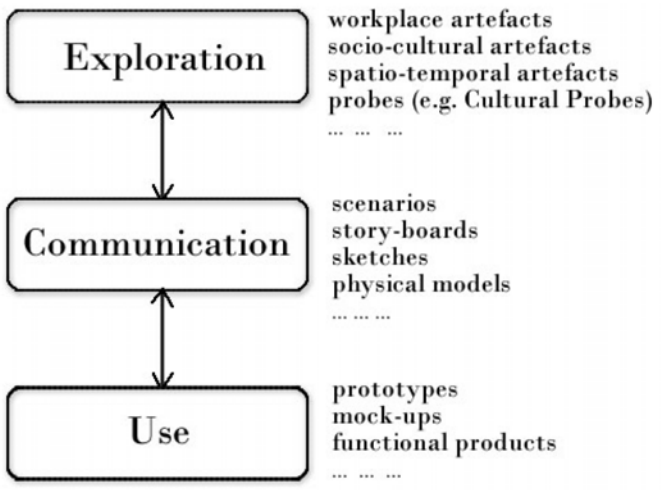


Figure 6.3: Three levels of a typical design cycle where material artefacts play an experiential role.

Exploration From the fieldwork, I observed that design practitioners take into account workplace artefacts, socio-cultural artefacts (within domestic settings) and the life cycle of these artefacts. These artefacts are already in the environment and the way they are organized, arranged and maintained informs designers about how these are experienced by people. In some cases, user-generated artefacts produced during different design exploration methods such as participatory design or a cultural probes study [82] also inform designers about people's experiences. These artefacts represent and embody users' expressions, performance and reasoning of their everyday life. In the exploration phase, to a certain extent, design practitioners try to develop a sense of empathy with users through these artefacts. These artefacts bring about dialogical

effects confirming the physical, emotional and conceptual realities. These artefacts may not be seen as isolated objects indicating aspects of users' experiences but these are evidences of the happenings that are related to social and cultural circumstances.

Communication In this phase I observed how material artefacts, that are created by designers as design representations, such as sketches, storyboards, mood-boards, physical models and so on, help in communicating the experiential information within design teams. These artefacts help in building an experiential common-ground in teams. Importantly, material artefacts such as physical models allow the designers' direct and bodily engagement and hence broaden communicative resources by evoking sensory experiences. The multi-modality and ability to support and convey information through all senses, makes the use of an artefact experientially rich [129]. In the case of joint design activities, co-workers do not just interact with these artefacts when they are designing, they actually get the feeling and experience of each other's activities through these artefacts. This really helps in the process of collaborative design in which the designers are always in search of new, creative and inspirational ideas. The communication channels that are established by these multi-modal artefacts go beyond facilitating and satisfying basic task-oriented activities.

To an extent, as I observed, the whole design practice progresses through the use and manipulation of these representations and through iterative refinements of both the conceptual and physical designs of products being designed.

Use This is the phase where designers try to develop a better understanding of what it is really like to use the products and services that they have collaboratively designed. They come up with several versions and low and high-tech prototypes of their envisioned system and try to use and test their system themselves or they invite prospective users to use the system in their natural environment. For designers, the goal is to convey a specific type of experience through the use of the artefacts they have designed. In my fieldwork I observed that designers needed to have quick feedback on their designs. There are two ways of achieving this. First, designers interact with each other and try to use and observe the initial experiential effects of their products. This obviously happens in an informal way. In the next step, designers go to their potential users, and ask them to use the system. Trying to maintain the integrity of experience is priority here. However, the experience of the product in the current situation also adds to the overall quality of use. A final system evolves during an iterative process where designers experiment first with low-fidelity artefacts and later with functional prototypes to collect feedback on the user-experience.

6.4.1.2 Exploration

Before arriving at a concrete design idea, designers go through innovative and iterative cycles of exploration. Designers explore new ideas and concepts at different stages of their design cycle using different material artefacts such as sketches, mock-ups, models, working prototypes and so on. These types of external representations help designers to establish a creative sensibility. For example, sometimes sketching is used for visualizing designers' thinking as it stimulates creativity not only within their head but also with their hands. As one designer commented, *"in order to make design decisions you need to do explorations and for that you need to make different levels*

of prototypes". These explorations may not necessarily be about the products themselves but about the interaction and expression that designers want to communicate through the products. These explorations can be of simple interactions, for example, sliding, rotating, tilting, and stretching mechanisms that could be incorporated into a product. The very basis of the exploration process is experiential in nature. Designers do not use explorative processes only to solve a problem or to carry out a design task, but to try out ideas, satisfy their imagination, envision and experience creativity.

In my fieldwork, I observed that the process of exploring and playing with material artefacts was continuously present and seen throughout the design of products. It covered a broad category of design activities: from very early during the brainstorming session, through developing interaction mechanisms, and designing concepts to evaluating the final prototype. I observed that designers' decisions to choose different design representations and materials for their design explorations were heavily based on these design stages. As one designer suggested: *"I start with sketches and doodles, my room is filled with these doodles, and eventually I try making detailed sketches, and then foam models and wood models. So, the process is like starting from 2-D and then make it 3-D and give more details over and over."* I observed that designer's selection of representations utilizing different material artefacts was based on their own interests and choices and the adequacy and appropriateness of their design representations. One designer suggested that, *"the way I go about developing a new concept is starting very broadly and narrow it down to a specific idea."*

I provide two examples of explorative practices from two collaborative design projects. The first project uses sketching as a tool to explore new ideas, whereas the second project makes use of material objects to explore an open-ended idea.

1) The first example was a part of a design project that aimed at developing an interactive 'emotional diary'. My particular emphasis in this example is on the use of paper sketching and how the use of such a routine approach helped designers to support experiential qualities in their thinking and in designing of systems. Figure 6.4 shows a few examples of design and concept sketches that the designers showed me during an interview session. In the following I provide a brief excerpt from an interview with the group members of this project, where one of the team members starts with describing the concept of the emotional diary.

Member 1: *"This diary is meant to be the closest friend of its owner. So, only by holding it against the chest* (sketch in 6.4a) *a designer would be able to open it. The diary will feel the heart bits and warmth of the body and only then it lets you open it and you can read its contents. So, it is a very private encounter."*

Member 2: *"We wanted to achieve an interaction shown in this sketch (points to 6.4a). So made several different versions of sketches to visualize how this could work. We came up with different interaction styles.* (Referring to the sketches in figure 6.4b) *We thought of touch screen to provide a digital insight with dynamic contents. Another concept was like the diary grows with the person. So, when you write negative things in it, it starts looking dirty and when you write happier things it starts looking shiny."*

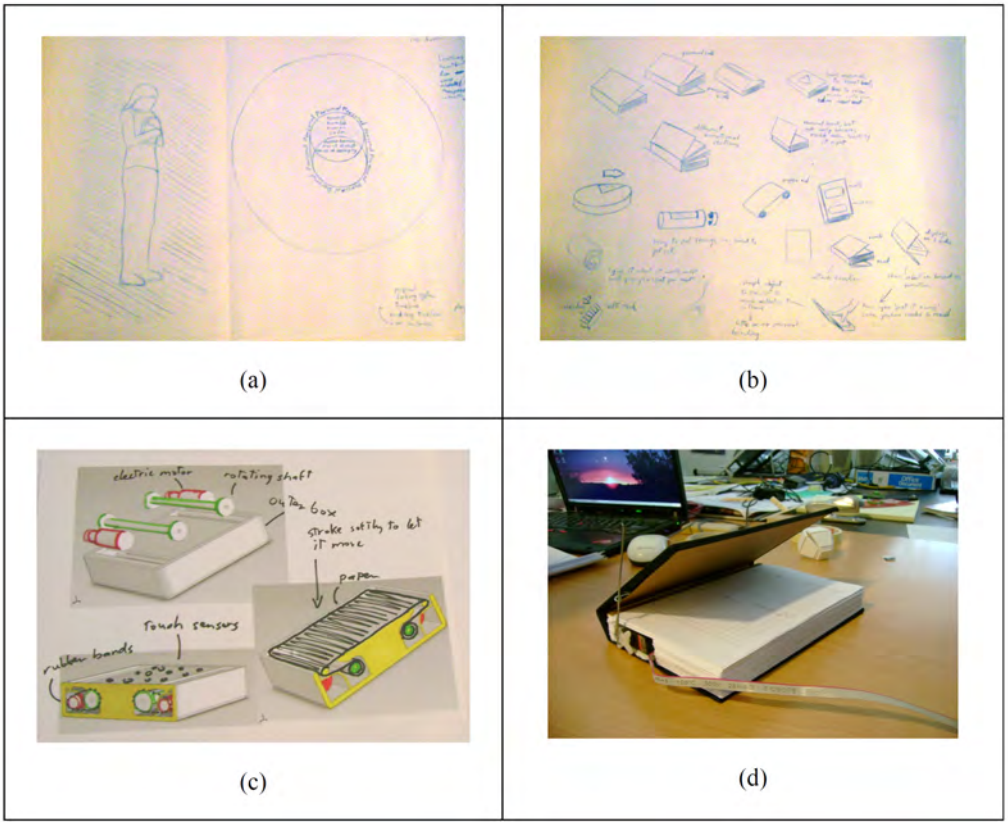


Figure 6.4: A set of sketches of an interactive diary concept developed by a designer for exploring emotional interactions.

Member 3: *"We also explored different forms for the diary with these kinds of sketches. For example, here* (referring to figure 6.4c) *we thought of a page scrolling mechanism in the diary. The pages can only be scrolled in one way, so others cannot see the older contents. In this sketch, we also tried to figure out the technology that might be used to make such a scrolling mechanism possible."*

The design team developed a large number of sketches during the course of their project. The members of the team preferred sketching as a way of exploring new ideas. One of the members commented: *"Sketching could be a very quick and inexpensive way of exploring forms and interaction mechanisms that you want to use in your product."* From the above excerpt, one can see that the sketching process allowed designers to make their creative and innovative ideas visible in a quick-and-dirty way. The diary's form factors, interaction mechanisms, and use of technology were explored by creating inexpensive design sketches. Figure 6.4d shows one of the prototypes that was developed by this group, where a diary is equipped with an Arduino micro-controller. The use of design sketches for easing communication difficulties and sharing creative ideas is well known [9]. The example here shows that in addition to communication and sharing, design sketches also play an important role in cooperative explorations of design ideas.

2) Use of sketching for developing design ideas has some limitations as it might

not allow designers to experience and feel the three-dimensional qualities of their design ideas. As from the field observations, there were several designers who chose other techniques to explore new ideas, particularly utilizing material artefacts such as cardboard models and wood models. Creating design models in different forms and textures allows designers to get a feel of their products. A physical model allows designers to extend their mental conceptualization of their product to a sensory one. A designer commented during the contextual interview session: *"Seeing something on a paper is definitely not the same as having something on your hands. With a physical thing, I can touch it and I can imagine how to interact with such as thing far more easily compared to just looking at a paper sketch."* Another designer, by showing a wood model in his hands, comments: *"I am not that good in drawing, so I prefer making 3D quick-and-dirty models. This kind of model can provide the feeling of vibrations and elasticity effects through the sound, movements and other behaviors. With this you can communicate so much to others and also test your concept at the same time. And through that cycle of talking to others and playing with this object you get new ideas or even strengthen your original idea."*

I observed that there are things that designers cannot easily envision through drawing or sketching. They have to practically apply their ideas in different forms of physical prototypes. From a contextual interview with a student designer, I provide an example of such a design project – where the goal of the design team was to develop a communication system that uses 'sensory cues'. To achieve this goal the groups of designers adapted a highly creative design process which involved exploring different sensory phenomena. The aim of this process was to create an aesthetically pleasing, unobtrusive way to communicate information utilizing different sorts of sensory mechanisms. I will provide a set of examples of material artefacts that were used to support collaborative exploration process. More importantly, I found that these explorations did not serve any direct purpose of solving a design problem but helped designers' imagination, creativity and allowed them to be able to experience certain phenomena that are not possible via other means of explorations.

Figure 6.5 shows four such explorative setups that this group developed to be able to visualize and select an appropriate communicative effect. Figure 6.5a is an example of exploring the effect of smoke and different light colors in different shapes of glass. The idea here is to explore which combination would be suitable for a given situation. This designer explains that *"there are certain things that you cannot envision in a normal situation, things like 'smoke'. So in order to understand the behavior and interaction with smoke and utilizing it into design you have to build some things and play with it."* By joining the exploration of smoke with different kinds of lights, the designer explains, *"even by playing with a light I can get several ideas about new ways of interacting with lights, like blinking, fading, making patterns, so expressing new behaviors through the use of lights and different colors of lights. This opens up my visualization skills and provides new spaces for design. In this case if I just sketch this smoke with light, I wouldn't get that feeling. Here you can play with your hands, move the smoke around, this is a very different kind of design expression and gives me a different feeling."* Figure 6.5b shows a model to explore the pendulum effect of three small ball-like objects. The goal here was to communicate 'urgency'. As the designer commented, *"you can*

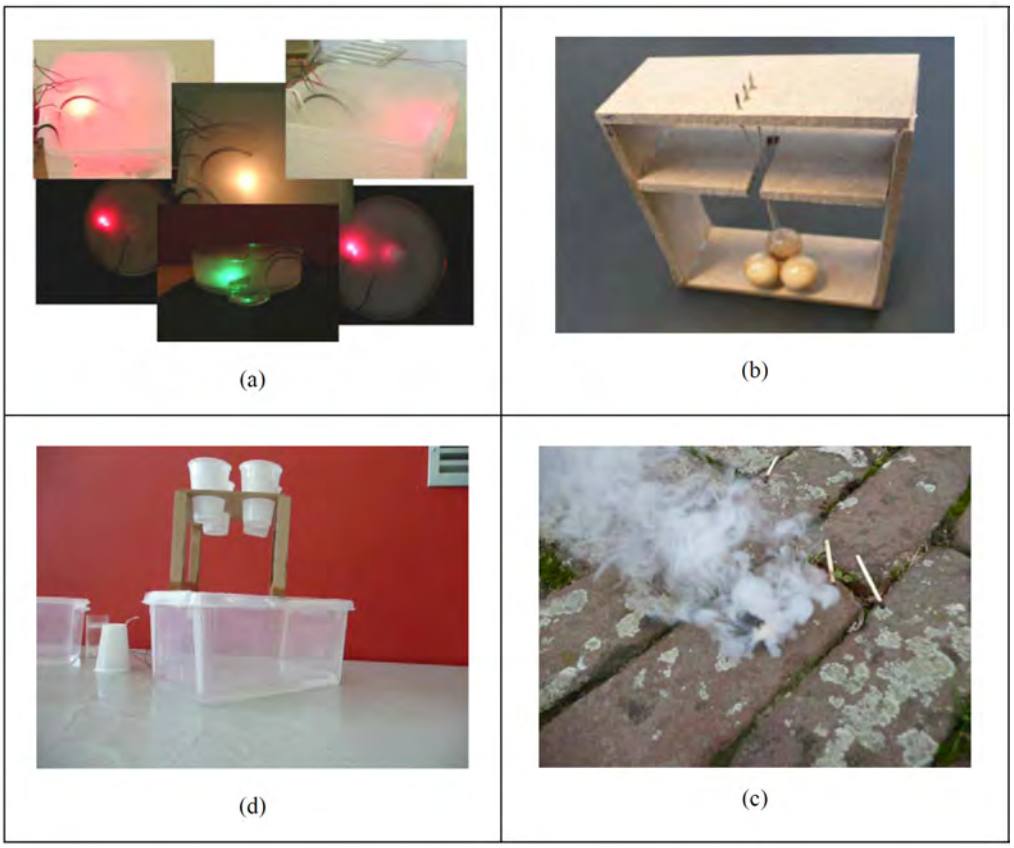


Figure 6.5: Playing and exploring with smoke and lights to develop new ideas. (Photo courtesy of Rob Tieben).

change the frequency or use sounds or add other types of behavior to it. An important thing is to see what we understand of it. You can't take this to users as this does not have any functionality. But within us designers this gives a lot of information and helps to explore new possibilities." Figure 6.5c shows a model where designers aimed at understanding the behavior of water streams from different sources. The model uses some plastic glasses with holes in them and different lights are beamed from outside to see how the water behaves in the bucket. Figure 6.5d shows a very mundane experiment of matchsticks' smoke mainly to see if such smoking patterns would be appropriate for the designers' needs.

These explorative setups do not tell us much about what the product would look like or how it would behave. Some of the explorative models may not seem useful to others but for designers making such models can be a valuable resource for their design process. Overall, I believe that designers' explorative practices using different design artefacts can help in establishing 'experiential' common ground between designers which helps their creativity, imagination and innovation processes.

6.4.1.3 Material Richness

The material qualities of design artefacts play an important role in supporting communication and coordination between designers. Design artefacts have a wide range of

physical properties such as, spatial (size, shape, proportion, location in space), material (weight, rigidity, plasticity), energy (temperature, moisture), texture (roughness or smoothness, details) as well as other dynamic properties. Designers continuously make use of the richness of material qualities of different design artefacts before arriving at the final version of their product. The material richness carries substantial experiential effects and is not only observable in the final product but also within different design representations that designers create during their practice. Using an example I will illustrate how designers utilize the richness of the materials they use in their design exploration.

Figure 6.6: A set of physical models seen at the desk in a design studio.

In the previous section, we saw several examples of explorative models. These examples also illustrate how designers try to understand and exploit the material richness before arriving at the final product. In their day to day work, designers continuously make use of the richness of different materials, depending on their needs and preferences. Figure 6.6 shows a range of physical models developed from clay, foam, wood and plastic. The aim here was to make an 'interactive toy' for kids and exploring different shapes using different materials could provide useful information for the designers. These artefacts help in building an experiential common-ground in teams. Material artefacts such as physical models allow the designers' direct and bodily engagement and hence broaden communicative resources by evoking sensory experiences. The multi-modality and ability to support and convey information through all senses, makes the use of an artefact experientially rich [129]. In the case of joint design activities, co-workers do not just interact with these artefacts when they are designing, they actually get the feeling and experience of each other's activities through these artefacts. This really helps in the process of collaborative design in which the designers are always in search of new, creative and inspirational ideas. The communication channels that are established by these multi-modal artefacts go beyond facilitating and satisfying basic task-oriented activities. On the preferences of different material for designing products, a designer suggested, *"I have been a fan of MDF wood. It is solid but at the same time you can mold it in different shapes and sizes and it feels heavy and beefy. When some products are made from solid materials, they are perceived as real products, like a heavy remote control of a television. When a prototype is light it may not be perceived a serious one."*

Figure 6.7 shows an example of a designed product of a master's student called

Figure 6.7: Afterlife object: An experiential system that preserves the uniqueness of the body of the loved one. (Photo courtesy of Jan van der Asdonk)

'Afterlife object'. Afterlife object is a lighting system that preserves the uniqueness of a person by representing his/her unique DNA patterns through dynamically generated crystals on its top surface. According to the design student, this device is a new way of preserving the unique body of a loved one for reminiscing purposes. Connecting a person's unique DNA patterns with the growth patterns of a specific type of crystals represents that something of the person is still with his/her family members. The quality and details of the product carry a lot of emotional and personal significance. The shape of the product is based on the Shinto religion. It is like a holy object that should not be held in hands, hence is developed in a square shape (and not round) preserving its 'reservedness' and 'importance'. Its external body uses the rare African Bubinga wood. When somebody stands close to it, the device lights up and the crystal at the top surface develops a specific pattern. The object shows an afterlife of a person. The variety of materials used in this object – crystal, wood, glass, light, and so on shows the material richness that is exploited by a designer to evoke specific experiences in people.

The afterlife objects is the final version of the designer's work. This example shows how the designer has carefully taken into account the materiality and selected specific materials to fulfill his design objectives. As I mentioned earlier, the richness of materiality is also exploited at different stages of design. I observed that material richness is utilized for exploring and playing in the design space, for externalizing design ideas and for establishing communication with different stake-holders of the design project.

6.4.2 Use of space

"Space is a resource that must be managed, much like time, memory, and energy. When we use space well we can often bring the time and memory demands of our tasks down to workable levels. We can increase the reliability of execution, and the number of jobs we can handle at once."

– David Kirsh [140]

Space and spatial arrangements play an important role in our everyday social interactions. The way we use and manage our surrounding space is not coincidental, on the contrary, it reflects the way we think, plan and act. Within collaborative contexts, its ability to support social activities makes space an important component of human cognition in the post-cognition era. To some extent space can be seen as a technology that we use to support our actions. The use of space has become so implicit in our everyday lives that we do not realize how it helps in our thinking, planning and other behavior. The use of space theme refers to how design practitioners utilize their physical surroundings within design studios in order to support collaboration and creativity in their work. In the academic as well as professional design studios that we studied, it was observed that design teams used their office walls, whiteboards, clipboards, wooden panels and so on as carriers of their design-related information. The types of information that are attached to these spatial objects have instrumental and productivity related functions and can be seen in the form of design ideas, sketches, to-do lists, project-related information, work-in-progress data and other organizational details. At the same time, they also carry inspirational, provocative and other non-instrumental details such as posters and innovative design sketches. We saw that the way information was represented in the space provided indications about collaborative and methodic practices of designers [244]. This way of making work visible reminded the designers of ideas to be pursued or further developed, of tasks to accomplish, of standards, and so on. It is also an important vehicle for peripheral participation in a project, allowing visitors to enter its context. Conversations are opened up; designers are forced to explain to continuously changing interactors. They can create and communicate their identity without closing it too much. Figure 6.8 gives

Figure 6.8: An example of creative ecology in a design studio.

a glimpse of a section of a design studio where a design team has used clipboards, large sheets of cardboards and movable tables to develop a creative environment. In

addition, there is information about project plan, post-it notes, design sketches on the clipboard, as well as the prototype on the table. An environment such as this establishes a *'creative ecology'* within a design studio both at personal and social level. In the following, I will discuss how arrangements such as these help in establishing creativity.

In this section, I will provide a set of examples from the fieldwork where space and spatial resources were used to support coordinative design practices. I will first provide the notion of artful surfaces – referring to the creativity and resourcefulness of designers to create a workspace that is full of design-related materials. Using examples I will describe how these artful surfaces come about helping in designers' everyday work. Next, I will discuss how spaces are created to support collaborative projects.

6.4.2.1 Artful Surfaces

Design studio surfaces such as designers' desks, office walls, notice boards, clipboards and drawing boards are full of informative, inspirational and creative artefacts such as, sketches, drawings, posters, storyboards and post-it notes. Studying the use of these surfaces, I introduced the idea of artful surfaces [244] – surfaces that designers create by externalizing their work-related activities, to be able to effectively support their everyday way of working. By artful surfaces I mean how artfully designers integrate these surfaces into their everyday work and how the organization of these surfaces comes about helping designers in accomplishing their creative and innovative design practices. Studio surfaces are not just the carriers of information but importantly they are sites of methodic design practices, in other words, they indicate, to an extent, how design is being carried out. For us, the conceptualization of studio surfaces is not limited to different physical locations or physical objects and their placement, but more a phenomenological notion of 'place' that interweaves material, social and situated views of studio surfaces. Hence, when I talk about design surface, I do not talk about the mere physical space but an appropriated design workplace that has design artefacts such as sketches, posters, drawings and storyboards attached to its surfaces.

In the two industrial design departments that I studied, I observed that many surfaces were specifically created and shared amongst a group of co-located designers and design students. The main purpose of using these kinds of surfaces was to share resources and information amongst relevant groups of people. Here, the surface itself was shared but not necessarily the informational and inspirational artefacts on it. However, there were some examples of jointly owned artefacts on these shared surfaces.

Normally, these shared surfaces were created and used over a long period of time. They were mainly in the vertical form and very rarely in the horizontal form. Most shared surfaces were large notice boards, clip-boards, and physical walls within design studios. They carried both informational and inspirational design artefacts. Typical candidates were informative artefacts such as design sketches, scenarios, use-cases, design principles and guidelines. And inspirational artefacts such as posters, magazine cuttings and related material were also used. Importantly, artefacts like

Figure 6.9: A shared wall, full of sketches, design ideas and other informational artefacts with an added layer of post-it notes and other annotations.

sketches have an inherent nature of sharability. I also observed that these artefacts were also indicative of different phases in the design process: past ideas, the current state, future planning, and so on. During the interviews, one designer commented, *"depending on the phase of the project, I arrange my surroundings. It's important for me to have these artefacts around so that I can register where I am at in the project".* Hence, these design artefacts are also the markers for reminding. Another design student commented, *"the space allows me to organize my work and get reminded what I am doing daily. Also for the purpose of communicating with my peers I can very easily show what I am doing."*

Additionally, as shown by Baskinger [9], two-dimensional design sketches are useful not only to develop a design idea, they are used for envisioning, recording, and narrating ideas, sharing and reflecting both at an individual level as well as at social levels. These design artefacts can be pointed to, talked about or annotated on. Design artefacts can function as mediators between different individuals or groups in design. As an example of shared surfaces, figure 6.9 shows a part of an office wall cluttered with different artefacts that was shared between 3 -4 design students in a co-located setting. Since these surfaces were used by several people for different purposes, these surfaces had some form of loose organization. It is well documented in several design studies (e.g. [183]) that design artefacts such as sketches because of their material properties play an important role in supporting communication between different designers. Figure 6.9 shows different labeling and patterning schemes in order to allow clear understanding of the information. It also shows colored post-it notes indicating categories of the artefacts and annotations and comments made by co-inhabitants. In this case, the shared surface is used in a multi-layered way and their portability helps in (re)arranging these artefacts. The intention of creating and using shared surfaces is not necessarily to support coordination of ongoing work but to make each other

aware of certain ongoing activities.

The surfaces also include resources from designers' past projects. When faced with a design problem, designers apply knowledge that has been acquired in previous situations to draw references to existing solutions as inputs for their idea generation [169]. Similar patterns were also seen in my findings where designers utilized product samples, catalogs, photographs, slides and so on from their past work and organized them into mood-boards, collages and folders. In many cases, I observed that designers and design students were working on several projects at the same time. Another reason for organizing the personal space in such a way was that unless certain design artefacts are visibly placed on these surfaces, they tend to get 'lost' in the muddle of tasks and parameters that are normally considered simultaneously. For some of these designers, even a slight or unintended change can lead to problems in their design practices and in some cases once a design artefact is lost from the 'sights' of designers, it would eventually mean that the design artefact may never be retrieved again in a near future. In these cases, such an organization of personal surfaces would lead to quick response from designers in a timely pressured situation.

I now explore the communicative role of these personal surfaces. The purpose of these personal surfaces was to have a quick look at different artefacts on these surfaces and to provide ease to bystanders while communicating on specific design issues. The communicative role of personal surfaces, in fact, leads to utilizing the vertical surfaces such as walls, notice-boards and drawing-boards, compared to horizontal surfaces such as a desk. I observed that certain design artefacts were placed in a way so that others can 'fly through', take in 'at a glance', and 'recognize immediately' what is going on. These selected reminders of the context of a project which is one of many are different in kind from the detailed view needed for completing particular design tasks. During the interview session, a designer commented, *"within a project I need a strong foundation to start with. So, when I am communicating my ideas I need to have several different aspects about my design. Because when the foundation is strong it helps in convincing people. These visual objects around me show my foundational work and work as strong building blocks."*

Figure 6.10: Shared Surfaces: at students' workspace (a) and at a designers' workspace (b).

Figure 6.10 shows two examples of shared space that we captured during the

ethnographic fieldwork. The example on the left (6.10a) shows a shared surface artfully created by a group of designers working at a co-located space. Making this a 'tea-corner', a group of design students had developed multi-layered shared surfaces using wooden panels. The purpose of these surfaces was mainly educational as it included visual design guidelines and best practice schemes. This way of creation and use of surfaces showed how design students wanted to influence and learn from each other. As Downing [55] suggested, humans learn to value certain things from their communal networks. His notion of transcending memory becomes very relevant and important here. For students, when they share their design artefacts such as sketches and posters in a visual public space, it not only helps students to understand the essence and meaningfulness of these artefacts but also helps them imagining the future concepts and design ideas by referring to those original design artefacts. In figure 6.10, the example on the right (6.10b) shows a shared surface in a studio of senior designers. On a large common wall, designers kept information about their individual project work, some design posters, their calendars and work schedules and some design prototypes of interactive photo frames can also be seen on the wall. Interestingly, one can see commonly used tools such as printer, cupboards and post boxed aligned with these design artefacts on the shared surface. This in fact increases designers' interaction with the shared surface.

I observed that the physical and public nature of shared surfaces encouraged designers and design students to easily discuss and manipulate the contents incorporated in these shared surfaces. It was seen that these kinds of arrangements were configured and re-configured in a series of different situations to which the designers can react. The examples in figure 6.9 and 6.10 showed a mix of different types of design artefacts placed for different purpose. By mixing narrative elements with descriptions of design ideas a sensibility for the actual context at hand can be supported.

Figure 6.11 represents an example of another artful surface. A professional designer organized his workplace by sticking different images, sketches and posters on two of the walls in his office. In the following I provide an excerpt of the contextual interview he gave us:

Designer: *"I like this room, because I can work in a silent environment. I can also turn on music. Sometimes, it is very stimulating to have music in the background. On the other hand, this space allows me to organize my work and get reminded what I am doing on the daily bases."*

Interviewer: *"What are these images on the wall?"*

Designer: *"I have actually two walls. This is more a dynamic wall (figure 6.11a), here you can see a design project that I am currently working on, involving digital photo frames. So, here are some objects related to that project. On this wall things go off and on from time to time."*

Interviewer: *"What about the other wall?"*

Designer: *"This is more like the traces of my design carrier. So, you see all kinds of projects that I have worked on. Here you see (by pointing fingers) a project where*

(a) (b)

Figure 6.11: Walls inside a designer's office, representing inspirational and project specific artefacts.

I developed a set of persona, in the middle you see my graphic design work that I have done for others. And in the bottom you see other projects that have worked on."

Interviewer: *"What about this big poster?"*

Designer: *"This is something very special to my heart. It has a spiritual significance in my life and gives me a good feeling when I start my day. And then here are some pictures of people who inspire me."*

One of the walls in this designer's office was more or less static (figure 6.11b) and the other was dynamic (figure 6.11a) in a sense that its contents were changed over time. The static wall had artefacts ranging from inspirational sources to information about successful projects representing a portfolio-type appearance summarizing the designer's interests and achievements. This was an example of creating and displaying 'social identity'. On the other hand, the dynamic wall had information about current projects and the arrangement of these items was a bit messy. In addition, he also kept documents about his plans within projects on his office desk. Overall, the portability and flexibility of these material artefacts help designers to personalize their work environment.

6.4.2.2 Project-specific Spaces

These types of surfaces are created by a team of designers when they work on a collaborative project. These surfaces are normally away from designers' personal workspaces. The organization, placement and interaction with these surfaces depend

(a) (b)

Figure 6.12: Project-specific surfaces.

on the kind of project that designers are working on. The surfaces are developed using movable whiteboards, wooden walls, tables, or a more fixed placeholders such as walls. These surfaces hold artefacts that are relevant to a specific project. Informational artefacts related to project definition, project schedule, to-do list, division of work, design concepts and sketches and so on are normally seen on these surfaces. As the project progresses the contents of these artful surfaces emerge or change, but also diverge. Figure 6.12 shows two examples of project-specific surfaces. Figure 6.12a shows a workspace made of soft wooden sheets (created for temporary purposes) that carries information about a particular project that deals with designing an Instant Messaging (IM) system. On these surfaces one can find information related to project description and goal, a detailed project schedule, initial sketches, related literature information and possible design concepts. Interestingly, the physical space is intentionally used to create a rich ecology of where a group of designers can completely focus on the project. Figure 6.12b shows another example of project-specific surface, where office walls are used to contain information related to a specific design project designing for bus stop passengers. On the wall one can see images of different types of bus stops, sketches about design ideas, some scenarios and a project schedule.

An important aspect of project-specific surfaces is their support for planning and organizing ongoing design projects. As can be seen both the examples in figure 6.12, as projects progresses designers add and change new information to the surface and the new schema of the surface provides an overview of the work-in-progress information. Project-specific surfaces are explicitly intended to capture or summarize the point that a project or part of a project has reached. And such an environment helps during the time when negotiation needs to take place or agreement needs to be obtained from within the design team or from outside parties. The design artefacts on these surfaces can be referred to as *"boundary objects"* as these artefacts serve as a common ground for supporting group related activities [221]. Latour [148] has argued that visualizations simultaneously support constructing the artefact and staging its performance and understanding by others. In this case, project-specific surfaces serve as a visualization of different activities from assemblies of artefacts which tell a

'story', such as the story of the design concept or of a particular choice of material and product. On the other hand they enrich the imagination space both of the design team itself and of the audiences to which the project will be presented. Although not all the material created in the design process will be published, it is hard to distinguish at this point between different uses and audiences. All of the representational material will be used by the team itself - creating a representation always means taking a step forward in the common understanding of the design.

Another important use of project-specific surfaces can be seen in figure 6.12b about maintaining a connection between the rich context of a given problem domain. As I mentioned earlier, designers use contextual and in-situ methods such as ethnographic studies and participatory design to "step into the users' shoes", get an insight of users' world. And often, it becomes difficult to communicate this experiential and contextual information to co-workers by verbal means. By keeping visual information about study contexts helps designers to ease this communication difficulties and even help remind them about their work. So, in this example the images of different bus stops and different design sketches related to them can provide contextual sensibilities and allow designers to focus on these contextual cues. Secondly, this also helps in visualizing and coming up with new concepts about their design solutions. The physical space allows people a kind of flexibility by which designers can make connections and associations of design sketches, images and other visual representations. Association of objects helps designers to grasp 'abstract' concepts. Mitchell's [168] observation that although an image (or idea) may be 'abstract', *"language, narrative, and discourse can never - should never - be excluded from it" (p. 226)*. In this sense, association objects are used for bringing the narrative element in a concept to the fore. And obviously, language, and metaphors are also used for emphasizing specific design qualities.

In addition, I also observed that design teams used other forms of horizontal as well as vertical surfaces to support their collaborative design activity within an ongoing project. Figure 6.13 shows two examples of movable whiteboard, where, in figure 6.13a, a group of design students working on developing 'an interactive toy for kids' have kept different concept sketches, time-schedules and scribbles about desired functionalities. This kind of artful surfaces can be taken along to different meeting places, where designers, using pens, can add or change its details. Similarly, figure 6.13b is a whiteboard with written information about project schedule, deliverables, plans and current status of the project. We can see indications of changes by co-members of the team. This kind of arrangement allows team members to constructively criticize as well as build on each other's work throughout the duration of a project.

As we can see from all these examples, the function of project-specific surfaces is largely productivity-focused. Time-management, scheduling, work progress and division of workload were the most important functions of these artful surfaces. A normal time line of this kind of artful surface is the duration of the project (2 to 6 months) in the case of students I observed. During the project, these surfaces allow a team to organize, manage and reflect on their work in an effortless, visual manner. The informational artefacts that are attached to these surfaces are used both in synchronous and asynchronous manner. During a group meeting, for example,

(a) (b)

Figure 6.13: Movable whiteboards full of design artefacts.

designers can easily refer to or demonstrate particular design phenomena by showing or pointing to specific artefacts. On the other hand, it allows individual members of a team to leave traces of their actions when not all members are present. In both cases, this type of artful surfaces serves as mediators of social coordination.

6.4.3 Designerly Practices

By designerly practices, I mean a certain kind of practices that are specific to the design studio culture. These practices cannot be seen from a functionalist or task-based perspective, as they do not serve any immediate purpose of solving a design-related problem. Designers apply these practices to enrich their design and stimulate creativity in their work. In the fieldwork I observed several of these practices that supported coordination and awareness within groups of design teams.

6.4.3.1 Use of Body

During ongoing design projects, designers accomplish activities and tasks not only through their internal cognitive processes but by utilizing cooperative 'embodied' actions [194]. Designers creatively make use of their bodies while, for example, talking, explaining a design sketch to others or in referring to spatial arrangements within a design studio. While the use of gestures and other bodily representations for discussing design ideas is common in design studios, there is an increasing use of design methods such as role playing, body storming or design choreography in design groups [119]. Using these methods, designers explore and experience design possibilities for themselves, intentionally make these ideas public and allow other designers to reflect

Figure 6.14: Exploring design possibilities through performances. (Photo: courtesy of Rob Tieben)

on these ideas. Here the design cooperation is achieved by the mutual perception of these actions as the basis for the ongoing creation of shared meanings in a particular design task. The use of bodies can be seen in different design stages to support different needs. In the following I will explain how the use of bodies helps in creativity.

It has been suggested that bodily movements are suitable as a design technique, as our bodies convey emotions as well as geometry and interactions [119]. Role play methods allow designers to imagine and empathize a given design challenge. A physical activity is a primary source here to explore new possibilities. In the fieldwork I found that many of these bodily actions were aimed at better understanding of the design task context and at exploring new possibilities. Figure 6.14 shows two examples of exploring design possibilities. Here, the participants, using different bodily patterns, are exploring the possible behaviors of the product to be designed. The vividness of these experiences and the bodily understanding of a given design situation help designers to make better design decisions [29].

Our verbal languages may not be enough when communicating issues related to complex technologies. While designing new technologies or products, designers have to think about out-of-the-box ideas that may be difficult to articulate using verbal means. One of the main objectives of applying role play methods is to communicate early design ideas and concepts in an engaging and participative way that could establish common-ground for the group of designers [29]. Additionally, many product designers need to deal with issues such as branding, marketing and advertising. Methods such as role play help in dealing with all these issues in one package that requires a combination of functionality, expression and communication. Studies have shown that gestures, in addition to their purely communicative role, help lighten cog-

nitive load when a speaker or performer uses them in combination with speech [231]. Through role playing, a performer's ability to map his/her actions to certain features or tasks of design could help in understanding the envisioned product.

Our physical bodies play a central role in shaping human experience in the world, in understanding of the world, and in interaction with the world [142]. In addition to exploring new ideas and improving communication possibilities, I also observed that the use of role play and other participatory methods provided new perspectives on bodily experiences. When designers enact a particular scenario, they go through a set of emotional and experiential phases that not only make their actions personally meaningful but also lead them to envision how a potential experience should be.

6.4.3.2 Thinking by Doing

Figure 6.15: Externalizing design knowledge on different materials such as paper based sketches. (Photo: courtesy of Connie Golsteijn)

Designers communicate through a varied set of design representations often involving different materials, modalities and scale. To an extent, the whole design practice progresses through the use and manipulation of these representations and iterative refinements of both the conceptual and physical forms of products to be designed. Through externalization designers can visualize their ideas and concepts by actually creating them (putting things into practice) and not just by thinking about them. The physical activities and tasks that designers carry out allow them to think about the design of their products in a better way. During an iterative design process design artefacts such as sketches or models 'talk back' to designers [209]. The epistemic knowledge developed during the process of constructing different design artefacts and externalizing design ideas leverages the way designers deal with elements of surprise and unexpectedness.

Our fieldwork on designers underscores the centrality of 'thinking through doing' (or thinking through externalizing). It was observed that a single design team would collectively develop an average of 50 to 100 external representations of their design

ideas, depending on the project. These vary from paper based sketches or cardboard models to physical models. Because different styles and levels of fidelity of a representation yield different perspectives, meanings and experiences, externalizing ideas through a variety of prototypes affords a richer understanding of a design. Figure 6.15 shows an example where a particular design representation is used to support discussions. Figure 6.15 shows a design group using a collection of paper based sketches with annotations on post-its attached to them. Being able to create more than one representation and alternatives of an idea and to try them out is in fact a major requirement for supporting creativity [68]. The thinking through doing theme suggests that the effort invested in developing different design alternatives helps co-designers to compare and judge important aspects such as the difficulty of building the final product.

6.4.3.3 Creative Social Practices

By creative social practices, I refer to a large set of collaborative methods and approaches that designers employ in their design activities. I observed several types of these practices from the fieldwork. It would be impossible to talk about all of them, instead, I provide a glimpse of these by providing examples. Designers apply some innovative and creative social approaches to experientialize the design of their products. What this shows is that designers do not work in an orderly fashion and they are not task-oriented. During the interview session, I asked designers if they used any check-lists, protocols or guidelines while designing their products. Strikingly none of the designers had a predefined way of working. According to them, since their design projects have a large diversity, ranging from designing a postcard to intelligent products and from designing a tooth brush to automobile instruments, applying a formal and pre-specified design approach is not desirable.

Designers use different brainstorming techniques (figure 6.16) at different stages of their design process. For example, at an early stage of design, techniques such as keyword generation, word-associations, and sketching ideas on a large sheet of paper are used to get a broader perspective on the design. Whereas during the concept development stage, techniques such as interaction mapping, role-playing or theater techniques are used to develop behavioral mechanisms in the product.

The most important aspect of these kinds of social practices is that discussions within a design team help to get a better perspective and refinement of the original idea. As a design student suggested, *"I prefer working in teams. While working in a team you can have an exchange of ideas and concepts and also of each others' feelings about the design. You can build on each other's ideas and that gives a big advantage."* Influencing each other's work is also an important aspect. As can be seen in figure 6.17, designers are working on a large sheet of paper. In this case working in very close proximity not only helps them talk and see each other's work but also allows learning, adapting and improving on their own work. As one of the design researchers commented that *"it is always an iterative process of creating and reflecting on it. By sitting close to each other and explaining ideas through drawing you can design together and co-reflect on your work."*

In dealing with their users and clients it is important that designers develop empa-

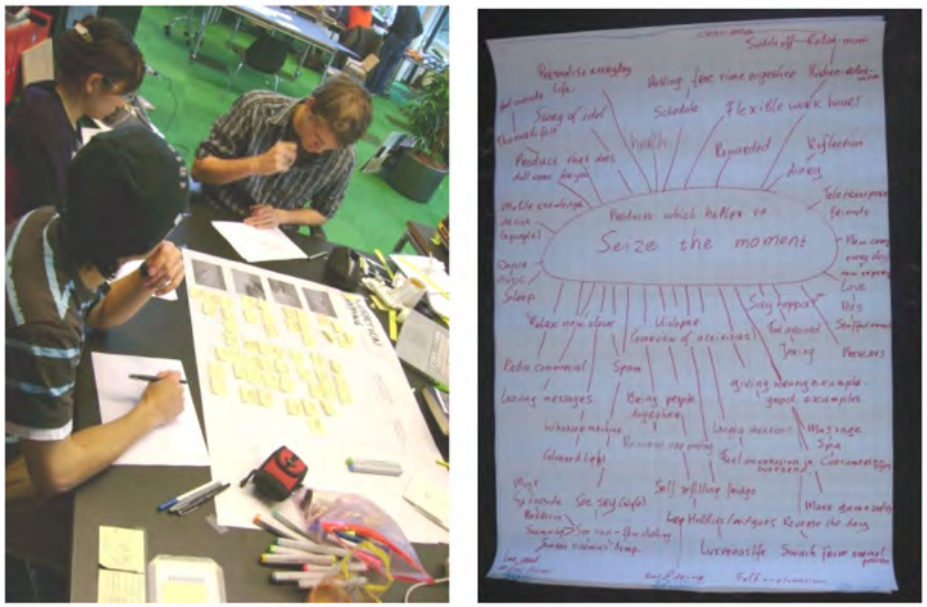


Figure 6.16: Design students brainstorming at a table and a large sheet with brainstormed information (photo courtesy of Connie Golsteijn).

Figure 6.17: An example of drawing together on a large sheet of paper.

thy with them. Clearly, it is not just about collecting data as a set of requirements and direct observations of users but it facilitates going much deeper into understanding users' experiences. In cases where designers cannot easily collect information from users, they try to use innovative methods amongst themselves. One of the design researchers commented, *"For designing for elderly, we asked some of our undergraduate and graduate students to understand what life is like as 80+ years-old what we call geriatric sensitivity training. By limiting students' physical and sensory capabilities, they were asked to perform very generic activities. This lead to an empathy about the eyesight, movements, and range of motion of the elderly. When students developed this type of understanding, it allowed them to look through things more critically, they could deal*

with questions in a better way." In a different example some of the design students attempted to design for people with sleeping disorders by not sleeping for 2 nights themselves and getting a feeling of what it is like to be really tired and still have to finish your everyday things.

6.4.3.4 Ephemeral Collaborations

One of the striking aspects that I observed in the academic design studio was the informality and ephemerality of the way design students communicated and collaborated with each other. This was certainly not considered unusual; in fact this was expected from the students. It was preferred that students would not just sit-down and design all their products on their own. The students would intentionally move around, change the location of their work, create new collaborative spaces, play with different things in the studio, and so on. This is clearly not what we see in other, especially the more formal, work-environments.

Figure 6.18: Ephemeral meeting places, full of sketches, post-it notes and other artefacts.

As a result of this kind of practices designers develop their own ephemeral environments as can be seen in the above two examples in figure 6.18. The advantages of these kind of practices by designers are a) this allows them to communicate in close spatial proximity and hence make the information publicly available to all the members of the design team and establishes common-ground in the team; and, b) it provides personalization and flexibility in a sense that it can change the look and shape of the collaborative work environment. These kinds of ephemeral practices support designers' creativity, innovative thinking and comprehensibility.

6.5 Discussion and Implications

In section 6.4, I did not talk about the 'awareness' aspects of the design studio culture. Instead, I provided a broad set of collaborative and coordinative practices, using 'physicality' as an analytical lens. In the quest for studying awareness, Schmidt [203] has laid several important questions that need to be answered. One of them is: How do actors exploit the material and conventional environment in monitoring unfolding events? As Schmidt [203] emphasizes, it is not entirely clear how actors emit (act of displaying) and collect (act of monitoring) these cues. Schmidt also suggests that

the materiality and physicality of work environments play an important role in this. It both facilitates and constrains the processes of displaying and monitoring of these cues. Additionally, in the information rich work environments, actors can find infinite ways to display and monitor these cues and traces. In the field of design and in particular product design studios, the information that needs to be conveyed goes beyond productivity, task-based and other instrumental aspects of work.

The aim of this fieldwork was to inform the design of an awareness system for design studios. The results shed light on three generic themes of coordinative practices, namely, use of artefacts, use of space and designerly practices. I illustrated these themes using examples from the fieldwork and showed how material and physical aspects play a role in supporting coordination in the design studio culture. I focused on understanding awareness by means of the coordinative practices that designers employ in going about their everyday work. In particular, I focused on the material and physical aspects of these coordinative practices. My approach borrows several conceptual instruments from Schmidt and Cimone's [206] notion of 'coordinative mechanisms'. Their focus on the role of material artefacts is central to the understandings of material coordinative practices. In fact, the role of materiality in supporting cooperative work is well acknowledged in the CSCW literature [216, 120, 7, 207]. Several conceptual notions such as distributed cognition [120], cognitive artefacts [174], boundary objects [221] and external memory, among others, have shown that material artefacts have several qualities that allow actors to use them more than just as retainers of information but as memory aid and a communication and coordination tool. The field of work plays an important role on how material artefacts and other spatial resources are utilized by its actors to be able to convey awareness-related cues. As we saw in this chapter, designers extensively utilize the material qualities of design artefacts in their day to day work. They also make creative and resourceful use of spatial arrangements and use design methods that are very particular to the field of product design. Clearly, a functionalist approach [54] to explore awareness and cooperative work in this context may not be able to encapsulate experiential, aesthetic and inspirational aspects that are frequently communicated between designers.

Regarding the two distinct settings that I studied, academic and professional, questions might be raised about how I could reconcile the results or how I could generalize them since these are two different 'settings'. Firstly, my topic of study was the design studio culture, which in fact exists in both academic and professional fields of product design. Even though, one might find difference between these two settings, a large amount of work practices remain the same. Secondly, I would like to stress that what I have presented in this chapter is what normally called 'ethnography for design' [189]. I do not seek to make claims about the field of design, per se. I seek to find plausible ways to design new technologies that can be used in a given environment. In fact, the following section will provide details of design implications that might be used for developing a new awareness system.

6.5.1 Implications for Design

In the last two decades, new breeds of interactive systems utilizing mobile, tangible and augmented-reality technologies have emerged that support ubiquitous and flexi-

ble collaborative work. In particular, several researchers [239, 50, 224, 5, 159, 114, 27] have pursued a particular design theme: computationally augmenting everyday, mundane artefacts and work spaces in order to facilitate and enhance more 'natural' interactions amongst the collaborating participants. Interactive furniture, tabletop displays, and other types of smart objects have been realized in recent times. Researchers have been exploring the elements that make up interactive spaces and the effects these spaces have on collaboration. Different approaches have been implemented to support group work with adapted office spaces and room elements, but so far, at this early stage of development, none of these approaches alone offers a consistent solution to the question of how to integrate technologies in objects and environments in a way to support collaboration. One of the advantages of this kind of interactive systems is that since our everyday furniture and workspaces are universal and socially already adapted and integrated, operating with this augmented system is well understood. In such scenarios, the computer disappears and objects take advantage of computational capabilities to support new usage scenarios [50]. The domain of work being carried out and work practices of people situated in it also play important parts.

Technologies developed for supporting design practices have mainly focused on the conversation paradigm of face-to-face interaction between meeting participants. This chapter focused on the coordinative and awareness practices of industrial designers. Unlike other more formal domains of work (e.g. finance, medicine), work in the design profession has an inherent embodied and ubiquitous nature. Being a part of the creative industry, design professionals have to be innovative, creative and sometimes playful in order to successfully meet the demands of building new products and services. Their everyday collaborations go well beyond conversations and talks and involve communication of expressions, feelings and artistic reflections through design related artefacts such as sketches, physical models, prototypes, and so on.

The results of the fieldwork points to four important design implications that can be considered for developing awareness system for the design studio culture.

6.5.1.1 Artefact-mediated Interaction

As I showed in this chapter and also echoed by other studies on design and architectural practices [124, 207, 183], designers develop a multitude of design artefacts in the form of paper sketches, drawings, physical models and so on over the course of their design projects. The materiality, stigmergy, public availability and knowledge landmarks left on design artefacts help in establishing and supporting communication and coordination between designers. I believe that an awareness system should be able to incorporate these artefacts (at least partially) into its design space so that its natural and experiential qualities can still be exploited by designers. I believe that the ubiquitous computing research needs to focus beyond merely digitizing physical objects and take into account the material qualities and the role of these artefacts and their value in design studio culture. As Sellen and Harper [216] showed in their work, *The myth of the paperless office*, the value of a physical artefact such as paper is its materiality and affordances which allow for mobility, portability, sharability, that are not easily substituted by a new digital paper technology. I believe that there is a

value in sustaining the sanctity of a material artefact and a technology should build on these material qualities and not replace them. More importantly, in the design studio culture, design artefacts are both the 'product' and the 'process' of a joint design endeavor. Hence, any technological intervention cannot isolate a designer's interaction from these design artefacts themselves. Hence, I propose the design of an awareness system that can utilize artefact-mediated interaction.

6.5.1.2 Utilize Spatial Resources

The way designers keep these artefacts and organize them in their workspace affect their work organization, communication and coordination practices. It is this spatial flexibility of, for example, sticking sketches and drawings on a shared office wall, that allows designers to discuss, criticize and explore new possibilities of their design work. In order to provide technological support for spatial flexibility, we need to think beyond desktop computers and involve the spatial and dynamic aspects of design studios, as shown in [141, 50]. The importance of physical space in supporting communication between designers and easing up the cognitive load, stimulating creative and inspirational thinking and supporting flexibility and portability of organizing work should not be ignored while designing a new technology. Additionally, in particular to the design studio culture, the spatial resources are frequently managed by designers to support certain design activities such as design reflections, group criticism, and brainstorming. A desktop-based technology may not be sufficient to satisfy these needs that use space as a highly valuable resource. Directions for a new awareness system can be explored in table-top interfaces that combine both physical and digital resources to support communications, or a mobile phone based tagging system that can be spread across a locality.

6.5.1.3 Creative Explorations

I observed that designers spend a considerable amount of time in exploring new ideas and concepts by utilizing different techniques and design representations. This nature of designers goes back to the fact that designers use synthesis as an approach to problem solving [152]. In a co-located situation such as a design studio, spatiality and visibility play an important role to support creative explorations. There is a plethora of multi-modal and heterogeneous artefacts and tools designers use based on the needs, preferences and the stage of design. The fieldwork suggests that for creative explorations there is a need for an infrastructure that allows designers to capture, integrate, and arrange these artefacts. Obviously, this should be done in line with the current practices of designers. There are well thought out examples in this domain that focus on specific aspects of design processes, for example interfaces for collaborative drawings [18, 231], for creating architecture plans [241] and for making clay models [186]. These are some good examples of supporting design explorations, however, we need more work to support a larger array of design practices. In some cases, it might also be important to see and understand where digitization of physical artefacts (such as sketches) will be beneficial.

There is a value in associating and connecting different design artefacts. Tech-

nological restrictions currently mean that there is little opportunity to associate the digital and physical, but there is no reason to suppose that opening up that possibility would not add value. For example, a cardboard model of a design idea can be made richer if it can be linked to other representations such as sketches, storyboards and so on. Similarly, with a new technology co-designers should be able to attach valuable annotations and background work to these artefacts. With a large heterogeneity, some of the artefacts should be provided specific representation and interaction styles not only because of their multi-modal nature but to support the kind of expression and annotations they carry.

6.5.1.4 Social Flexibility

I observed that the use of design artefacts and physical space allowed a level of flexibility in designers' everyday social interactions. This helped designers to discuss and talk about things anywhere and anytime. I believe that an awareness system should not impose social order onto designers; on the contrary it should allow designers to bring about and establish new practices for design. The technology should not impose tedious and unfamiliar practices for using it; instead it should be smoothly integrated into designers' everyday work. Different projects require designers to use different collaborative approaches and methods. Additionally, they do not follow strict protocols or design guidelines. A technology should be able to incorporate this heterogeneity and informality into the design of a collaborative system.

Most of the collaborative systems to support design work have focused on the real-time communications by supporting limited modalities (mainly visual and speech). In order for designers to reflect on their work, we need to provide a platform where designers can constructively criticize and build on each other's work. For this, designers need more than an on-line chat system. An asynchronous way of communicating and reflecting on each other's work could also be considered as it may allow more time and space for the designers.

6.6 Summary

This chapter showed that collaborative and coordinative practices of product designers should be studied from an experience-focused perspective. Several activities and methods product designers employ or design artefacts they use and produce during their everyday work may not seem relevant to an outsider but are in fact crucial to their creativity and innovative practices. My EM orientation towards the design studio culture provided me with a naturalistic view on how an implicit phenomenon such as awareness is practiced. I provided an ethnographic account of how designers support their coordinative practices that go beyond productivity and functionalist measures, within the design studio culture. My intention for doing this kind of research is to understand and support the ubiquitous nature of everyday design practices. Based on the results of the fieldwork I provided possible ways forward for designing new awareness systems.

7

CAM and its Field Trials[1]

7.1 Introduction

In the previous chapter, I showed the material character of the design studio culture and provided four main design implications to develop an awareness system. In this chapter, utilizing these design implications, I will 1) describe the design of an awareness system called Cooperative Artefact Memory (CAM) and 2) describe a field trial of CAM in an academic product design studio. My analysis will particularly focus on awareness and design-related activities by the participants to support their ongoing design projects.

CAM is a low-tech, mobile-tagging based messaging system that was built using the design implications from chapter 6. CAM allows designers to collaboratively store relevant information onto their physical design artefacts, such as sketches, collages, storyboards, and physical mock-ups in the form of messages, annotations and external web links. The current prototype of CAM integrates WiFi enabled camera phones with Microsoft TagReader clients; a set of 2D barcodes generated using Microsoft Tag's online services; and a JAVA web server application that uses Twitter API. To explore the use of CAM, I applied it as a *"probe"* in an academic product design studio in three different student design projects. Since, I intended to explore the awareness support of CAM, I believed that probing of CAM would lead to providing new insights

[1]This chapter is based on the following published papers.

1. Vyas, D., Nijholt, A., and van der Veer, G. (2010) Supporting Cooperative Design through "Living" Artefacts. In Proceedings of the 6th Nordic Conference on Human-Computer Interaction: Extending Boundaries **(NordiCHI '10)**. ACM, New York, NY, USA, 541-550. ISBN: 978-1-60558-934-3.

2. Vyas, D., Nijholt, A., and Kroener, A. (2010) CAM: A Collaborative Object Memory System. In Proceedings of the 12th international conference on Human computer interaction with mobile devices and services **(MobileHCI '10)**. ACM, New York, NY, USA, 415-416. ISBN: 978-1-60558-835-3.

3. Vyas, D., Nijholt, A., Heylen, D., Kroener, A. and van der Veer, G. (2010) Remarkable Objects: Supporting Collaboration in a Creative Environment. In Proceedings of the 12th ACM international conference on Ubiquitous computing **(Ubicomp '10)**. ACM, New York, NY, USA, 37-40. ISBN: 978-1-60558-843-8.

4. Vyas, D., and Nijholt, A. (2010) Building boundaries on Boundary Objects: A Field study of a Ubicomp tool in a Design Studio. **International Reports on Socio-Informatics** (an online journal). pp 280-297. ISSN 1861-4280.

into not only the awareness practices of the participants but also the results of such a probing-based field trial could shed light on other important design practices.

The field trials of CAM showed that it supported awareness by allowing designers to store and share asynchronous messages on to the individual design objects to convey updates and other related information to co-workers involved in a collaborative design project. These messages varied from notifying updates on projects, new decisions, agreements, task distributions and so on. For example, a participant wrote the following message as a confirmation onto a design artefact to notify all the members about one particular design concept developed by a participant named Jochen:

— We use Jochen's lamp concept and develop it further next time.

An important aspect of CAM is that the messages stored on different design artefacts cannot be read without scanning the barcodes attached on the artefact itself. With this, context of the messages can be understood by looking at the actual state of the artefact and the whole history of messages written on the artefact. In a sense, CAM also allows design artefacts to have an individual digital profile where relevant information can be added, updated or changed collaboratively by designers. The field trials of CAM provided details about the kind of awareness messages that were sent by the participants. In addition to its use in supporting awareness, I observed that CAM facilitated new ways of collaborating in design projects. The serendipitous and asynchronous nature of CAM facilitated expressions of design aesthetics, allowed designers to have playful interactions, supported exploration of new design ideas, and supported designers' reflective practices [255**?** , 253]. The results of this field trial confirms my objectives to support creative communications between designers. The result in general also suggests a new perspective on looking at design artefacts as no longer being static objects but active participants in the design process. I can enrich design environments with this kind of analogy where design artefacts can expand their basic nature from being static to more dynamic and experiential. The results do not suggest better results in design, but a different perspective on design.

7.1.1 Related Work

In the literature, there are several examples of applications that link physical objects to digital contents. In these applications, RFID, barcodes, or other sensing technologies are used to augment physical objects so that digital information can be linked to these physical objects. One of the earliest technologies was the eTag system by Want et al. [262] that used electronic tags on items such as books and posters linked to online information and actions. These authors demonstrated the utility of linking the electronic services and actions that are naturally associated with their form. In the WebStickers system [156], barcode stickers were attached to physical objects making them act as bookmarks to the WWW. WebStickers enabled users to take advantage of their physical environment (e.g. by sticking these stickers at different places such as office doors) when organizing and sharing bookmarks. AURA [13] was a PDA and barcode based system for linking digital content to physical objects. It integrated a wireless Pocket PC with a barcode reader so that users could scan books, CDs, DVDs, packaged grocery products and other barcoded objects and then view, store and share

related metadata and annotations. The term 'physical mobile interaction' describes interaction styles in which a user interacts with a mobile device and the mobile device communicates with objects in the real world [191]. These objects generally have some sort of tags (e.g. NFC, RFID, visual barcodes) that have communication abilities [237, 96]. They enable the ubiquitous use of mobile services that are connected with smart objects. The usage of physical mobile interactions simplifies the discovery and use of mobile services, enables new kinds of object, person or location-based applications and overcomes several limitations of mobile devices. O'Hara et al. [176] studied the use of a location-based mobile-tagging application in the London zoo and found that their subjects used the system for supporting non-instrumental aspects such as identity creation and play.

In the design studio context, Gronbaek et al. [92] developed a set of Physical Hypermedia applications that extended the well-known web navigation paradigm. Within the domain of Architecture, they used RFID tags and readers where users could tag important physical material and could track these materials by antennas within their work environment. Blevis et al. [16] and Jacucci and Wagner [124] developed ubicomp technologies that could support and enhance inspirations and creativity, by utilizing spatial aspects of the design studio environment. In all these examples, I observed that supporting joint activities through a technology was missing.

7.2 Cooperative Artefact Memory (CAM)

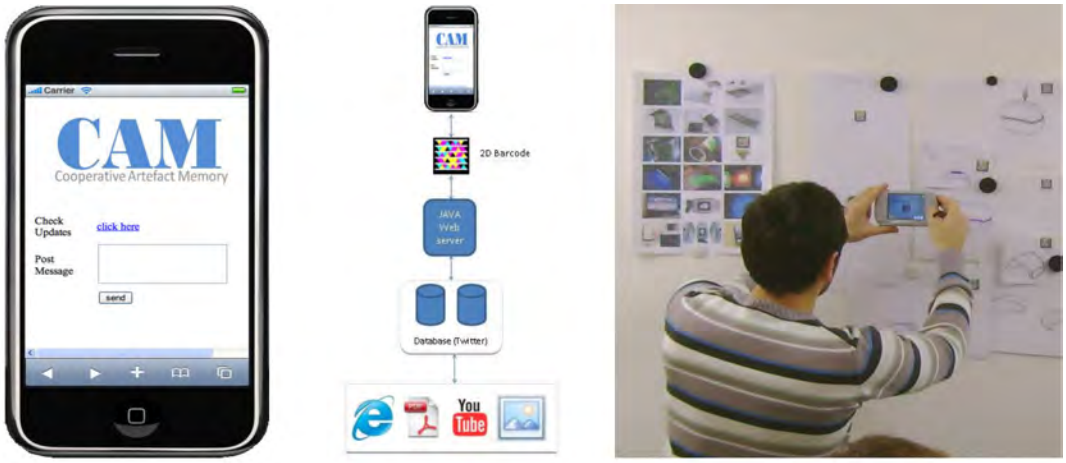


Figure 7.1: (a) CAM running on an iPhone; (b) High-level architecture of CAM, and (c) Reading a design sketch using Microsofts TagReader client. A video about CAM can be viewed on this link: `http://www.youtube.com/watch?v=v_sUImLGsA0`

CAM (figure 7.1) is a mobile-tagging based messaging system, with which designers can send and store messages, annotations and other relevant information onto their physical design artefacts using mobile phones. The messages and annotations pertaining to a design artefact can be accessed by all members of a design team. CAM is meant for supporting communication and collaboration amongst team members in

co-located design studio settings.

The current prototype of CAM uses low-tech, off-the-shelf tools such as Microsoft's mobile-tagging application TagReader, 2D high capacity color barcodes and a JAVA web server that uses Twitter API. Figure 7.1a shows the user interface of CAM. Figure 7.1b shows a high level architecture of CAM. In a typical scenario, when a designer scans a design artefact's 2D barcode with her mobile phone camera, a web browser running the CAM application starts. Using the interface of CAM (figure 7.1a), the designer can read messages pertaining to that particular design artefact or can choose to write a new message onto the artefact, which will be stored as a tweet to the artefact's twitter id. CAM has a very simple user interface and has only two functionalities: reading messages and sending messages. The "Check Updates" link allows viewing of all the messages written and stored onto a design artefact. The "Post Message" text-box allows one to write and send a new message to a design artefact. The central idea in CAM is that it associates each 2D barcode to a Twitter account. Hence, when one reads a 2D barcode attached to a design sketch (Figure 7.1c), for example, one can read a set of messages about the object in the Twitter interface.

7.2.1 How CAM follows 'Design Implications'

In the introduction of this chapter, I had mentioned that the design of CAM was based on the four design implications that were generated from the fieldwork in design studios (chapter 6). In this section, I will show how those design implications were applied.

1. *Artefact-mediated Interaction.* This implication is central to the design of CAM. In order to read or write messages about ongoing project activities, designers have to interact with a design artefact first as the 2D barcodes are attached to these artefacts. The main idea behind CAM is that since design artefacts have rich material and physical qualities that can covey very useful information with other designers, CAM merely adds an extra communication layer using barcodes that allows designers to convey asynchronous messages explicitly. As the previous research [207, 216, 120] has shown, the material aspects of an object (such as a paper) can be useful in mediating information. CAM exploits this feature to support a dual way of communication – by the design objects themselves and by the messages written onto them.

2. *Utilize Spatial Resources.* The design of CAM has also considered utilizing spatial resources of design studios. To an extent, CAM does not need any extra space, unlike a desktop or even a table-top system. A designer can easily attach a barcode to an artefact and keep the artefact anywhere that suits the designer's interaction and keeping the intended participants aware of certain issues in a design project, for example. CAM's spatial flexibility of, for example, sticking sketches and drawings on a shared office wall can lead designers to discuss, criticize and explore new possibilities of their design work. Clearly, the use of space only adds to designers' flexible ways of utilizing the physical space of the design studio – which, as we saw in section 6.2, is an integral part of designers' creative practices.

3. *Creative Explorations.* My fieldwork in the previous chapter suggested that for creative explorations there is a need for an infrastructure that allows designers to collaboratively generate innovative ideas. CAM does not provide any sophisticated technical resources to support explorations. Instead, the minimalist design of CAM allows designers to carry out any design explorations in their preferred ways. Importantly, the collaborative nature of CAM which allows other designers to provide useful comments and feedback on one's work can lead to generating new ideas.

4. *Social Flexibility.* One of the major aspects of CAM in supporting collaborative design activities is its flexibility in adapting the use of CAM to suit different situations. CAM does not impose any new ways of working. CAM fits well into the everyday practices of designers without introducing a new social order. As we shall see in this chapter, CAM not only supported awareness and communication between co-designers, it added a level of playfulness, evocation and serendipity in designers' work.

7.3 Field Trials

In an academic product design studio, I studied the use of CAM in three different design projects. I asked three student design teams to use CAM for their one week long design projects. All teams had four members. Table 7.1 shows the details of the design participants and their design projects. I gave them each a WiFi enabled camera phone. I created several temporary Twitter IDs and the same number of 2D barcodes generated using Microsoft Tag. The participants were first given a demonstration about how CAM works and how they could send and receive messages. During the period of their projects, they were asked to use CAM as a tool to support their design process. At the end of their projects, students were given twenty Euros each as a token of appreciation.

Design Team	Educational Year	Design Subject	Number of Participants
1	1st Year	Remote Control	4
2	3rd Year	Alarm Clock	4
3	5th Year	Intelligent Lamp	4

Table 7.1: Details of participants.

As I mentioned earlier, my intention was to use CAM as a "probe" to learn how it influences, and possibly supports, awareness and related design activities in design studio environments and not to test CAM as a fully functional technology. I left it completely to the design teams to use CAM in their preferred ways. They were encouraged to use CAM as much as possible. I also encouraged them to use the Internet from the mobile phones. Throughout the course of the three design projects, I videotaped their design sessions and interviewed team members at the end of the sessions.

I collected the logs of the 2D barcodes and used Tweet logs in my analysis. Additionally, I used an awareness questionnaire, adapted from the ABC (Affective Benefits in Communication) questionnaire [8] to understand how CAM changed designers' perceptions about their workplace awareness. The questionnaire had a seven-point Likert scale and consisted of 10 questions, and was used both before and after the use of CAM. Appendix 3 provides details of these questions.

7.4 Observations

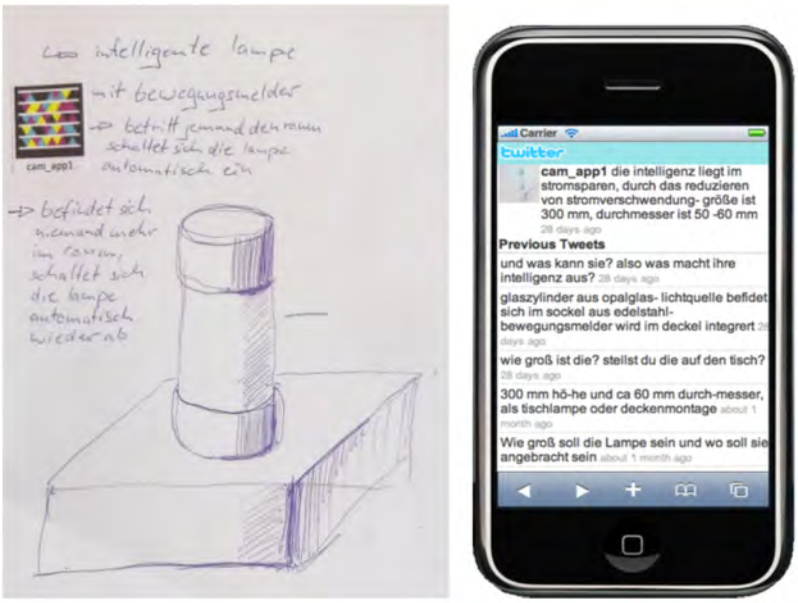
The three design teams were able to easily integrate CAM into their everyday design practices. Participants attached 2D barcodes to their design sketches, physical mock-ups, collages and Post-it notes and using CAM they added annotations, messages and other relevant information to these artefacts. Since all the team members had access to the Internet via the mobile phones, they also added web contents in their messages. Figure 7.2 shows one of the design teams that utilized a whiteboard to display their design sketches and discuss ideas during their face-to-face meetings – a theme seen in all three design projects.

Figure 7.2: In the Product Design studio, a white board full of design artefacts with 2D barcodes.

In the following, I will provide the results of my analysis, describing 1) how CAM was used by the participants and 2) how CAM supported awareness and design activities.

7.5 Results I: How CAM was used...

I first start by providing an example of a tagged design artefact and show how it was used by the participants. Figure 7.3a shows a design sketch that describes the concept of an intelligent lamp. The sketch shows the form and shape of the lamp and an annotated description of the lamp. The creator has attached a barcode to it and added a further description onto the digital profile of this artefact. Over the course



(a) (b)

Figure 7.3: Tagged sketch of an Intelligent Lamp concept (a), and Tweets sent by the co-participants to provide a design description, written in German (b).

of the design project, other members have read these messages and added their own comments and suggestions about this particular design sketch. When one reads the 2D barcode on a mobile phone, one is be able to see a complete log of comments as shown in Figure 7.3b. This log shows the dialog and negotiations that took place between co-participants. In Figure 7.3b, one could read the description about the size of the lamp and its functionality. Importantly, the log also shows questions and issues raised by co-workers such as: "where the lamp should be placed", "what material should be used" and "what should be its size".

In the three design projects, I observed that not all the design artefacts were tagged with a 2D barcode. Participants tagged their artefacts only when they wanted to show or to communicate their ideas to the others. Remarkably, once the participants tagged an artefact they never made any changes in the original artefact. Hence, tagging gave a design artefact its own identity.

7.5.1 Digital Extension of Physical Objects

As shown in the above example, one of the advantages of CAM for the participants was to be able to extend a static physical design artefact to a digital space where dialogues between participants can take place. Clearly, a paper-based design sketch has a limited physical space, so in order to provide comments or to make changes in the artefact; a designer would have to create an additional design artefact. What CAM does is that it adds a digital layer of communication on the physical design artefact, where information pertaining to the artefact can be collaboratively stored and negotiated. Several participants commented that they saw Tweet messages as an extension of their physical design objects. One of the participants commented: *"For*

me, it is an extension to the usual way I work. It is just like sending an SMS to somebody, but the messages are stored on the object."

This digital extension also seemed to provide organization cues to the participants' everyday work. CAM was described as a tool for setting reminders, triggers, notices, exhibits and resource sharing. Additionally, the use of CAM was also seen as storing "minutes" of a particular design session, as relevant information can be read easily. A team member suggested: *"These 2D barcodes provide immediate access to the information to what you want without a need to switch on the computer."*

7.5.2 Design narratives

I observed that the narration and description of design activities during the course of design projects can be traced through the Tweets that were sent using CAM. Although the technological limitations (140 character limit on message length) would influence the narrative structures, these narratives did provide a clear indication of how design was carried out. One of the important aspects of these design narratives was their 'cooperative' nature. The design narratives in the form of Tweet logs represented different views expressed by participants in a particular design project. This form of interaction provided an opportunity for collaborative concept creation. The design narrations depicted in the form of Tweets provided information about the design process that was used by the design teams. When asked about what they thought of these design narrations, a designer had the following comment: *"In my opinion, this is like making a design story. Maybe not a complete story. But it has a great deal of information about the conversation that I had while we were working"*.

7.5.3 Design archive

CAM was also seen as a tool to archive design related information, as a design artefact, with a barcode, could store information about different design activities that took place earlier. Several of the design participants thought that after the current project, they could use their old sketches as design archives. One participant said: *"If I have to design a new alarm clock again, I can go back and retrieve all the information that is stored in this sketch and see how I can continue with that."* This showed the value of CAM for design students.

7.5.4 Types of tagged artefacts

In each of the 3 groups, I identified four distinct types of design artefacts that were tagged to support different design activities, differing in the amount of physicality: 1) 3D Physical objects, 2) 2D Sketches, 3) Textual descriptions, and 4) Abstract references. See Figure 7.4.

1. The physical objects were three-dimensional objects or models made from wood, foam or cardboard that product designers created once their design ideas became concrete. Figure 7.4a shows a foam model of an intelligent lamp (team 3), tagged with a barcode.

(a) (b) (c) (d)

Figure 7.4: Different types of design artefacts tagged during design sessions. (a) a physical model of a lamp, (b) a sketch of a remote control, (c) a written note, and (c) a reference object for planning.

2. The paper-based sketches were representations of design, mainly used for exploring and communicating design ideas amongst co-designers. Figure 7.4b shows a tagged design sketch of a remote control.

3. The textual descriptions varied from specifications of an early design solution to a collection of brainstorming ideas, see Figure 7.4c.

4. The abstract references do not contain much information as such, but they point to ideas and discussions on the digital profile. Figure 7.4d shows an artefact that was created by designers to refer to all planning and coordinating activities. Its actual meaning during the process (i.e., the history of messages sent to it) could only be accessed using CAM.

Comparing the four types of artefacts in this order reveals a transition from physical, information rich artefacts to artefacts that do not contain information themselves but refer to a set of content available only through CAM. These design artefacts are by their very nature boundary objects [240] in themselves. If I take the example of the physical model of the lamp (Figure 7.4a), one can get information about its form, texture, and size, and one can physically experience and interact with the lamp. Hence, at one level, the physical object itself can provide important information to co-participants. On the second level, when one reads the tag, one can collect information about the product as described by participants and the dialog and information exchange that subsequently took place between them. If I move to sketches (Figure 7.4b), notes (Figure 7.4c), and abstract references (Figure 7.4d), increasingly information needs to be inferred, which, however, is supported by the messages stored to the artefacts. In the case of abstract references, the actual information is in the digital form and can only be accessed though CAM.

7.5.5 Statistics of use

Inspection of Tweet messages and Microsoft Tag's usage log reveal that between the three design teams a total of 53 design artefacts were tagged with barcodes, 197 Tweet messages were sent to these artefacts and these were read 488 times in total.

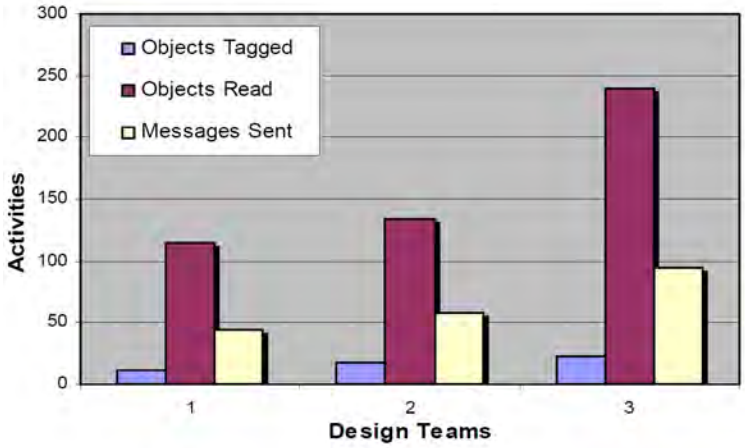


Figure 7.5: Team-wise usage of CAM.

The team-wise distribution is presented in Figure 7.5. The high number of "Objects Read" in all three design teams was because reading a design artefact was always the first step to understand the ongoing and new activities. Hence, participants frequently read updates from design artefacts. Additionally, participants preferred reading old messages before commenting or making suggestions about an artefact (i.e. "Messages Sent"). In the field trial, I invited participants from different educational levels; which might be the reason why Group 1 (first year students) tagged only 11 design artefacts whereas Group 2 and 3 (senior students) tagged 19 and 23 artefacts, respectively.

7.6 Results II: how CAM Supported Awareness and Design Activities

7.6.1 Awareness and Communication

Communication is central to any design process. While observing the use of CAM, I discovered several interesting coordination and communication patterns. Supporting interaction though artefacts was a central logic behind CAM (design implication 1). CAM sustained the sanctity of physical design artefacts, and hence supported a kind of interaction that was mediated through these artefacts. Several ethnographic studies have shown that material artefacts play an important role in supporting communication between co-workers [7, 120, 189, 195, 221]. However, with the use of CAM, design artefacts such as a sketch developed an added channel for communication between participants. Participants could access messages attached to different design artefacts, make comments about each other's work and could negotiate specific design ideas using CAM. One of the participants commented: *"CAM makes the sketch interactive not only because of the details of the sketch but the communicational support it provides us, because all the team members can read what others have written about a particular design object."*

In the current version, CAM does not allow automatic capture of information, and designers have to send messages manually. Nevertheless a collection of messages on objects enables designers to be aware of different activities. The use of CAM

allowed participants to get a quick overview of the ongoing design activities. This helped them to coordinate their ongoing design activities. All the three design teams used large vertical surfaces such as a whiteboard to display their design artefacts so that all team members could see and comment about each other's work. The spatial flexibility (design implication 2) and ease of access supported by CAM allowed participants to quickly scan individual design artefacts and understand the narratives of ongoing design activities. Here is a comment that I received during the group interview sessions: *"If you stand in front of these things and scan everything, it helps to think about and understand what's going on in the project."* The issue of public availability [195] played an important role in supporting coordination.

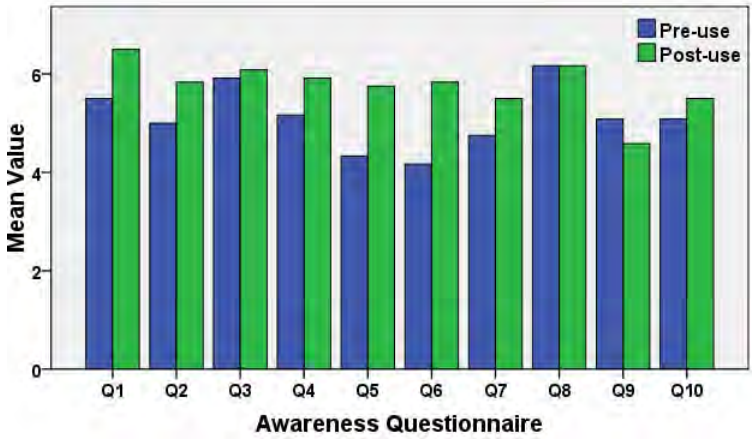


Figure 7.6: Mean scores of pre-use and post-use of CAM on the awareness questionnaire.

To analyze the ratings of the questionnaire (provided in Appendix 3), I used the Wilcoxon signed-rank test to check significant differences in experience of awareness between pre-use (n=12) and post-use (n=12) of CAM, and also to see how well design objects supported awareness. The mean scores for the questionnaire are shown in figure 7.6. the data showed a significant difference in participants' knowledge of "current state of the ongoing project" (Q6; Z=-2.620, p=0.009). Participants also reported a significant difference in their "awareness of important events in the project" (Q1; Z=-2.489, p=0.013); in "establishing and retaining connections with co-workers" (Q5; Z=-2.226, p=0.026); and in their "awareness of division of work" (Q7; Z=-2.165, p=0.030). I did not see a significant difference in the perception of participants being part of a group (Q2, Q3, Q4) and the experience of inviting and presenting work to co-workers (Q8, Q9, Q10).

Figure 7.7 shows a "Planning" object that design team 1 developed in order to make a specialized access point for organizing and planning their ongoing project. It also shows the Tweets that were sent to this object over the course of the project (latest message at the top). I have translated the Tweet log into English for better understanding. The purpose of this design artefact was to divide work responsibility, create a work schedule and for sharing important decisions between themselves. I observed during the course of their project that the design team iteratively added contents to this object. This kind of practice led to participants frequently checking the "Planning"

object in order to 1) review their previous activities, 2) coordinate their ongoing activities and 3) create milestones for future activities. This showed how participants appropriated CAM to support their local needs.

>> Thursday: Grigorios - presentation Sketch
>> Thursday: Eric - technical drawing
>> Thursday: Tarek & Julia - finishing the design model
>> Make technical drawing
>> Wednesday: planning, task distribution. Grigorios
>> Wednesday: Braille design with Eric
>> Proposals on the buttons:
Payment
Volume
Channels
Program Selection
>> Joey's?
>> What else should we add for supporting touch-based facilities?
>> I would very much like to order pizza for tomorrow. Better designs with full stomach
>> Touch screen OUT. Agreed on the use of Braille writing system. Any proposals on the form?
>> How many keys does a blind remote control require?
>> I propose that we combine both the concepts, your form and our concept of designing for "blind people"

Figure 7.7: A "Planning" object and its log (translated from German).

Figure 7.7 shows a "Planning" object that design team 1 developed in order to make a specialized access point for organizing and planning their ongoing project. It also shows the Tweets that were sent to this object over the course of the project (latest message at the top). I have translated the Tweet log into English for better understanding. The purpose of this design artefact was to divide work responsibility, create a work schedule and for sharing important decisions between themselves. I observed during the course of their project that the design team iteratively added contents to this object. This kind of practice led to participants frequently checking the "Planning" object in order to 1) review their previous activities, 2) coordinate their ongoing activities and 3) create milestones for future activities. This showed how participants appropriated CAM to support their local needs. In this example, one can read how different activities were assigned to participants and important decisions were made public to support coordination.

One participant suggested that CAM could also be suitable for large groups of people collaborating over a long period. In large corporations, where teams from different disciplines work together on a project, CAM can provide additional and relevant information of a multidisciplinary nature. He commented: *"In a scenario, where I have to hand over our work to product developers and engineers, these 2D barcodes can help these professionals who have not been closely informed about the kind of design process that I have applied to these design objects. So, I think CAM could also be helpful for inter-team collaborations."*

7.6.1.1 Types of Awareness Messages

In this section, I will provide my analysis of the types of awareness messages that were sent to different objects using CAM. I present these different types in the following four themes of messages.

1. *Notification and Updates:* The analysis of twitter log showed that the most common use of CAM was to provide notifications and updates about participants' ongoing design activities. During the field trials, I observed that when individual participants worked on their own parts, they provided the updates about their work by sending new messages onto their design objects. In turn, participants who entered the design studio would first try to check updates from different design artefacts to know any changes or updates in the ongoing activities. This was obviously done when the participants did not have a formal meeting to discuss. The following example is a message sent by a participant who is notifying his updates to others.

   — Philip's draft concept is improved and refined. Check it out.

   At times, just to keep *minutes* of the design project, participants were recording most of the important decisions, agreements and activities onto design artefacts. This way participants kept the history of their design projects. I observed that this practice of participants helped them to "catch up" on several aspects, if they missed a meeting or a design session. A participant, during the final interview session, commented that: *"I always first go to the whiteboard* [figure 7.2] *and look for any new messages for these sketches. I might have forgotten something, or may be lagging behind in my assignment. These updates help me to know how far others have done their work. I can also look into the part activities to guide my design thinking."*

2. *Work Assignments:* As I showed above, the "planning" object was used to keep an organization of different design activities during projects. One of the important parts of these "planning" objects was that these were used to notify work division. The following example provides an excerpt from one such planning object, where the messages are suggesting tasks that design participants are supposed to finish on a particular date.

   — Tuesday 19.01.2010, Feliks and Meike will accurately describe all the functions of their design

   — Tuesday 19.01.2010, Jochen and Grigorios will make a foam model... GP

3. *Anonymity vs. Identity:* There was an interesting theme where participants chose to send anonymous messages in some cases and in others wanted to identify themselves with the message. The above example shows the initials "GP" left on a message. Which refereed to a known identity. This characteristic of CAM allowed participants to express their views in different ways. In particular, the anonymity supported by CAM was seen as a useful phenomenon, as one of the

participants said: *"I think that sometimes this anonymity turns out to be better. I think it is less emotional and less personal when somebody tells you something through these design objects. You don't take this so personally. So, when I was asked if my design idea for an alarm clock was for children, I found it funny. So, this feels less confronted or attacked"*. This example shows how CAM supported flexibility in expressing ideas to other participants, without being too personal.

4. *"Did you know" Messages:* To improve and guide the design process, some participants wrote informative messages to the 'owners' of design artefacts to let them think about other options, in the form of "did you know about ...". I saw several examples of these kinds of messages. At times, such "Did you know" messages led to interesting face-to-face discussions. The following messages are two examples that I would like to report here.

   — Nice idea. Try also looking at fiber optics for your lamp.

   — Can you think about touch screen technology for remote controls for blind people?

7.6.2 Expression and Aesthetics

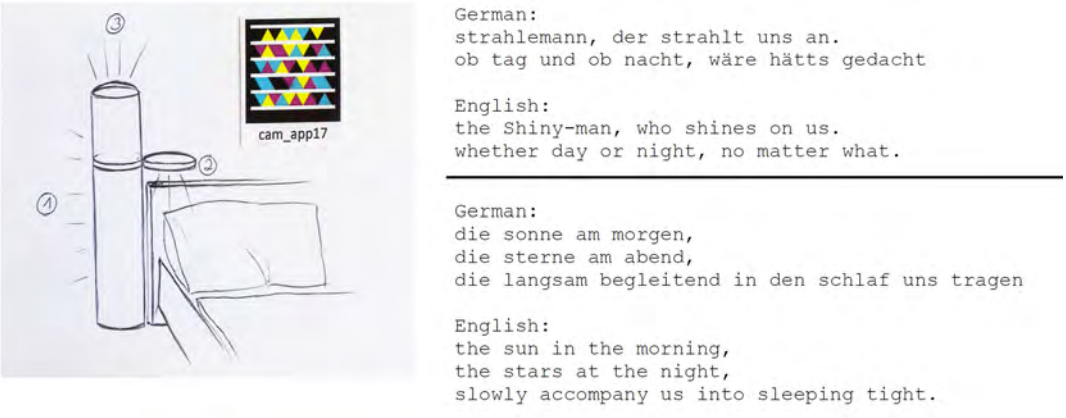


Figure 7.8: The final sketch of a conceptual Intelligent Lamp and the poetic messages (translated from German).

By making connections between a physical design artefact and relevant messages as its digital extension, CAM provided an interesting opportunity for the participants to express aesthetic qualities, something that they would not express during their everyday cooperative design sessions. Figure 7.8 shows a sketch and concept developed by one of the groups. In this case, a designer wrote a poetic message to express the aesthetic quality and functionality of the lamp. This example shows how the need to express aesthetic and poetic design ideas was supported by CAM. During the final group interview session with the design team, I asked about these poetic exchanges. The following was their response:

Designer #: "The poem shows the poetry of the product. It is something about having a good night sleep and a nice way for waking up"

Designer #: "I think it makes the concept of our lamp more romantic and magical, if you like"

Designer #: "Somebody wrote a poem about the lamp. It's just funny. It describes the lamp in an artistic way. And the cool thing is that you are totally anonymous. This is something that makes this sketch beautiful"

Designer #: "I didn't know who wrote it. And when I first discovered it, I thought look somebody wrote a poem. It was really amusing. It could be something to tell the customers who might buy this lamp. This could be something that separates this product from others"

The way designers used CAM and wrote messages onto their design artefacts had expressive and aesthetic qualities. Some of the Tweets that were written on the design artefacts showed enthusiasm and affection. A participant commented: *"Sometimes you do see an enthusiasm of the designers in their messages. In some cases, I have seen detailed descriptions of a design sketch in the messages and sometimes its not detailed enough."* The following is a comment of one of the participants who intentionally wrote messages to get co-workers attention. *"I would like to know if others like my sketches and design ideas. What do they think about my work? When they don't have a chance to speak to me, they can write something on these sketches using CAM."*

7.6.3 Playful

The expressive nature of CAM seemed to provoke a degree of playfulness and creativity. By playfulness, I do not suggest unproductive or non-work activities, but carrying out the design process using creative and non-conventional approaches. I observed playful ways of using CAM while working on the design projects. One of the important aspects of the playfulness of using CAM was its inherently 'open' setting. The participants enjoyed the freedom of tagging any kind of physical design artefact and writing messages onto it. At the same time, CAM introduced limitation on dealing with mainly textual messages of 140 characters, since it utilized Twitter. As a result, the messages were written in a way that could communicate ideas in quick-and-dirty ways. This kind of interaction often led to surprising and intriguing reactions amongst the team members. Since all the design students were given individual mobile phones, I observed that on many occasions messages represented different perspectives on design. The 'open' setting on CAM facilitated participants to balance the information storage on the physical design artefact and its digital extension. This allowed participants a choice to represent their design ideas in two different ways.

The asynchronous and serendipitous nature of CAM also added to the playful effect. CAM had a level of asynchrony, in a sense that messages and updates were only accessible when a participant went to a design artefact and read its barcode. This actually added an element of surprise and curiosity during the interaction with CAM. In some cases, participants intentionally kept information in the digital from by writing messages. One of the participants expressed this playfulness in this following comment: *"To me it's a fascinating experience to read the details about the lamp that I designed in a mobile phone. It is like seeing the same thing in a different way."*

Figure 7.9: An empty paper with barcode used as a "Voting" mechanism for different versions of design ideas.

Figure 7.9 is another example of a playful act of carrying out an important design activity. In this instance, participants in group 2 individually developed conceptual sketches for an interactive alarm clock. After their discussion and constructive criticism of each other's work, they decided to tag an empty sheet of paper and asked each other to vote for their choice of design idea. See Figure 7.9 where CAM was used as a *"voting"* device to select the best design idea. Central to this activity was the importance of anonymity and asynchrony supported by CAM. Here, I see an intertwined relationship between design team members pragmatic activity of completing a design task and utilizing CAM as a tool to support expressive and playful interactions.

7.6.4 Creative Exploration

CAM supported and to an extent encouraged design explorations. Previous research has indicated that designers do not work in a pre-determined, mechanical fashion [45, 124]. In fact they apply different approaches in different situations, involving different media (ranging from paper, foam, and wood to digital tools) to understand and explore their design problems. Being able to explore and try out new design ideas is central to their design work. I observed that the social and collaborative nature of CAM triggered all members of a design team to actively participate in the exploration process (design implication 3).

In one instance, a team member developed several concept sketches for the Intelligent Lamp project (figure 7.10). Sketching is clearly one of the quicker ways to express and communicate design ideas to co-workers. However, in this particular case, the team member's intention was to gather co-workers comments about different exploration ideas that she developed. Figure 7.10a was meant to explore different shapes of lamp; 7.10b and 7.10c show the ways to apply intelligence into the lamp; and 7.10d explores different projection styles for the lamp. The intention here was to have a discussion via sending views and ideas onto the design artefacts and discuss these during the face-to-face meetings. Here is a comment from that design member: *"CAM does help in creative thinking. Sometimes when I am drawing, I wouldn't know all the technical details. So after reading these comments about my sketches, I did find some*

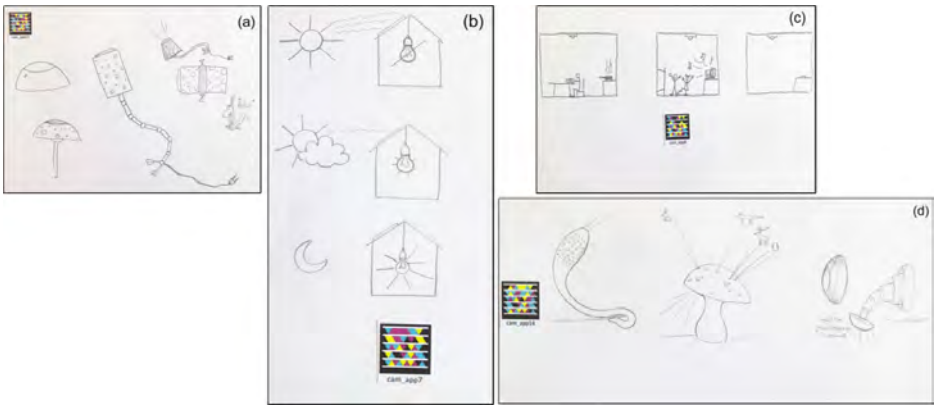


Figure 7.10: Design sketches to explore ideas for an Intelligent Lamp.

tips about changing my original ideas." The following are some of the messages that other participants sent to the sketches to provide new ideas regarding the intelligent lamp concept.

— Responds to temperature and no. of people in the room
— Open the top and it becomes a reading lamp; close it at night and light will be dim

By receiving comments from each other, members of design teams collaboratively learned and improvised their ongoing design projects. A participant commented: *"The useful thing about CAM is the new ideas that I get from others. I found this very stimulating for my creativity. For example, Max had this function of pushing in the alarm clock and I had a separate switch. From Max's design and my design I merged the interesting ideas and came up with a combination in the final design idea."*

```
>> are both concepts for the same lights? GP
>> Light Modes: Reading-mode, Sleeping-mode,
   Waking up-mode. Dimensions: no larger than
   40cm in diameter!
>> good question, as we see in the
   Submarines: Blue for normal and Red for
   danger
>> what are the exact dimensions in the various
   positions?
>> which light color for what mood?
>> lights recognizes the mood in room.
>> So, more work to follow on Monday... would
   be more comfortable... please ...
>> looks like a reading lamp
>> extensible, recognizes in the mood in the
   room and projects light accordingly (color,
   intensity).
```

Figure 7.11: A design sketch representing an Intelligent Lamp and its log (translated from German).

Here is another example (Figure 7.11), where a team member developed a design

sketch, where a lamp can detect activities of people and adapt its light projection in a room. When somebody is reading in the room then it changes its focus to the reader's book. Here is the Tweet log of the design sketch which shows how the concept was discussed and negotiated by the co-participants. These Tweets suggest how collaborative exploration took place, ideas were exchanged and in particular how participants built on each others suggestions to make the explorative process work.

7.6.5 Reflection and Critique

Reflection is described as a tacit phenomenon that professionals exhibit in the form of knowing-in-practice [209]. Reflection as a mechanism for learning from experience is an important aspect of professional design practice. In the field trial, I observed that the use of CAM facilitated participants to critically look at their own work and the work of others. As CAM encouraged participants to write down their activities in the form of messages, this provided a reflective platform to evaluate ongoing activities. The Tweet log provided information about past activities of all the co-workers, which inherently helped participants to constantly review, plan and refine future activities in a global sense. This also helped participants to organize their ongoing design projects and to be accountable. One of the team members said: *"I think it might be a good thing if I can write down what I am thinking about during the process of making sketches. This would be a good practice as well."* Additionally, the movement from the physical design artefacts to their digital profile and back again successfully scaffolded creative and reflective thinking. This facilitated the participants to look at their designs from two different points of view: what it was and what was said about it.

Criticism is a highly important aspect of studio based design [45]. CAM not only provides a dialog for constructive design criticism but its spatial flexibility supported and encouraged designerly criticism. Since it was quite easy for the participants to display their design artefacts such as sketches on whiteboards, this deliberate act invited and made it easy for other participants to provide design criticism.

Critical and reflective dialogs were also triggered by the Tweets sent by the co-workers about some previous design activities, which contained comments and suggestions that led participants to critically look at their design artefacts. Sometimes, these reflections seemed to prompt decision-making and sometimes led to face-to-face discussions between team members. The asynchrony and serendipity of messages and comments helped design teams to reflect on their own work as well as to learn from, and constructively criticize, each other's work. One of the participants commented: *"The system does help you to reflect on what you designed and what you wrote about it. At the same time what others have said about your work."*

7.7 Discussion

In this chapter I explored the awareness and creative design support provided by CAM. CAM was, to a large extent, designed to enable creative communications between a team of designers by enabling them to asynchronously send messages onto design objects. CAM incorporates all the four design implications generated from the ethnographic fieldwork. First, it sustains the sanctity of material design artefacts and

at the same time provides a channel to support communication between participants. Second, it offers a kind of setting that is not dependent on the physical space and instead allows participants to utilize space to support their work. Third, it offers a level of flexibility by which designers can support exploration and playful interactions to bring quality to their work. And fourth, it does not impose any social order to the design participants and fits into the everyday practices of designers.

My main intention for carrying out the field trial of CAM was to apply it as a *probe* and to be able to understand the possibilities and consequences of tagging physical design artefacts to allow communicating to, and through, these. The main question here was: Can this type of technology support awareness and enrich the design process? As the results showed, tagging design artefacts provided 1) awareness and communication resources, 2) expression of the aesthetic qualities of the design artefacts, 3) support for playful interaction between designers, 4) exploration support, and 5) allowed designers to reflect on and critique each other's work.

The use of CAM showed that tagging design artefacts can expand their static nature to create more dynamic and active objects. As I explored during the field trial, the design artefacts became *"living objects"*. These objects received a special status at the moment of tagging, where they were no longer a person's private artefact, hence, they were no longer changed. They now had their own 'identity'. From this moment on they were communicated to, which resulted in the tagged artefact developing its own history of communications. The history could be, and in fact was, frequently read by the team members and was added to. The history of these artefacts showed that they were considered "living" identities reflecting the team's growing understanding, discussions, and expressions. Design participants continuously scanned the barcodes to gather updates from these "living" artefacts.

CAM supported design teams to establish a creative working culture. Reading the design artefacts triggered building on and learning from each other's work. The collaborative and social nature of CAM fostered creativity amongst the group of designers. The anonymity of Tweets played a role in establishing curiosity and playfulness. Designers were triggered to reflect on their own as well as each other's work in a critical manner. One of the important aspects of the logs generated by CAM was their communicative and coordinative abilities. Using their mobile phones, participants were able to read updates of different design artefacts and were able to get a sense of what was going on in the project. The "Planning object", described in figure 7.7 was an example of a design team's organizing activities.

In the following I provide two approaches through which the notion of "living" artefacts can be further developed.

7.7.1 Internet-of-Things

Although not implemented in the current version of CAM, I propose a mechanism by which individual design artefacts can be linked to each other with some semantic relationships. These kind of connected objects are sometimes referred to as the "Internet of Things". Internet of Things [73] can be seen as a sub-vision of Ubiquitous Computing [253], where objects are connected to each other and are aware of each other's status and activities. In design studios such a vision could mean that design

artefacts that are scattered around a design studio can be connected to each other. The connections can be established based on chronology or version control, across different multi-modal and spatio-temporal aspects.

7.7.2 Object Memory

In the current version of CAM, I have used Twitter as a storage tool. Although Twitter has a limitation on the length of messages one can write (140 characters), its use allowed us to quickly find out whether CAM has a potential in the design studio culture. There certainly is a need for more robust and reliable ways of storing and retrieving object related information. In the domain of logistics and supply chain, researchers have been working on approaches to develop appropriate information storage structures for smart environments [48]. This kind of data structures are often referred to as Object Memory or Product Memory. One such approach is used in object memory infrastructure [208]. In the current version of CAM, information is not automatically collected and stored. However, using the product memory approach this can be easily achieved.

7.8 Summary

I designed a simple technology – CAM, that uses off-the-shelf tools, specifically to probe and find out how CAM would support awareness in design teams when physical artefacts are an important part of the design studio ecology. I did not intend to improve the end result of design but to find out how this new approach could enrich the awareness dynamics and support new forms of collaboration. I am fully aware of the ad hoc nature of the technical implementation. More sophisticated approaches need to be developed (one such mentioned in [208] to realize a fully fledged working technology in such an environment.

Part IV

Reflections

8

Discussions on Awareness

8.1 Introduction

The goal of this thesis was to explore the possibilities of incorporating 'experience-focused HCI' perspective into the design on awareness systems. In this chapter, I will discuss the important issues related to awareness, particularly from the two design cases.

8.2 Experience-focused HCI

So, how was experience-focused HCI perspective applied in the two design cases? I believe that both design cases follow the experience-focused HCI perspective at several levels – encompassing the whole design cycle. To be precise, I attempted to incorporate experience-focused HCI perspective at the following levels: 1) intended value of design, 2) workplace studies and methods, 3) design of prototypes, and 4) field trials. Here, I explain how this is done, with respect to both the design cases.

In the first design case, the main goal or the intended value of design was seen to be supporting playfully-mediated interactions between staff members to fuel community building in the department. I intended to support non-work, non-critical and pleasurable interactions between staff members. Thus, the main value here was in supporting social experiences. Secondly, during the workplace studies (chapter 4), I paid specific attention to the staff members' existing practices that were experiential in nature. For example, the practice of staff members to attach postcards, holiday pictures, magazine clips and so on on the staffroom door was a practice that did not intend to fulfill the purpose of workplace productivity or efficiency. This was a practice to support pleasurable social experience by means of making an announcement in the public areas of the department. Similarly, the use of the organizational probes method led to some useful information about staff members' everyday experiences at the department. This method was an adapted version of cultural probes [82] – that is a well-known approach to gain insight into subjects' experiences. Although such methods are used to 'inspire' the design, the results of organizational probes showed

staff members' routines, their likes and dislikes, perceptions of the working environments and so on. Thirdly, the design of the prototype – Panorama was also inspired by the experience-focused HCI perspective. Panorama, as a large-screen display in the staffroom, did not have a productivity or efficiency-related task to support. It followed Weiser's [264] vision of *calm computing*, in which, Panorama became the center of attraction and talks at times and on other occasions it went into the background of staff members' interaction. Additionally, Panorama utilized an existing technological platform called ViP that has been used for art and theater productions [59]. Finally, during the field trials of Panorama, the importance was on the experience of such a system in the staff room of a department, rather than, on evaluating the technology itself. The results of trials showed that Panorama created curiosity among staff members, provided new insights into their colleague's lives and facilitated staff members' to cherish old memories. These are some of the well-known aspects of experience-focused HCI's research.

In the second design case, the intended value of design was to be able to support creative communications between designers within design studio environments. So, even though I was looking at supporting communication – the very instrumental aspect of a work environment, it was the creativity that I was interested in supporting. Although, it is central to several work domains, creativity is certainly not a task-based activity nor can it be constrained to specific aspects. Secondly, during the workplace studies in different design studios, I explored several experiential and tacit practices that are not discussed in the main stream design research. For example, the use of material artefacts to explore new design ideas, illustrated an important practice that was experiential in nature. I also reported that material artefacts played an experiential role at different stages of design. To give another example, the way designers used their bodies during role playing and other participatory methods helped them in gaining experiential insights into the design of a particular object. Thirdly, the design of the prototype CAM was also inspired by the experience-focused HCI perspective. Following work practices of designers, a mobile-tagging technology was used so that the experiential qualities of a material artefact (such as a paper-based sketch) could be sustained. More importantly, CAM was not intended to support any specific tasks, rather, its design was specifically kept in way that it allowed designers a level of flexibility. This was certainly seen in the field trials of CAM. In the trials, it was observed that CAM supported playful ways of conveying design ideas, incorporated design aesthetics, allowed designers to support creative exploration and to reflect on each other's work. Hence, in both the design cases, the whole design cycle followed the experience-focused perspective.

8.3 Awareness grounded in people's practices

Understanding people's everyday practices to inform the design of new technologies has become an important practice in the CSCW research. Following this tradition, both of the design cases reported in this thesis, started off by gaining a thorough understanding of people's work (or non-work) practices. There were several examples of people's everyday practices that indicated how awareness was achieved and

maintained. I will describe only a few of these practices to make my point.

In design case 1, one of the ways awareness was achieved was through announcing and publishing personal interests. As it was seen in the example of staffroom door, notice boards and on the corridors of the department, staff members intentionally placed informative resources to the 'public availability' so that passersby could easily and quickly view these details. These informative resources had quality that ranged from evocative magazine clips – invoking debates in the group to holiday pictures – sharing an enjoyable moment with colleagues to announcing the birth of a baby – sharing emotional and sentimental news with others. The aspect of public availability has been debated in great detail within the CSCW literature [106, 195, 194]. Using Merleau-Pontys phenomenology, Robertson [195] suggests that public availability of practices and artefacts plays an important role in supporting awareness as it is lived. She states, *"awareness can only be achieved by the skillful activity of participants in a shared space if the resources they have learned to recognize, and therefore understand, are publicly available to them."* (p. 306)

Another example of such a practice that is in line with the notion of public availability is the ways designers used the physical space around their studios, in design case 2. Within ongoing projects, designers used spatial resources to lay the progress of their work by attaching their updated sketches, planning, and other design ideas on notice boards, whiteboards and so on. This not only showed the progress of the ongoing work but also helped in managing and planning the future activities. Use of spatial resources is a very common practice in design studios. Such practices can never be ignored while designing technology. The design prototype, CAM, incorporates this practice, by which designers can continue using the spatial resources and still be able to exploit the advantage of a digital technology.

Another practice of supporting and conveying awareness that I took into the prototypes was the use of artefacts, in design case 2. Exploring ideas by sketching or making models is a common practice among designers. In fact, it is through these design artefacts, such as paper-based sketches or cardboard models, the whole design process progresses. These design artefacts serve not only as a communication tool but also a means of establishing common ground among co-designers. During the process of establishing a common ground, the materiality, spatio-spatiality and sensorial qualities of these artefacts play an important role. The design prototype – CAM has utilized this practice and facilitated designers to exploit the material richness of design artefacts.

8.4 Artefacts and Physical Space

From this thesis, there were two issues that came out very strong in supporting awareness: the role of artefacts and physical space. Both these issues point to the fact that materiality has a powerful role in the organization of work or other joint activities. A large set of HCI and CSCW literature is devoted to the appreciation of artefacts and space in supporting coordinative activities [188, 7, 207, 216, 138, 140, 245]. Even some of the well-known conceptual frameworks to understand collaborative work such as distributed cognition [120], activity theory [171] and actor-network-theory

[150] incorporate the notion of artefacts and space. In a way, artefacts and physical space cannot be seen separately as two mutually exclusive phenomena, as a set of artefacts and their ecological arrangement in a workplace constitute to the very nature of the workplace.

In the two design cases, the role of artefacts and physical space in supporting awareness was quite apparent. In design case 1, artefacts such as the postcards on the staffroom's door conveyed a kind of interpersonal awareness to other members that was personal and sentimental in nature. The staffroom door as a spatial entity played a role of a placeholder. Staff members' familiarity within different geographical locations in the department and their understanding of the 'social' nature of the staffroom led to their practice of using staffroom door as a notice board for supporting purely social and sentimental purposes. In the example of the secretary's office door, it was seen that the situatedness of her office at a very central and accessible location in the department led to the secretary's practice of keeping post-it notes (describing her status and specific messages to others) whenever she was away and keeping the doors open when she was in the office. Similarly, the playful artefacts (chapter 4, figure 4.4), kept outside the office doors, with a rotating arrow to mark the current activity of the office owner made passersby aware of the physical status of the office owner.

In design case 2, there were several examples where design artefacts such as sketches, drawings, storyboards and physical models played a role in conveying awareness of the ongoing work. As I addressed in chapter 6, these material design artefacts played not only the coordinative and organizational roles but also the experiential role. The way designers were able to exploit the material, interactive and experiential qualities of an artefact helped designers in all stages of the design process. The physical space of design studios also helped in the design process by providing organizational resources and fueling creative thinking. The way designers adapted their physical space and other spatial resources also helped in supporting their reflective thinking.

8.5 "Less is more" – for supporting awareness

It is also important to provide a short commentary on a design sensibility that is relevant to my design approach, namely – 'less is more' design sensibility. Less is more was the central theme of Ludwig Mies van der Rohe's minimalist design and has since became a known design principle. It advocates for simplistic and clear design with minimal functionality. I believe that *less is more* sensibility can be relevant for designing for awareness. This is due to the fact that awareness is a subtle aspect of people's communicative and coordinative behaviors. It is not a directly observable phenomenon, as it is not a specific thing that people do to be aware of others. The point that I want to make here is that people develop skills and adapt spatial resources to maintain awareness information. By a minimalistic design, users can be provided with usage and interpretive flexibility, by which they can establish and maintain awareness. This is also central to the experience-focused perspective, as from an experience-focused perspective, users are seen as active creators of experience [49, 167].

In both the design cases, the prototypes that I have designed have minimal functionality. Panorama simply projects the visual information that is sent by staff members or captured by wireless sensors in a compelling manner. This, as I showed in the field trials of Panorama, provided 'interpretive flexibility' and led to participants' curiosity, amusement and surprise. CAM simply allows designers to store relevant information onto their material design objects. This, as I showed in the field trials of CAM, provided 'usage flexibility' and led the participants to use CAM for different purposes: storing meeting minutes, as design archive, exploring design ideas and other creative uses. I believe that because of such a simple and minimalistic functionality, these technological prototypes became more easily integrated into the everyday practices of their potential users. These two prototypes cannot be termed as smart technologies. Neither CAM nor Panorama made decisions for their users, these technologies merely facilitated with information which could then be made sense of by their users. As shown in the field trials of CAM, the complete control was in the hands of designers who used CAM in their design project by appropriating its use. In short, less immediate complexity is seen to give rise to the eventual possibility of more overall functionality.

9

Conclusions

This thesis has explored the design of awareness systems by following the experience-focused HCI perspective. In this chapter, I will conclude my work by summarizing the contribution, briefly discussing the methodology, providing the limiting aspects of this work and finally, giving future directions.

9.1 Contributions

I will summarize the major contributions of this thesis. In the introduction of this thesis, I stated that the contributions of this thesis can be seen in terms of conceptual, empirical and technological viewpoints.

On the conceptual viewpoint, I believe that this thesis showed how people's "experiences" can be understood in their natural settings and how it can be supported by technological means, in two different situations. In design case 1, I used the lens of 'situatedness' to understand how staff members practiced non-work and pleasurable social awareness in an academic department. In addition to contextual interviews and naturalistic observations, I applied a participatory method called organizational probes, in order to gain access to the situated experiences staff members have in the department. In design case 2, the notion of 'physicality' was used to understand collaborative practices – that supported creativity. In this case, I analyzed live and video-recorded design sessions of professional and student designers. A greater insight into physicality was also drawn from the use of methods such as contextual interview and naturalistic observations. Both situatedness and physicality are quite inherent in understanding practices and experiences of people at work.

On the empirical viewpoint, both the design cases highlighted some of the very interesting practices that people apply in their everyday work life. Since, both the design cases targeted different types of awareness systems, a large set of varying practices were seen during the fieldwork. In design case 1, the practices of using staff room door for attaching social, personal and sentimental objects; using notice boards and other publicly available media to make announcements; keeping playful objects to inform others about one's status, and so on were seen to be some useful

ways for conveying awareness. In design case 2, the practice of utilizing the richness of material artefacts to explore creative ideas, using drawing boards for showing the current status of an ongoing project, supporting reflective practices by using spatial resources, using 'bodies' to explore design ideas were only a few examples of how design was practiced in, both, academic and professional design studios. Although, I do not intend to make any claims on 'design practices' in general, the empirical results showed some new insights into the design studio culture.

From a technological viewpoint, the thesis reports the development of prototypes of awareness systems, in two different design cases. In both the design cases, I have utilized existing or off-the-shelf technologies to show a proof-of-concept. Both the design cases, however, did need some alterations and adaptations in existing technologies to suit the needs. This is not an uncommon approach in HCI, rather this is sometimes valued more, where technologies are intentionally left unfinished so that user testings can provide useful guidance to make further improvements. As Harper et al. [99] suggests *"in the future, more lightweight, rapid prototyping and design iteration processes will be required, ones that will allow complex ecosystem experiences to be investigated as well as simpler, human-machine relationships."* In both the design cases, I did not intend to develop a fully fledged system that can be used as is but focused on learning new insights from these lightweight prototypes.

9.2 A word on Methodology

Both of my design cases were divided into two chapters. In one, I provided an understanding of people's current practices and experiences and, in the second chapter, I showed an early design of prototypes that can be put to trial in natural settings. Methodologically, I utilized a *bottom up* design approach in both the design cases. In this sense, the design of the prototypes was informed by the empirical results of the fieldwork. The design decisions for both of the prototypes are completely based on the empirically-informed 'design implications'. The *bottom up* approach to design helped ground both the design prototypes in people's practices and experiences.

9.3 Limitations

It is important to point out the limitations of my thesis. At the outset, I acknowledge that my personal interests, motivations and financial and temporal resources of the project had (positively or otherwise) affected this thesis. However, to point out a few specific issues, in the following I discuss the limitations of my work.

This research, in general, follows a qualitative approach to achieve its goal. The thesis can be seen as a combination of four qualitative field studies – chapter 4 to 7. One of the main limitations of this research would be its 'generalizability'. Given the exploratory nature of this research, it was not possible to conduct hypothesis testing experiments. The kind of approach used in the thesis emphasized on letting different phenomena emerge from a given context, rather than, studying predefined or known phenomena. Hence, on the one hand, it might be difficult to reproduce the results generated from these qualitative field studies. One the other hand, however,

it provides a unique and rich perspective on people's experiences. The two awareness systems that were designed as a part of this research, namely, Panorama and CAM may not be seen as the only possible ways to support awareness. Using the design implication, generated in chapter 4 and 6, one can come up with completely different systems. This is more of a richness of the qualitative orientation than its limitation.

Another limitation of this thesis is the difficulty in recruiting participants. This is more the case in design case 2. For studying cooperative design practices, I looked at both academic and professional design studios. As I mentioned in chapter 4, I have had a prolonged exposure to the academic design studios compared to professional ones. Ideally speaking, I would have liked to spend as much time in the professional design studios, as I did in academic one. However, I could not get prolonged access to professional product design studios. This was partly due to the nature of my research – which needed to look into the creative processes used by designers. In professional design studios, such information may not be easily shared to others. Fortunately, I could get, somewhat limited, access to a few professional studios, where data was collected using contextual interviews and semi-formal observations.

9.4 Future Directions

Awareness systems can be seen as communication devices, although they do not support *direct* communication. I see a great potential in developing a 'new' genre of communication devices using experience-focused perspective. The experience-focused perspective on design incorporates a holistic and a wide ranging view on people's everyday lives. This is certainly more valued than the task-based approaches. I propose to find new and better ways to explore the *holistic* view on people's activities. This will require the articulation of diverse methodologies. The two prototypes that are presented in this thesis show that they support much more than conveying specific information. They incorporate play, expressions and creativity. I believe that research in awareness systems should focus on aspects such as these that are social and personal in nature.

On a conceptual level, I see potential in utilizing the notions of 'physicality'. This notion is not new to the field of HCI. In fact, tangible computing, tabletop displays, and a large portion of ubiquitous computing research attempt to utilize natural interactions and in turn utilize the notions of physicality. However, there is more to physicality than support for natural interaction. As I have shown in this thesis, physicality can be used to study and understand people's interactions, their use of artefacts and physical space. I believe that several other aspects related to physicality are not explored within HCI.

One of the important aspects that came out of the field trials of CAM was its lifelogging support. Technologically, I believe that the concept of 'lifelogging' can have great potential in supporting wide ranging activities that should be explored further. CAM can be seen as a tool that supports lifelogging of an artefact such as a paper sketch. There are applications that support lifelogging activities for humans such as SenseCam [213] to provide memory aid. I believe that lifelogs of objects as well as humans can be exploited in several productive ways to explore new design ideas.

For example, a recent research showed that lifelogs can help patients of diabetes not only to support their health management activities but also to construct their identity [160]. Technologies that can support lifelogging can be used in domains such as learning, health care, supply chain and so on. As HCI practitioners, we should explore these different possibilities of lifelogging.

9.5 Final Words

I believe that the experience-focused HCI perspective will play an important role in the conception and design of interactive systems. Clearly, much more work is needed to arrive at a precise definition and frameworks to apply the experience-focused HCI perspective. In this thesis, I applied this perspective to conceptualize awareness and design awareness systems. I also showed how this perspective can be used for the complete design cycle: starting from problem definition, through ethnographic field-work and designing prototypes to reporting the field trials of these prototypes. The thesis showed how both the prototype systems, Panorama and CAM, not only supported awareness but they also turned out to be 'reflective devices'. Reflective devices [217] allow people to reflect on their activities and behaviors by interactive means. Moreover, the 'bottom-up' approach used in this thesis to study and design for awareness seems more appropriate, since practices of awareness may differ in different situations. It is also well-suited for creative designing. Another important aspect of the experience-focused HCI perspective is the evaluation. In both the design cases, open-ended field trials were carried out instead of a 'formal evaluation'. This is simply because, the aim behind these two prototype awareness systems was not to follow a particular task but bring value to users' everyday experiences.

Bibliography

[1] E. Aarts and S. Marzano. The New Everyday: Visions of Ambient Intelligence, 010 Publishing. *Rotterdam, The Netherlands*, 116, 2003.

[2] G.D. Abowd and E.D. Mynatt. Charting past, present, and future research in ubiquitous computing. *ACM Transactions on Computer-Human Interaction (TOCHI)*, 7(1):29–58, 2000.

[3] M.S. Ackerman and C. Halverson. Organizational memory: processes, boundary objects, and trajectories. In *System Sciences, 1999. HICSS-32. Proceedings of the 32nd Annual Hawaii International Conference on*, page 12. IEEE, 2002.

[4] T.J. Allen. Managing the flow of technology: Technology transfer and the dissemination of technological information within the R&D organization. *MIT Press Books*, 1, 1984.

[5] E. Arias, H. Eden, G. Fischer, A. Gorman, and E. Scharff. Transcending the individual human mindcreating shared understanding through collaborative design. *ACM Transactions on Computer-Human Interaction (TOCHI)*, 7(1):84–113, 2000.

[6] L.J. Ball and T.C. Ormerod. Applying ethnography in the analysis and support of expertise in engineering design. *Design Studies*, 21(4):403–421, 2000.

[7] J.E. Bardram and C. Bossen. A web of coordinative artifacts: collaborative work at a hospital ward. In *Proceedings of the 2005 international ACM SIGGROUP conference on Supporting group work*, page 176. ACM, 2005.

[8] J. Baren, W. IJsselsteijn, N. Romero, P. Markopoulos, and B. Ruyter. Affective Benefits in Communication: The development and field-testing of a new questionnaire measure. In *PRESENCE 2003, 6th annual international workshop on Presence, Aalborg, Denmark, October 6-8 2003*, page 48. Citeseer, 2003.

[9] M. Baskinger. COVER STORY Pencils before pixels: a primer in hand-generated sketching. *interactions*, 15(2):28–36, 2008.

[10] K. Battarbee. *Co-experience: Understanding user experiences in social interaction*. PhD Thesis. University of Art and Design in Helsinki, 2004.

[11] K. Battarbee, N. Baerten, M. Hinfelaar, P. Irvine, S. Loeber, A. Munro, and T. Pederson. Pools and satellites: intimacy in the city. In *DIS '02: Proceedings of the 4th conference on Designing interactive systems*, pages 237–245, New York, NY, USA, 2002. ACM.

[12] RKE Bellamy. Designing educational technology: computer-mediated change. *Context and consciousness: Activity theory and human-computer interaction*, pages 123–146, 1996.

[13] AJ Bernheim Brush, T. Combs Turner, M.A. Smith, and N. Gupta. Scanning objects in the wild: Assessing an object triggered information system. *UbiComp 2005: Ubiquitous*

Computing, pages 305–322, 2005.

[14] T. Binder, G. De Michelis, M. Gervautz, G. Jacucci, K. Matkovic, T. Psik, and I. Wagner. Supporting configurability in a mixed-media environment for design students. *Personal and Ubiquitous Computing*, 8(5):310–325, 2004.

[15] E. Blevis, Y. Lim, E. Stolterman, T.V. Wolf, and K. Sato. Supporting design studio culture in HCI. In *CHI'07 extended abstracts on Human factors in computing systems*, page 2824. ACM, 2007.

[16] E. Blevis, Y.K. Lim, M. Ozakca, and S. Aneja. Designing interactivity for the specific context of designerly collaborations. In *CHI'05 extended abstracts on Human factors in computing systems*, pages 1216–1219. ACM, 2005.

[17] S. A. Bly, S. R. Harrison, and S. Irwin. Media spaces: bringing people together in a video, audio, and computing environment. *Commun. ACM*, 36(1):28–46, 1993.

[18] S.A. Bly. A use of drawing surfaces in different collaborative settings. In *Proceedings of the 1988 ACM conference on Computer-supported cooperative work*, pages 250–256. ACM, 1988.

[19] M. Blythe and P. Cairns. Critical methods and user generated content: the iphone on youtube. In *Proceedings of the 27th international conference on Human factors in computing systems*, CHI '09, pages 1467–1476, New York, NY, USA, 2009. ACM.

[20] M. Blythe, A. Monk, C. Overbeeke, and PC Wright. Funology: From usability to user enjoyment, 2003.

[21] S. Bødker. A human activity approach to user interfaces. *Human–Computer Interaction*, 4(3):171–195, 1989.

[22] S. Bødker and E. Christiansen. Computer support for social awareness in flexible work. *Comput. Supported Coop. Work*, 15(1):1–28, 2006.

[23] K. Boehner. *Interfaces with the ineffable*. Unpublished PhD Thesis, University of Cornell., 2006.

[24] K. Boehner, J. Vertesi, P. Sengers, and P. Dourish. How HCI interprets the probes. In *Proceedings of the SIGCHI conference on Human factors in computing systems*, page 1086. ACM, 2007.

[25] S.U. Boess. First steps in role playing. In *CHI'08 extended abstracts on Human factors in computing systems*, pages 2017–2024. ACM, 2008.

[26] J. Bowers, G. Button, and W. Sharrock. Workflow from within and without: Technology and cooperative work on the print industry shopfloor. In *Proceedings of the fourth conference on European Conference on Computer-Supported Cooperative Work*, pages 51–66. Kluwer Academic Publishers, 1995.

[27] S. Brave, H. Ishii, and A. Dahley. Tangible interfaces for remote collaboration and communication. In *Proceedings of the 1998 ACM conference on Computer supported cooperative work*, pages 169–178. ACM, 1998.

[28] B. Brown, A. Taylor, S. Izadi, A. Sellen, J. Kaye, and R. Eardley. Locating family values: A field trial of the Whereabouts Clock. *UbiComp 2007: Ubiquitous Computing*, pages 354–371, 2007.

[29] M. Buchenau and J.F. Suri. Experience prototyping. In *Proceedings of the 3rd conference on Designing interactive systems: processes, practices, methods, and techniques*, pages 424–433. ACM, 2000.

[30] M. Buscher, S. Gill, P. Mogensen, and D. Shapiro. Landscapes of practice: Bricolage as

a method for situated design. *Computer Supported Cooperative Work (CSCW)*, 10(1):1–28, 2001.

[31] M. Buscher, M. Kompast, R. Lainer, and I. Wagner. The Architects Wunderkammer: Aesthetic Pleasure & Engagement in Electronic Spaces. *Digital Creativity*, 10(1):1–17, 1999.

[32] M. Buscher, P. Mogensen, D. Shapiro, and I. Wagner. The Manufaktur: supporting work practice in (landscape) architecture. In *ECSCW99*, pages 21–40. Springer, 1999.

[33] G. Button. *Ethnomethodology and the human sciences*. Cambridge Univ Pr, 1991.

[34] G. Button. The ethnographic tradition and design. *Design Studies*, 21(4):319–332, 2000.

[35] B. Buxton and W. Buxton. *Sketching user experiences: getting the design right and the right design*. Morgan Kaufmann Pub, 2007.

[36] M. Callon. Actor-network theory: the market test. *Actor network theory and after*, pages 181–195, 1999.

[37] M. Chalmers and A. Galani. Seamful interweaving: heterogeneity in the theory and design of interactive systems. In *DIS '04: Proceedings of the 5th conference on Designing interactive systems*, pages 243–252, New York, NY, USA, 2004. ACM.

[38] K. Cheverst, A. Dix, D. Fitton, C. Graham, and M. Rouncefield. Situatedness of Awareness Information: Impact on the Design and Usage of Awareness Systems. *Awareness Systems*, pages 397–422, 2009.

[39] K. Cheverst, A. Dix, D. Fitton, M. Rouncefield, and C. Graham. Exploring awareness related messaging through two situated-display-based systems. *Human-Computer Interaction*, 22(1):173–220, 2007.

[40] H. Chung, C.H.J. Lee, and T. Selker. Lover's cups: drinking interfaces as new communication channels. In *CHI'06 extended abstracts on Human factors in computing systems*, page 380. ACM, 2006.

[41] H.H. Clark. Coordinating with each other in a material world. *Discourse studies*, 7(4-5):507, 2005.

[42] A. Crabtree. Ethnography in participatory design. In *Proceedings of the 1998 Participatory design Conference*, pages 93–105. Citeseer, 1998.

[43] A. Crabtree, T. Hemmings, T. Rodden, K. Cheverst, K. Clarke, G. Dewsbury, J. Hughes, and M. Rouncefield. Designing with care: Adapting cultural probes to inform design in sensitive settings. In *Proceedings of the 2004 Australasian Conference on Computer-Human Interaction (OZCHI2004)*, pages 4–13, 2003.

[44] A. Crabtree and T. Rodden. Domestic routines and design for the home. *Computer Supported Cooperative Work (CSCW)*, 13(2):191–220, 2004.

[45] N. Cross. *Designerly ways of knowing*. Springer, 2006.

[46] T. Dalsgaard, M. Skov, M. Stougaard, and B. Thomassen. Mediated intimacy in families: understanding the relation between children and parents. In *Proceedings of the 2006 conference on Interaction design and children*, IDC '06, pages 145–152, New York, NY, USA, 2006. ACM.

[47] G. De Michelis, F. De Paoli, C. Pluchinotta, and M. Susani. Weakly augmented reality: observing and designing the work-place of creative designers. In *Proceedings of DARE 2000 on Designing augmented reality environments*, pages 81–91. ACM, 2000.

[48] C. Decker, T. Riedel, M. Beigl, L.M.S. de Souza, P. Spiess, J. Muller, and S. Haller. Collaborative business items. In *3rd IET International Conference on Intelligent Environments, 2007. IE 07*, pages 40–47. Citeseer, 2007.

[49] J. Dewey. *Art as experience*. Perigee, 1934.

[50] P. Dillenbourg, J. Huang, and M. Cherubini. *Interactive artifacts and furniture supporting collaborative work and learning*. Springer, 2008.

[51] A. Dix. First steps in physicality. *Preface to Physicality*, pages 257–274, 2006.

[52] P. Dourish. *Where the action is: the foundations of embodied interaction*. The MIT Press, 2004.

[53] P. Dourish. Implications for design. In *Proceedings of the SIGCHI conference on Human Factors in computing systems*, CHI '06, pages 541–550, New York, NY, USA, 2006. ACM.

[54] P. Dourish and S. Bly. Portholes: supporting awareness in a distributed work group. In *Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 541–547. ACM, 1992.

[55] F. Downing. Transcending memory: remembrance and the design of place* 1. *Design Studies*, 24(3):213–235, 2003.

[56] K. Ducatel, M. Bogdanowicz, F. Scapolo, J. Leijten, and J.C. Burgelman. Scenarios for ambient intelligence in 2010, 2001.

[57] C. Eckert and J.F. Boujut. The role of objects in design co-operation: communication through physical or virtual objects. *Computer Supported Cooperative Work (CSCW)*, 12(2):145–151, 2003.

[58] P. Ehn, M. Agger Eriksen, P. Linde, B. Peterson, S. Niedenthal, T. Binder, G. Jacucci, K. Kuutti, G. De Michelis, A. Rumpfhuber, et al. Opening the Digital Box for Design Work-Supporting performative interactions, using inspirational materials and configuring of place. *The disappearing computer: interaction design, system infrastructures and applications for smart environments*, page 50, 2007.

[59] A. Eliëns and J.F. Hoorn. Odyssee–explorations in mixed reality theatre. In *Proc. GAMEON-NA*, pages 62–64, 2006.

[60] M.R. Endsley. Toward a theory of situation awareness in dynamic systems. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, 37(1):32–64, 1995.

[61] Y. Engestrom. Learning by expanding: An activity-theoretical approach to developmental research, 1987.

[62] Y. Engestrom. Developmental studies of work as a testbench of activity theory: The case of primary care medical practice. *Understanding practice: Perspectives on activity and context*, pages 64–103, 1993.

[63] Y. Engestrom. Expansive learning at work: Toward an activity theoretical reconceptualization. *Journal of education and work*, 14(1):133–156, 2001.

[64] D. Fallman. *In romance with the materials of mobile interaction: A phenomenological approach to the design of mobile information technology*. Unpublished PhD Thesis., 2003.

[65] D. Fallman. Supporting Studio Culture in Design Research, 2007.

[66] D. Fallman and J. Waterworth. Dealing with user experience and affective evaluation in hci design: A repertory grid approach. In *Workshop Paper, CHI*, pages 2–7, 2005.

[67] S. Fels. Designing intimate experiences. In *Proceedings of the 9th international confer-*

ence on Intelligent user interfaces, page 3. ACM, 2004.

[68] G. Fischer. Social creativity: turning barriers into opportunities for collaborative design. In *Proceedings of the eighth conference on Participatory design: Artful integration: interweaving media, materials and practices-Volume 1*, pages 152–161. ACM, 2004.

[69] R.S. Fish, R.E. Kraut, and B.L. Chalfonte. The VideoWindow system in informal communication. In *Proceedings of the 1990 ACM conference on Computer-supported cooperative work*, pages 1–11. ACM, 1990.

[70] R.S. Fish, R.E. Kraut, R.W. Root, and R.E. Rice. Video as a technology for informal communication. *Communications of the ACM*, 36(1):48–61, 1993.

[71] G. Fitzpatrick, S. Kaplan, T. Mansfield, D. Arnold, and B. Segall. Supporting public availability and accessibility with Elvin: Experiences and reflections. *Computer Supported Cooperative Work (CSCW)*, 11(3):447–474, 2002.

[72] M. Fjeld, K. Lauche, M. Bichsel, F. Voorhorst, H. Krueger, and M. Rauterberg. Physical and virtual tools: Activity theory applied to the design of groupware. *Computer Supported Cooperative Work (CSCW)*, 11(1):153–180, 2002.

[73] C. Floerkemeier, M. Langheinrich, E. Fleisch, F. Mattern, and S.E. Sarma. *The internet of things*. Springer-Verlag Berlin Heidelberg, 2008.

[74] NV Flor and E. Hutchins. Analyzing distributed cognition in software teams: a case study of collaborative programming during adaptive software maintenance. In *Empirical Studies of Programmers: Fourth Workshop, Ablex, Norwood, NJ*, pages 36–64, 1992.

[75] J. Fogarty, J. Forlizzi, and S.E. Hudson. Aesthetic information collages: generating decorative displays that contain information. In *Proceedings of the 14th annual ACM symposium on User interface software and technology*, pages 141–150. ACM, 2001.

[76] J. Forlizzi and K. Battarbee. Understanding experience in interactive systems. In *Proceedings of the 5th conference on Designing interactive systems: processes, practices, methods, and techniques*, pages 261–268. ACM, 2004.

[77] J. Forlizzi and S. Ford. The building blocks of experience: an early framework for interaction designers. In *Proceedings of the 3rd conference on Designing interactive systems: processes, practices, methods, and techniques*, pages 419–423. ACM, 2000.

[78] S.R. Fussell, L.D. Setlock, and R.E. Kraut. Effects of head-mounted and scene-oriented video systems on remote collaboration on physical tasks. In *Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 513–520. ACM, 2003.

[79] H. Garfinkel. *Studies in ethnomethodology*. Polity press, 1967.

[80] H. Garfinkel and H. Sacks. On formal structures of practical actions. *Theoretical sociology: Perspectives and developments*, pages 337–366, 1970.

[81] B. Gaver. Provocative awareness. *Computer Supported Cooperative Work (CSCW)*, 11(3):475–493, 2002.

[82] B. Gaver, T. Dunne, and E. Pacenti. Design: cultural probes. *interactions*, 6(1):21–29, 1999.

[83] W. Gaver. Designing for homo ludens. *I3 Magazine*, 12:2–6, 2002a.

[84] W.W. Gaver, J. Beaver, and S. Benford. Ambiguity as a resource for design. In *Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 233–240. ACM, 2003.

[85] W.W. Gaver, A. Sellen, C. Heath, and P. f. One is not enough: Multiple views in a media space. In *Proceedings of the INTERACT'93 and CHI'93 conference on Human factors in computing systems*, pages 335–341. ACM, 1993.

[86] C. Geertz. *The interpretation of cultures*. Basic Books, 1994.

[87] J.J. Gibson. *The ecological approach to visual perception*. Lawrence Erlbaum, 1986.

[88] B.G. Glaser and A.L. Strauss. Awareness contexts and social interaction. *American Sociological Review*, 29(5):669–679, 1964.

[89] B.G. Glaser and A.L. Strauss. *The discovery of grounded theory: Strategies for qualitative research*. Aldine Transaction, 2007.

[90] J.M. Greenbaum and M. Kyng. *Design at work: Cooperative design of computer systems*. L. Erlbaum Associates Inc. Hillsdale, NJ, USA, 1991.

[91] A. Grimes and R. Harper. Celebratory technology: new directions for food research in hci. In *Proceeding of the twenty-sixth annual SIGCHI conference on Human factors in computing systems*, CHI '08, pages 467–476, New York, NY, USA, 2008. ACM.

[92] K. Gronbaek, J.F. Kristensen, P. Orbaek, and M.A. Eriksen. Physical hypermedia: Organising collections of mixed physical and digital material. In *Proceedings of the fourteenth ACM conference on Hypertext and hypermedia*, page 19. ACM, 2003.

[93] M.D. Gross. The Electronic Cocktail Napkin–a computational environment for working with design diagrams. *Design Studies*, 17(1):53–69, 1996.

[94] T. Gross, C. Stary, and A. Totter. User-centered awareness in computer-supported cooperative work-systems: Structured embedding of findings from social sciences. *International Journal of Human-Computer Interaction*, 18(3):323–360, 2005.

[95] C. Gutwin and S. Greenberg. Support for group awareness in real-time desktop conferences. In *Proceedings of the Second New Zealand Computer Science Research Students' Conference*, pages 1–12. Citeseer, 1995.

[96] J. Haikio, A. Wallin, M. Isomursu, H. Ailisto, T. Matinmikko, and T. Huomo. Touch-based user interface for elderly users. In *Proceedings of the 9th international conference on Human computer interaction with mobile devices and services*, pages 289–296. ACM, 2007.

[97] L. Hallnas and J. Redstrom. *Interaction design: foundations, experiments*. University College of Borås. The Swedish School of Textiles. The Textile Research Centre, 2006.

[98] C.A. Halverson. *Inside the cognitive workplace: new technology and air traffic control*. University of California, San Diego, 1995.

[99] R. Harper, T. Rodden, Y. Rogers, and A. Sellen. *Being human: Human-computer interaction in the year 2020*. Microsoft Research, 2008.

[100] R.H.R. Harper and J.A. Hughes. *What a f-ing system! Send'em all to the same place and then expect us to stop'em hitting: Making Technology Work in Air Traffic Control*. Routledge, London, 1993.

[101] S. Harrison and P. Dourish. Re-place-ing space: the roles of place and space in collaborative systems. In *Proceedings of the 1996 ACM conference on Computer supported cooperative work*, pages 67–76. ACM, 1996.

[102] S. Harrison, D. Tatar, and P. Sengers. The three paradigms of HCI. In *Alt. Chi. Session at the SIGCHI Conference on Human Factors in Computing Systems San Jose, California, USA*. Citeseer, 2007.

[103] M. Hassenzahl. The thing and I: understanding the relationship between user and product. *Funology*, pages 31–42, 2003.

[104] M. Hassenzahl. The interplay of beauty, goodness, and usability in interactive products. *Human-Computer Interaction*, 19(4):319–349, 2004.

[105] C. Heath, M. Jirotka, P. Luff, and J. Hindmarsh. Unpacking collaboration: the interactional organisation of trading in a city dealing room. *Computer Supported Cooperative Work (CSCW)*, 3(2):147–165, 1994.

[106] C. Heath and P. Luff. Collaboration and controlCrisis management and multimedia technology in London Underground Line Control Rooms. *Computer Supported Cooperative Work (CSCW)*, 1(1):69–94, 1992.

[107] C. Heath, P. Luff, and A. Sellen. Reconsidering the virtual workplace: flexible support for collaborative activity. In *Proceedings of the fourth conference on European Conference on Computer-Supported Cooperative Work*, pages 83–99. Kluwer Academic Publishers, 1995.

[108] C. Heath, M.S. Svensson, J. Hindmarsh, P. Luff, and D. Vom Lehn. Configuring awareness. *Computer Supported Cooperative Work (CSCW)*, 11(3):317–347, 2002.

[109] D. Hindus, S.D. Mainwaring, N. Leduc, A.E. Hagstrom, and O. Bayley. Casablanca: designing social communication devices for the home. In *Proceedings of the SIGCHI conference on Human factors in computing systems*, page 332. ACM, 2001.

[110] K. Holtzblatt, J.B. Wendell, and S. Wood. *Rapid contextual design: a how-to guide to key techniques for user-centered design*. Morgan Kaufmann Publishers, 2005.

[111] K. Hook, P. Sengers, and G. Andersson. Sense and sensibility: evaluation and interactive art. In *Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 241–248. ACM, 2003.

[112] T. Horgen. *Excellence by design: Transforming workplace and work practice*. Wiley, 1999.

[113] E. Hornecker. Understanding the benefits of graspable interfaces for cooperative use. *Cooperative systems design: a challenge of the mobility age*, page 71, 2002.

[114] E. Hornecker. A design theme for tangible interaction: embodied facilitation. In *ECSCW 2005*, pages 23–43. Springer, 2005.

[115] E. Huang and E. Mynatt. Semi-public displays for small, co-located groups. In *Proceedings of the SIGCHI conference on Human factors in computing systems*, CHI '03, pages 49–56, New York, NY, USA, 2003. ACM.

[116] J.A. Hughes, D. Randall, and D. Shapiro. Faltering from ethnography to design. In *Proceedings of the 1992 ACM conference on Computer-supported cooperative work*, pages 115–122. ACM, 1992.

[117] J. Huizinga. *Homo Ludens*. Routledge & K. Paul, 1949.

[118] J. Hulstijn and A. Nijholt, editors. *Computational Humor: Automatic Interpretation and Generation of Verbal Humor*, volume 12 of *Twente Workshop on Language Technology*. University of wente, Enschede, the Netherlands, 1996.

[119] C. Hummels, K.C. Overbeeke, and S. Klooster. Move to get moved: a search for methods, tools and knowledge to design for expressive and rich movement-based interaction. *Personal and Ubiquitous Computing*, 11(8):690, 2007.

[120] E. Hutchins. *Cognition in the Wild*. MIT press Cambridge, MA, 1996.

[121] E. Hutchins and T. Klausen. Distributed cognition in an airline cockpit. *Cognition and*

communication at work, pages 15–34, 1996.

[122] E. Hutchins and L. Palen. Constructing meaning from space, gesture, and speech. *Discourse, tools, and reasoning: Essays on situated cognition*, pages 23–40, 1997.

[123] H. Hutchinson, W. Mackay, B. Westerlund, B.B. Bederson, A. Druin, C. Plaisant, M. Beaudouin-Lafon, S. Conversy, H. Evans, H. Hansen, et al. Technology probes: inspiring design for and with families. In *Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 17–24. ACM, 2003.

[124] G. Iacucci and I. Wagner. Supporting Collaboration Ubiquitously: An augmented learning environment for architecture students. In *Proceedings of the eighth conference on European Conference on Computer Supported Cooperative Work*, page 158. Kluwer Academic Publishers, 2003.

[125] H. Ishii. TeamWorkStation: towards a seamless shared workspace. In *Proceedings of the 1990 ACM conference on Computer-supported cooperative work*, pages 13–26. ACM, 1990.

[126] H. Ishii, M. Kobayashi, and K. Arita. Iterative design of seamless collaboration media. *Communications of the ACM*, 37(8):83–97, 1994.

[127] S. Izadi, H. Brignull, T. Rodden, Y. Rogers, and M. Underwood. Dynamo: a public interactive surface supporting the cooperative sharing and exchange of media. In *Proceedings of the 16th annual ACM symposium on User interface software and technology*, pages 159–168. ACM, 2003.

[128] G. Jacucci. *Interaction as Performance: Cases of Configuring Physical Interfaces in Mixed Media*. University of Oulu, Department of Infomation Processing Science, 2004.

[129] G. Jacucci and I. Wagner. Performative roles of materiality for collective creativity. In *Proceedings of the 6th ACM SIGCHI conference on Creativity & Cognition*, page 82. ACM, 2007.

[130] E.E. Karapanos. *Quantifying diversity in user experience*. PhD Thesis, Technische Universiteit Eindhoven, 2010.

[131] J. Karat. Beyond task completion: evaluation of affective components of use. In *The human-computer interaction handbook*, pages 1152–1164. L. Erlbaum Associates Inc., 2002.

[132] J. Kaye. *The Epistemology and Evaluation of Experience-focused HCI*. Unpublished PhD Thesis, University of Cornell., 2008.

[133] J.J. Kaye. I just clicked to say I love you: rich evaluations of minimal communication. In *CHI'06 extended abstracts on Human factors in computing systems*, pages 363–368. ACM, 2006.

[134] J.J. Kaye and L. Goulding. Intimate objects. In *Proceedings of the 5th conference on Designing interactive systems: processes, practices, methods, and techniques*, pages 341–344. ACM, 2004.

[135] T. Kelley and J. Littman. *The art of innovation: lessons in creativity from IDEO, America's leading design firm*. Crown Business, 2001.

[136] G. Kelly. *Psychology of Personal Constructs: Volume Two: Clinical Diagnosis and Psychotherapy*. Routledge, 1955.

[137] F. Kensing and J. Blomberg. Participatory design: Issues and concerns. *Computer Supported Cooperative Work (CSCW)*, 7(3):167–185, 1998.

[138] A. Kidd. The marks are on the knowledge worker. In *Proceedings of the SIGCHI confer-*

ence on Human factors in computing systems: celebrating interdependence, pages 186–191. ACM, 1994.

[139] D. Kirk, A. Crabtree, and T. Rodden. Ways of the hands. In *ECSCW 2005*, pages 1–21. Springer, 2005.

[140] D. Kirsh. The intelligent use of space. *Artificial intelligence*, 73(1-2):31–68, 1995.

[141] S.R. Klemmer, K.M. Everitt, and J.A. Landay. Integrating physical and digital interactions on walls for fluid design collaboration. *Human–Computer Interaction*, 23(2):138–213, 2008.

[142] S.R. Klemmer, B. Hartmann, and L. Takayama. How bodies matter: five themes for interaction design. In *Proceedings of the 6th conference on Designing Interactive systems*, pages 140–149. ACM, 2006.

[143] S.S. Klooster and CJ Overbeeke. Designing products as an integral part of choreography of interaction: the product's form as an integral part of movement, 2005.

[144] R. Kraut, C. Egido, and J. Galegher. Patterns of contact and communication in scientific research collaboration. In *Proceedings of the 1988 ACM conference on Computer-supported cooperative work*, pages 1–12. ACM, 1988.

[145] R.E. Kraut, S.R. Fussell, and J. Siegel. Visual information as a conversational resource in collaborative physical tasks. *Human-computer interaction*, 18(1):13–49, 2003.

[146] S. Kuhn. The software design studio: An exploration. *Software, IEEE*, 15(2):65–71, 2002.

[147] R. Lainer and I. Wagner. Connecting qualities of social use with spatial qualities. In *Cooperative Buildings. Integrating Information, Organization, and Architecture: First International Workshop, CoBuild'98, Darmstadt, Germany, February 1998. Proceedings*, page 191. Springer, 1998.

[148] B. Latour. *Science in action: How to follow scientists and engineers through society*. Harvard Univ Pr, 1987.

[149] B. Latour. Visualisation and Cognition: Drawing things together. *Representation in Scientific Practice. Ed. Michael Lynch and Steve Woolgar*, 1990.

[150] B. Latour. *Reassembling the social: An introduction to actor-network-theory*. Oxford University Press, USA, 2005.

[151] B. Latour and S. Woolgar. *Laboratory life: The construction of scientific facts*. Princeton Univ Pr, 1986.

[152] B.R. Lawson. Cognitive strategies in architectural design. *Ergonomics*, 22(1):59–68, 1979.

[153] D. Leonard-Barton and W.C. Swap. *When sparks fly: Igniting creativity in groups*. Harvard Business Press, 1999.

[154] A.N. Leont'ev and M.J. Hall. *Activity, consciousness, and personality*. Prentice-Hall Englewood Cliffs, NJ, 1978.

[155] S.E. Lindley, R. Harper, and A. Sellen. Designing a technological playground: a field study of the emergence of play in household messaging. In *Proceedings of the 28th international conference on Human factors in computing systems*, pages 2351–2360. ACM, 2010.

[156] P. Ljungstrand, J. Redstrom, and L.E. Holmquist. WebStickers: using physical tokens to access, manage and share bookmarks to the Web. In *Proceedings of DARE 2000 on*

Designing augmented reality environments, page 31. ACM, 2000.

[157] P. Luff, J. Hindmarsh, and C. Heath. *Workplace studies*. Cambridge University Press, 2000.

[158] B. Mainemelis, S. Harvey, and G. Peters. Grow and play. *Business Strategy Review*, 19(1):38–43, 2008.

[159] H. Maldonado, B. Lee, and S. Klemmer. Technology for design education: a case study. In *CHI'06 extended abstracts on Human factors in computing systems*, pages 1067–1072. ACM, 2006.

[160] L. Mamykina, A. Miller, E. Mynatt, and D. Greenblatt. Constructing identities through storytelling in diabetes management. In *Proceedings of the 28th international conference on Human factors in computing systems*, CHI '10, pages 1203–1212, New York, NY, USA, 2010. ACM.

[161] M.M. Mantei, R.M. Baecker, A.J. Sellen, W.A.S. Buxton, T. Milligan, and B. Wellman. Experiences in the use of a media space. In *Proceedings of the SIGCHI conference on Human factors in computing systems: Reaching through technology*, pages 203–208. ACM, 1991.

[162] G. Mark, L. Fuchs, and M. Sohlenkamp. Supporting groupware conventions through contextual awareness. In *Proceedings of the fifth conference on European Conference on Computer-Supported Cooperative Work*, pages 253–268. Kluwer Academic Publishers, 1997.

[163] P. Markopoulos, B. De Ruyter, and W. MacKay. Awareness Systems: Advances in Theory, Methodology and Design, 2009.

[164] P. Markopoulos, N. Romero, J. van Baren, W. IJsselsteijn, B. de Ruyter, and B. Farshchian. Keeping in touch with the family: home and away with the ASTRA awareness system. In *CHI'04 extended abstracts on Human factors in computing systems*, pages 1351–1354. ACM, 2004.

[165] M. Mateas. Expressive AI: A hybrid art and science practice. *Leonardo*, 34(2):147–153, 2001.

[166] J. McCarthy, T. Costa, and E. Liongosari. Unicast, outcast & groupcast: Three steps toward ubiquitous, peripheral displays. In *Ubicomp 2001: Ubiquitous Computing*, pages 332–345. Springer, 2001.

[167] J. McCarthy and P. Wright. Technology as Experience, 2004.

[168] W.J.T. Mitchell. *Picture theory: Essays on verbal and visual representation*. University of Chicago Press, 1995.

[169] W. Muller and G. Pasman. Typology and the organization of design knowledge. *Design studies*, 17(2):111–130, 1996.

[170] E.D. Mynatt, J. Rowan, S. Craighill, and A. Jacobs. Digital family portraits: supporting peace of mind for extended family members. In *Proceedings of the SIGCHI conference on Human factors in computing systems*, page 340. ACM, 2001.

[171] B.A. Nardi. *Context and consciousness: activity theory and human-computer interaction*. The MIT Press, 1996.

[172] B.A. Nardi. Coda and response to Christine Halverson. *Computer Supported Cooperative Work (CSCW)*, 11(1):269–275, 2002.

[173] B.A. Nardi, S. Whittaker, and E. Bradner. Interaction and outeraction: instant messaging in action. In *Proceedings of the 2000 ACM conference on Computer supported*

cooperative work, pages 79–88. Citeseer, 2000.

[174] D.A. Norman. Cognitive artifacts, Designing interaction: psychology at the human-computer interface, 1991.

[175] D.A. Norman. *Emotional design: Why we love (or hate) everyday things*. Basic Civitas Books, 2004.

[176] K. O'Hara, T. Kindberg, M. Glancy, L. Baptista, B. Sukumaran, G. Kahana, and J. Rowbotham. Social practices in location-based collecting. In *Proceedings of the SIGCHI conference on Human factors in computing systems*, page 1234. ACM, 2007.

[177] J. O'Neill, D. Martin, T. Colombino, F. Roulland, and J. Willamowski. Colour management is a socio-technical problem. In *Proceedings of the ACM 2008 conference on Computer supported cooperative work*, pages 599–608. ACM, 2008.

[178] W.J. Orlikowski. Using technology and constituting structures: A practice lens for studying technology in organizations. *Resources, Co-Evolution and Artifacts*, pages 255–305, 2008.

[179] J. Ou, S.R. Fussell, X. Chen, L.D. Setlock, and J. Yang. Gestural communication over video stream: supporting multimodal interaction for remote collaborative physical tasks. In *Proceedings of the 5th international conference on Multimodal interfaces*, pages 242–249. ACM, 2003.

[180] S. Patil and J. Lai. Who gets to know what when: configuring privacy permissions in an awareness application. In *Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 101–110. ACM, 2005.

[181] E.R. Pedersen and T. Sokoler. AROMA: abstract representation of presence supporting mutual awareness. In *Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 51–58. ACM, 1997.

[182] M. Perry and D. Rachovides. Entertaining situated messaging at home. *Computer Supported Cooperative Work (CSCW)*, 16(1):99–128, 2007.

[183] M. Perry and D. Sanderson. Coordinating joint design work: the role of communication and artefacts. *Design Studies*, 19(3):273–288, 1998.

[184] M.G. Petersen, O.S. Iversen, P.G. Krogh, and M. Ludvigsen. Aesthetic Interaction: a pragmatist's aesthetics of interactive systems. In *Proceedings of the 5th conference on Designing interactive systems: processes, practices, methods, and techniques*, pages 269–276. ACM, 2004.

[185] B.J. Pine, J.H. Gilmore, et al. *The experience economy*. Harvard Business School Press Boston, MA, 1999.

[186] B. Piper, C. Ratti, and H. Ishii. Illuminating clay: a 3-D tangible interface for landscape analysis. In *Proceedings of the SIGCHI conference on Human factors in computing systems: Changing our world, changing ourselves*, pages 355–362. ACM, 2002.

[187] W. Prinz, W. Graether, T. Gross, S. Kolvenbach, KH Klein, U. Pankoke-Babatz, and L. Schaefer. TOWER: Presenting Activity Information in a Theatre of Work. In *Supplement Proceedings of the ACM 2002 Conference on Computer-Supported Cooperative Work-CSCW*, pages 91–94, 2002.

[188] D. Ramduny-Ellis, A. Dix, P. Rayson, V. Onditi, I. Sommerville, and J. Ransom. Artefacts as designed, Artefacts as used: resources for uncovering activity dynamics. *Cognition, Technology & Work*, 7(2):76–87, 2005.

[189] D. Randall, R. Harper, and M. Rouncefield. *Fieldwork for design: theory and practice*.

Springer-Verlag New York Inc, 2007.

[190] J. Redstrom, T. Skog, and L. Hallnas. Informative art: using amplified artworks as information displays. In *Proceedings of DARE 2000 on Designing augmented reality environments*, page 114. ACM, 2000.

[191] J. Rekimoto and Y. Ayatsuka. CyberCode: designing augmented reality environments with visual tags. In *Proceedings of DARE 2000 on Designing augmented reality environments*, page 10. ACM, 2000.

[192] Y. Riche and W. Mackay. PeerCare: Supporting Awareness of Rhythms and Routines for Better Aging in Place. *Computer Supported Cooperative Work (CSCW)*, 19(1):73–104, 2010.

[193] M. Rittenbruch and G. McEwan. An historical reflection of awareness in collaboration. *Awareness Systems*, pages 3–48, 2009.

[194] T. Robertson. Cooperative work and lived cognition: a taxonomy of embodied actions. In *Proceedings of the fifth conference on European Conference on Computer-Supported Cooperative Work*, pages 205–220. Kluwer Academic Publishers, 1997.

[195] T. Robertson. The public availability of actions and artefacts. *Computer Supported Cooperative Work (CSCW)*, 11(3):299–316, 2002.

[196] Y. Rogers. Coordinating computer-mediated work. *Computer Supported Cooperative Work (CSCW)*, 1(4):295–315, 1993.

[197] Y. Rogers. New theoretical approaches for human-computer interaction. *Annual review of information science and technology*, 38(1):87–143, 2004.

[198] Y. Rogers. Moving on from weisers vision of calm computing: Engaging ubicomp experiences. *UbiComp 2006: Ubiquitous Computing*, pages 404–421, 2006.

[199] A. Sachs. Stuckness' in the design studio. *Design Studies*, 20(2):195–209, 1999.

[200] S. Sarker, F. Lau, and S. Sahay. Using an adapted grounded theory approach for inductive theory building about virtual team development. *ACM SiGMIS Database*, 32(1):38–56, 2000.

[201] M. Scaife and Y. Rogers. External cognition: how do graphical representations work? *Int. J. Hum.-Comput. Stud.*, 45:185–213, August 1996.

[202] K. Schmidt. Some notes on mutual awareness. *COTCOS-Report, Universidade Técnica da Dinamarca, disponível em http://citeseer. ist. psu. edu/330273. html, último acesso em jan*, 1998.

[203] K. Schmidt. The Problem with Awareness': Introductory Remarks on Awareness in CSCW'. *Computer Supported Cooperative Work (CSCW)*, 11(3):285–298, 2002.

[204] K. Schmidt. *Cooperative work and coordinative practices: contributions to the conceptual foundations of computer-supported cooperative work (CSCW)*. IT University of Copenhagen, 2007.

[205] K. Schmidt and L. Bannon. Taking CSCW seriously. *Computer Supported Cooperative Work (CSCW)*, 1(1):7–40, 1992.

[206] K. Schmidt and C. Simone. Coordination mechanisms: Towards a conceptual foundation of CSCW systems design. *Computer Supported Cooperative Work (CSCW)*, 5(2):155–200, 1996.

[207] K. Schmidt and I. Wagner. Coordinative artifacts in architectural practice. *Cooperative Systems Design. A Challenge of the Mobility Age*, pages 257–274, 2002.

[208] M. Schneider and A. Kröner. The smart pizza packing: An application of object memories. In *2008 IET 4th International Conference on Intelligent Environments*, pages 1–8, 2008.

[209] D.A. Schon. *The reflective practitioner: How professionals think in action*. Basic Books, 1983.

[210] D.A. Schon and G. Wiggins. Kinds of seeing and their functions in designing. *Design studies*, 13(2):135–156, 1992.

[211] J.A. Seiler. Architecture at work. *Harvard Business Review*, 62(5):111–120, 1984.

[212] A. Sellen, R. Eardley, S. Izadi, and R. Harper. The whereabouts clock: early testing of a situated awareness device. In *CHI'06 extended abstracts on Human factors in computing systems*, pages 1307–1312. ACM, 2006.

[213] A. Sellen, A. Fogg, M. Aitken, S. Hodges, C. Rother, and K. Wood. Do life-logging technologies support memory for the past?: an experimental study using sensecam. In *Proceedings of the SIGCHI conference on Human factors in computing systems*, CHI '07, pages 81–90, New York, NY, USA, 2007. ACM.

[214] A. Sellen and R. Harper. Video in support of organizational talk. *Video-mediated communication*, pages 225–243, 1997.

[215] A. Sellen, R. Harper, R. Eardley, S. Izadi, T. Regan, A.S. Taylor, and K.R. Wood. HomeNote: supporting situated messaging in the home. In *Proceedings of the 2006 20th anniversary conference on Computer supported cooperative work*, page 392. ACM, 2006.

[216] A.J. Sellen and R.H.R. Harper. *The myth of the paperless office*. The MIT Press, 2003.

[217] P. Sengers, K. Boehner, S. David, and J.J. Kaye. Reflective design. In *Proceedings of the 4th decennial conference on Critical computing: between sense and sensibility*, page 58. ACM, 2005.

[218] P. Sengers and B. Gaver. Staying open to interpretation: engaging multiple meanings in design and evaluation. In *Proceedings of the 6th conference on Designing Interactive systems*, pages 99–108. ACM, 2006.

[219] D.Z. Shapiro, J.A. Hughes, D. Randall, and R. Harper. Visual re-representation of database information: The flight data strip in air traffic control. *HUMAN FACTORS IN INFORMATION TECHNOLOGY*, 11:349–349, 1994.

[220] C. Shen, F.D. Vernier, C. Forlines, and M. Ringel. DiamondSpin: an extensible toolkit for around-the-table interaction. In *Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 167–174. ACM, 2004.

[221] S.L. Star and J.R. Griesemer. Institutional ecology,'translations' and boundary objects: Amateurs and professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39. *Social studies of science*, 19(3):387–420, 1989.

[222] A. Strauss and J. Corbin. Grounded Theory Methodology. An Overview Handbook of Qualitative Research. *Handbook of qualitative research*, pages 273–285, 1994.

[223] A.L. Strauss and J.M. Corbin. *Basics of qualitative research: Techniques and procedures for developing grounded theory*. Sage Publications, Inc, 1998.

[224] N. Streitz, T. Prante, C. Rocker, D. Van Alphen, R. Stenzel, C. Magerkurth, S. Lahlou, V. Nosulenko, F. Jegou, F. Sonder, et al. Smart artefacts as affordances for awareness in distributed teams. *The disappearing computer: interaction design, system infrastructures and applications for smart environments*, pages 3–29, 2007.

[225] N.A. Streitz, C. Rocker, T. Prante, D. van Alphen, R. Stenzel, C. Magerkurth, I. Fraun-

hofer, and G. Darmstadt. Designing smart artifacts for smart environments. *Computer*, 38(3):41–49, 2005.

[226] R. Strong and B. Gaver. Feather, scent and shaker: supporting simple intimacy. In *Proceedings of CSCW*, volume 96, pages 29–30, 1996.

[227] L. Suchman. Centers of coordination: A case and some themes. *Discourse, tools and reasoning: Essays on situated cognition*, pages 44–62, 1997.

[228] L. Suchman. Embodied practices of engineering work. *Mind, Culture, and activity*, 7(1):4–18, 2000.

[229] L.A. Suchman. *Plans and situated actions: The problem of human-machine communication*. Cambridge University Press, 1987.

[230] M. Svensson, C. Heath, and P. Luff. Instrumental action: the timely exchange of implements during surgical operations. *ECSCW 2007*, pages 41–60, 2007.

[231] J.C. Tang. Findings from observational studies of collaborative work. *International Journal of Man-machine studies*, 34(2):143–160, 1991.

[232] J.C. Tang, E.A. Isaacs, and M. Rua. Supporting distributed groups with a Montage of lightweight interactions. In *Proceedings of the 1994 ACM conference on Computer supported cooperative work*, pages 23–34. ACM, 1994.

[233] A.S. Taylor and L. Swan. Artful systems in the home. In *Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 641–650. ACM, 2005.

[234] A.S. Taylor, L. Swan, R. Eardley, A. Sellen, S. Hodges, and K. Wood. Augmenting refrigerator magnets: why less is sometimes more. In *Proceedings of the 4th Nordic conference on Human-computer interaction: changing roles*, page 124. ACM, 2006.

[235] K. Tollmar, O. Sandor, and A. Schomer. Supporting social awareness@ work design and experience. In *Proceedings of the 1996 ACM conference on Computer supported cooperative work*, page 307. ACM, 1996.

[236] P. Tolmie, J. Pycock, T. Diggins, A. MacLean, and A. Karsenty. Unremarkable computing. In *Proceedings of the SIGCHI conference on Human factors in computing systems: Changing our world, changing ourselves*, page 406. ACM, 2002.

[237] M. Tomitsch, R. Schlogl, T. Grechenig, C. Wimmer, and T. Koltringer. Accessible real-world tagging through audio-tactile location markers. In *Proceedings of the 5th Nordic conference on Human-computer interaction: building bridges*, pages 551–554. ACM, 2008.

[238] N. Tractinsky, AS Katz, and D. Ikar. What is beautiful is usable. *Interacting with computers*, 13(2):127–145, 2000.

[239] B. Ullmer and H. Ishii. Emerging frameworks for tangible user interfaces. *IBM systems journal*, 39(3.4):915–931, 2010.

[240] B. Uluolu. Design knowledge communicated in studio critiques. *Design Studies*, 21(1):33–58, 2000.

[241] J. Underkoffler and H. Ishii. Urp: a luminous-tangible workbench for urban planning and design. In *Proceedings of the SIGCHI conference on Human factors in computing systems: the CHI is the limit*, pages 386–393. ACM, 1999.

[242] F. van Ham, H.J. Schulz, and J. Dimicco. Honeycomb: Visual Analysis of Large Scale Social Networks. *Human-Computer Interaction–INTERACT 2009*, pages 429–442, 2009.

[243] F. Vetere, M.R. Gibbs, J. Kjeldskov, S. Howard, F.F. Mueller, S. Pedell, K. Mecoles,

and M. Bunyan. Mediating intimacy: designing technologies to support strong-tie relationships. In *Proceedings of the SIGCHI conference on Human factors in computing systems*, page 480. ACM, 2005.

[244] D. Vyas. Artful surfaces in design practices. In *Proceedings of the 27th international conference extended abstracts on Human factors in computing systems*, pages 2691–2694. ACM, 2009.

[245] D. Vyas and A. Dix. Artefact Ecologies: Supporting Embodied Meeting Practices with Distance Access. In *Adjunct Proceedings of Ubicomp 2007*, pages 117–122. University of Innsbruck, 2007.

[246] D. Vyas, A. Eliëns, M.R. van de Watering, and G.C. van der Veer. Organizational probes: exploring playful interactions in work environment. In *Proceedings of the 15th European conference on Cognitive ergonomics: the ergonomics of cool interaction*, page 35. ACM, 2008.

[247] D. Vyas, D. Heylen, A. Eliëns, and A. Nijholt. Experiencing-in-the-world: using pragmatist philosophy to design for aesthetic experience. In *Proceedings of the 2007 conference on Designing for User eXperiences*, pages 1–16. ACM, 2007.

[248] D. Vyas, D. Heylen, and A. Nijholt. Physicality and Cooperative Design. In *Machine learning for multimodal interaction: 5th international workshop, MLMI 2008, Utrecht, The Netherlands, September 8-10, 2008; proceedings*, page 325. Springer-Verlag New York Inc, 2008.

[249] D. Vyas, D. Heylen, A. Nijholt, and G. van der Veer. Collaborative practices that support creativity in design. *In: ECSCW 2009: 11th European Conference on Computer Supported Cooperative Work*, pages 151–170, 2009.

[250] D. Vyas, D. Heylen, A. Nijholt, and G. van der Veer. Experiential role of artefacts in cooperative design. In *Proceedings of the fourth international conference on Communities and technologies*, pages 105–114. ACM, 2009.

[251] D. Vyas and A. Nijholt. Workplace surfaces as resource for social interactions. *Proceedings of International Conference on Social Intelligence Design 2009*, 2009.

[252] D. Vyas and A. Nijholt. Building boundaries on Boundary Objects: A Field study of a Ubicomp tool in a Design Studio. *International Reports on Socio-Informatics*, 2010.

[253] D. Vyas, A. Nijholt, D. Heylen, A. Kröner, and G. van der Veer. Remarkable objects: supporting collaboration in a creative environment. In *Proceedings of the 12th ACM international conference on Ubiquitous computing*, Ubicomp '10, pages 37–40, New York, NY, USA, 2010. ACM.

[254] D. Vyas, A. Nijholt, and A. Kröner. Cam: a collaborative object memory system. In *Proceedings of the 12th international conference on Human computer interaction with mobile devices and services*, MobileHCI '10, pages 415–416, New York, NY, USA, 2010. ACM.

[255] D. Vyas, A. Nijholt, and G. van der Veer. Supporting cooperative design through "living" artefacts. In *Proceedings of the 6th Nordic Conference on Human-Computer Interaction: Extending Boundaries*, NordiCHI '10, pages 541–550, New York, NY, USA, 2010. ACM.

[256] D. Vyas, M. van de Watering, A. Eliëns, and G. van der Veer. Being Social@ Work: Designing for Playfully Mediated Social Awareness in Work Environments. *Home Informatics and Telematics: ICT for the Next Billion*, pages 113–131, 2007.

[257] D. Vyas, M. van de Watering, A. Eliëns, and G. van der Veer. Engineering Social Awareness in Work Environments. *Universal Access in Human-Computer Interaction. Ambient*

Interaction, pages 254–263, 2007.

[258] D. Vyas, G. van der Veer, D. Heylen, and A. Nijholt. Space as a Resource in Creative Design Practices. *Human-Computer Interaction–INTERACT 2009*, pages 169–172, 2009.

[259] D. Vyas, G. van der Veer, A. Nijholt, and D. Heylen. Show me, how does it look now: remote help-giving in collaborative design. In *European Conference on Cognitive Ergonomics: Designing beyond the Product—Understanding Activity and User Experience in Ubiquitous Environments*, pages 1–4. VTT Technical Research Centre of Finland, 2009.

[260] D. Vyas and G.C. van der Veer. Experience as meaning: some underlying concepts and implications for design. In *Proceedings of the 13th Eurpoean conference on Cognitive ergonomics: trust and control in complex socio-technical systems*, pages 81–91. ACM, 2006.

[261] D. Vyas and G.C. van der Veer. Rich evaluations of entertainment experience: bridging the interpretational gap. In *Proceedings of the 13th Eurpoean conference on Cognitive ergonomics: trust and control in complex socio-technical systems*, pages 137–144. ACM, 2006.

[262] R. Want, K.P. Fishkin, A. Gujar, and B.L. Harrison. Bridging physical and virtual worlds with electronic tags. In *Proceedings of the SIGCHI conference on Human factors in computing systems: the CHI is the limit*, pages 370–377. ACM, 1999.

[263] M. Weiser. The computer for the 21st century. *Scientific American*, 272(3):78–89, 1991.

[264] M. Weiser and J.S. Brown. The coming age of calm technology. *Xerox PARC. Retrieved July*, 8, 1996.

[265] P. Wellner. Interacting with paper on the DigitalDesk. *Communications of the ACM*, 36(7):87–96, 1993.

[266] P. Wright and J. McCarthy. Empathy and experience in HCI. In *Proceeding of the twenty-sixth annual SIGCHI conference on Human factors in computing systems*, pages 637–646. ACM, 2008.

[267] A. Wu, J.M. DiMicco, and D.R. Millen. Detecting professional versus personal closeness using an enterprise social network site. In *Proceedings of the 28th international conference on Human factors in computing systems*, pages 1955–1964. ACM, 2010.

[268] S. Zuboff. *In the age of the smart machine: The future of work and power*. Basic Books, 1988.

Summary

Within Human-Computer Interaction (HCI) and Computer Supported Cooperative Work (CS- CW) research, the notion of technologically-mediated awareness is often used for allowing relevant people to maintain a mental model of activities, behaviors and status information about each other so that they can organize and coordinate work or other joint activities. The initial conceptions of awareness focused largely on improving productivity and efficiency within work environments. With new social, cultural and commercial needs and the emergence of novel computing technologies, the focus of technologically-mediated awareness has extended from work environments to people's everyday interactions. Hence, the scope of awareness has extended from conveying work related activities to people's emotions, love, social status and other broad range of aspects. This trend of conceptualizing HCI design is termed as experience-focused HCI. In my PhD dissertation, *designing for awareness*, I have reported on how we, as HCI researchers, can design awareness systems from experience-focused HCI perspective that follow the trend of conveying awareness beyond the task-based, instrumental and productive needs.

Within the overall aim to design for awareness, my research advocates ethnomethodologically-informed approaches for conceptualizing and designing for awareness. In this sense, awareness is not a predefined phenomenon but something that is situated and particular to a given environment. I have used this approach in two design cases of developing interactive systems that support awareness beyond task-based aspects in work environments. In both the cases, I have followed a complete design cycle: collecting an in-situ understanding of an environment, developing implications for a new technology, implementing a prototype technology to studying the use of the technology in its natural settings.

The first design case focused on mediating awareness in a work environment with a purpose of supporting social and informal interactions and community building. Using ethnomethodologically-informed ethnography, I studied an academic department over the period of six months and developed a prototype of an awareness system called Panorama that playfully mediated social awareness in a medium-sized work organization. Panorama is a large-screen display that supports mixed-initiative interaction. It allows co-workers to send their personalized objects such as holiday pictures, postcards and textual messages to be shown on the large screen in a dynamic way. At the same time, the system fetches abstract cues from the environment and represents these on the large screen. The purpose here is not to improve the work efficiencies but to create an environment that makes the co-workers socially aware

of each other's activities in a playful manner. I deployed the Panorama prototype in a staffroom of an academic department for two weeks and studied how it affected co-worker's interactions and awareness about each other.

The second design case was a part of a larger EU project called AMIDA (Augmented Multiparty Interaction with Distance Access). My goal was to design an interactive system to mediate awareness within a creative design studio environment. Using ethnomethodologically-informed ethnography, I studied 2 academic and a few professional design studios over eight months and developed a mobile phone bases prototype system called CAM (Cooperative Artefact Memory). CAM allows designers to collaboratively store relevant information onto their physical design artefacts, such as sketches, collages, story-boards, and physical mock-ups in the form of messages, annotations and external web links. After the implementation, I studied the use of CAM in a product design studio over three weeks to understand how CAM supported awareness during creative design sessions.

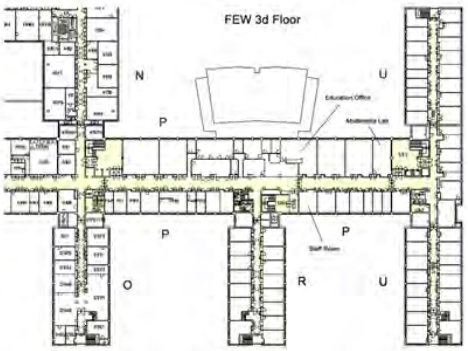
Overall, my PhD dissertation shows how ethnographically informed understanding of a work environment can help in designing systems. My ethnomethodologically-informed approach helps in both conceptualizing and designing for awareness in interactive systems. The work done in the two design cases provides important insights into designing awareness systems using experience-focused HCI perspective.

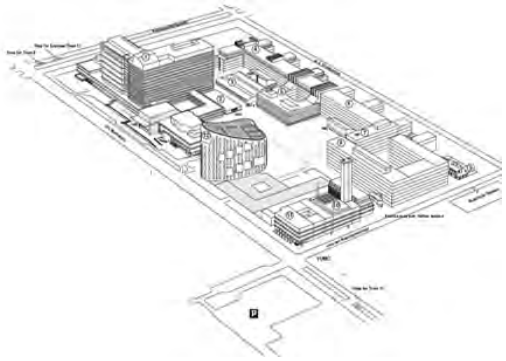
Appendix 1: Organizational Probes & Contextual Interview Questions (Chapter 4)

1. Organizational Probes: Sample Postcards

2. Organizational Probes: Sample Questions

1. Give us an overview of your life at the department in 6 to 10 photographs. Please describe what these images stand for and provide relevant reasons.
2. We have provided 2 maps here. First, for the Informatica Section (3rd Floor) and second, for the VU University campus. On these maps please mark the following, using the colored pencils:





   1. The places you visit frequently
   2. The places where you meet others
   3. The path(s)/route(s) that you usually take
   4. The places you go to, to fulfill a specific work supporting task (i.e. get your printouts)
   5. The places you do not like

   Please give your reasons for the areas you colored!
3. What do you do if you want to meet colleagues? Describe an example,
4. Tell us / Show us something funny about a colleague.
5. Things you like to know about your colleagues...
6. What things or events do you consider to be too private to share with your colleagues? Please explain why
7. Describe or illustrate a social gathering at the department (such as lunch, coffee-breaks, etc.).
8. Characterize your relationship with students. Provide an example
9. Describe your activities in the staffroom.
10. What do you like about the department? Provide details.
11. Describe the best time at the department.
12. Describe your favorite places at the department.
13. I feel good at work when...
14. Describe and show us your favorite items in the department.
15. Describe an ideal day at work and how you feel about such a day
16. Things that should be improved in the department...
17. What do you miss in the department? Please explain

18. Who do you miss in the department? Please explain
19. I feel lonely when...
20. Describe a tough day at work and how you feel about such a day.
21. Choose a metaphor from the following, and describe yourself along with your colleagues.



3. Contextual Interview: Sample Questions

1. What do you talk about with colleagues? For example: research, extracurricular activities, or any other topics as well.
2. What staff activities take place? Please describe one of them.
3. How do you share information with colleagues?
4. In general (modes of communication)
5. Using what type of tool or artifact
6. How do you know where a colleague is (when not at his/her desk)?
7. Would you like to know? Why?
8. How do you know what a colleague is planning to do (for example, conferences in the next two weeks)?
9. Would you like to know? Why?
10. How do you let colleagues know were you are and what you are up to?
11. What kind of information do you not want to share with colleagues (in general)?
12. Are there any difficulties in communicating with colleagues?
13. Could you give an example?
14. Do you like to know about a colleague's extracurricular activities and family? Why?
15. What would you like to know about your colleague's that is not shared now?

Appendix 2: Interview Questions & RGT Cards (Chapter 5)

1. Interview Questions

1. When looking at Panorama what draws most attention?
2. Does it enforce you to look at it?
3. Do you think Panorama supports social awareness
4. Would you send in content yourself?
5. Do you have any other remarks on Panorama?

2. RGT Cards


D1. Panorama
D2. Television
D5. Mobile phone
D3. Nintendo Wii
D4. Digital Camera

Appendix 3: Pre and Post-session Questionnairs (Chapter 7)

1. Questionnair

1. I am well informed about the important events in my project.
2. I find it easy to know what my project partners are doing.
3. I feel a part of the group while working in the project.
4. I am aware of the ongoing activities in my project.
5. I can easily establish and retain the connection with my project partners work.
6. I can easily know the current state of the project.
7. I am aware of my duties and tasks as well as other partners tasks in the project.
8. The physical design objects (such as sketches, models) are important for communicating information in the group.
9. I can easily present my work to other using this system
10. Inviting my project partners to look at my work is easy.

Thesis Publications

List of Publications (2007 — 2010)

1. Vyas, D., Nijholt, A., and van der Veer, G. (2010) Supporting Cooperative Design through Living Artefacts. In Proceedings of 6th Nordic Conference on Human-Computer Interaction (NordiCHI 10), Reykjavik, Iceland.
2. Vyas, D., Nijholt, A., and Kröner, A. (2010) CAM: A Collaborative Object Memory System. In Proceedings of 12th International Conference on Human-Computer Interaction with Mobile Devices and Services (MobileHCI 10), Lisbon, Portugal.
3. Vyas, D., Nijholt, A., Heylen, D., Kröner, A. and van der Veer, G. (2010) Remarkable Objects: Supporting Collaboration in a Creative Environment. In Proceedings of 12th ACM International Conference on Ubiquitous Computing (UbiComp 10), Copenhagen, Denmark.
4. Vyas, D., and Nijholt, A. (2010) Building boundaries on Boundary Objects: A Field study of a Ubicomp tool in a Design Studio. International Reports on Socio-Informatics (an online journal). ISSN 1861-4280. Originally presented as a workshop paper at the 9th International Conference on the Design of Cooperative Systems (COOP 10).
5. Vyas, D. (2009) Artful Surfaces in Design Practices. In CHI '09 Extended Abstracts on Human Factors in Computing Systems (CHI 09), Boston, USA. 4-9 Apr. ACM Press: NY, 2691-2694.
6. Vyas, D., Heylen, D., Nijholt, A. and van der Veer, G. (2009) Collaborative Practices that Support Creativity in Design. In Proceedings of 2009 11th European Conference on Computer Supported Cooperative Work (ECSCW 09). Vienna, Austria. 7-11 September. 151-170.
7. Vyas, D., Heylen, D., Nijholt, A. and van der Veer, G. (2009) Experiential Role of Artefacts in Cooperative Design. In Proceedings of 4th International Conference on Communities and Technologies (C&T 09). Penn State University, PA, USA. 25 27 June. ACM Press: NY, 105-114.
8. Vyas, D., van der Veer, G., Heylen, D. and Nijholt, A. (2009) Space as a Resource in Creative Design Practices. In Proceedings of 12th IFIP TC13 Conference in Human-Computer Interaction (INTERACT 09). Uppsala, Sweden. 26-28 Aug 2009. LNCS, Springer-Verlag. 169-172.
9. dos Santos, G., van Dijk, E.M.A and Vyas, D. (2009) Paper-based Mixed Reality Sketch Augmentation as a Conceptual Design Support Tool. In Proceedings of 23rd British HCI Group Annual Conference. British Computer Society (B-HCI 09). Cambridge, UK. 1-5 Sept. ACM SIGCHI, 447-452.
10. Vyas, D. (2009) Designing and Prototyping for Physicality. In Proceedings of Interact-2009 workshop on Touch Affordances, Interact-2009, Uppsala, Sweden.
11. Vyas, D., van der Veer, G., Heylen, D. and Nijholt, A. (2009) Show me, how does it look now: Remote Help-giving in Collaborative Design. In Proceedings of European Conference on Cognitive Ergonomics (ECCE 09). Helsinki, Finland. 30 Sept 2 Oct. ACM Press: NY, 1-4.
12. Vyas, D., and Nijholt, A. (2009) Workplace Surfaces as Resource for Social Interactions. In Proceedings of 8th International Workshop on Social Intelligence Design (SID 09) November 9th-11th, 2009, Kyoto, Japan, 187-198.

13. Van der Veer, G.C., Kulyk, O. and Vyas, D. (2009) Mirrors of the World - Supporting Situational Awareness with Computer Screens. In D. Gorgan and A. M. Guran (Eds.) Interactiune On-Calculator 2009. (RoCHI 09) Matrix Rom, Bucuresti, Romania, 1-7.

14. Vyas, D., Heylen, D., and Nijholt, A. (2008) Physicality and Cooperative Design. In Proceeding of 5th Joint Workshop on Machine Learning and Multimodal Interaction (MLMI 08). Utrecht, the Netherlands. LNCS 5237, 2008. Springer-Verlag Berlin Heidelberg, 325337.

15. Vyas, D., Eliëns, A., van de Watering, M. and van der Veer, G.C. (2008) Organizational Probes: Exploring Playful Interactions in Work Environment. In Proceedings of 15th European Conference on Cognitive Ergonomics (ECCE 08), Madeira, Portugal. ACM Press, 170-173.

16. Vyas, D., Dix, A. and Nijholt, A. (2008) Exploring Cool Interactions: A Design Exercise. In Proceedings of 15th European Conference on Cognitive Ergonomics (ECCE 08), Madeira, Portugal. ACM Press, 77-78.

17. Vyas, D. (2008) Aesthetics of Mundane Interactions. Dagstuhl Seminar No: 08292, The study of visual aesthetics in Human-Computer Interaction (13-16th July 2008), Dagstuhl, Germany. In the Dagstuhl Seminar Proceedings ISSN 1862-4405.

18. Vyas, D., Heylen, D., Nijholt, A., and van der Veer, G.C. (2008) Designing Awareness Support for Distributed Cooperative Design Teams. In Proceedings of 15th European Conference on Cognitive Ergonomics (ECCE 08), Madeira, Portugal. ACM Press, 23-26.

19. Vyas, D., van de Watering, M., Eliëns, A. and van der Veer, G.C. (2007) Being Social @ Work: Designing for Playfully Mediated Social Awareness in Work Environments. Book Chapter in "Home Informatics and Telematics: ICT for the Next Billion". (HOIT 07) IFIP, Vol. 241, Venkatesh, A.; Gonzalves, T.; Monk, A.; Buckner, K. (Eds.), Springer-Boston. 113-131.

20. Vyas, D., Heylen, D., Eliëns, A. and Nijholt, A. (2007) Experiencing-in-the-World: Using Pragmatist Philosophy to Design for Aesthetic Experience. In Proceedings of 3rd International Conference of Designing User eXperiences Changing Roles & Shifting Landscapes (DUX 07), Chicago, USA. ACM/AIGA Press, Chicago, 4-7 November 2007.

21. Vyas, D. and Dix, A. (2007) Artefact Ecologies: Supporting Embodied Meeting Practices with Distance Access. In Ubicomp 2007 Adjunct Proceedings. (UbiComp 07). Innsbruck, Austria. ISBN: 978-3-00-022599-4.

22. Vyas, D., van de Watering, M., Eliëns, A. and van der Veer, G.C. (2007) Engineering Social Awareness in Work Environments. Book Chapter in Universal Access in Human-Computer Interaction, (HCII 07), Beijing, China. LNCS 4555, Springer-Heidelberg, 254-263.

23. Vyas. D., de Groot, S. and van der Veer, G.C. (2007) 'Searching and Archiving': Exploring Online Search Behaviors of Researchers. In Proceedings of HCI-International 2007, (HCII 07), Beijing, China. LNCS, Springer-Heidelberg, 360-364.

24. Eliëns, A. and Vyas, D. (2007) Panorama Explorations in the Aesthetics of Social Awareness. In Proceedings of The European Simulation and AI in Games Conference (GAME-ON 07), Nov 20-22, University of Bologna, Marco Roccetti (ed.), p. 71-75, EUROSIS-ETI Publication, ISBN 9789077381373.

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Experience-focused HCI proposes a shift from HCI's traditional focus on supporting task-based and productivity-oriented goals to encompassing personal, emotional, fulfilling and other experiential aspects, while designing interactive systems. This thesis uses an experience-focused HCI perspective for designing *awareness systems* – technologies that can convey information about other people's status information, activities, behaviors and other contextual information. This thesis reports two design cases, in two different contexts: an academic department and a design studio. In both the design cases, the thesis illustrates a complete design cycle, starting from problem definition, through ethnographic fieldwork and designing prototypes to reporting the field trials of these prototypes. Overall, this thesis makes methodological, empirical and technological contributions to the current state of HCI.

This thesis gives a glimpse into the lives of academics and designers and insight into how to design engaging and reflective devices for them and others. Dhaval has a keen eye for the details of work-a-day life, and a mastery of the theoretical literature.

Prof. Alan Dix, Lancaster University, UK

This HCI thesis in the field of awareness systems shows a good appreciation of the relevant literature across a variety of fields. It also demonstrates the importance of performing extensive field studies in order to understand the phenomenon in question before creating prototype support systems, and provides informative evaluations of these resulting technologies.

Prof. Liam Bannon, University of Limerick, Ireland

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