DESIGNING ENGAGING INTERACTIVE ENVIRONMENTS: A PRAGMATIST PERSPECTIVE

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PhD Dissertation

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ABSTRACT

This dissertation summarizes three years of research guided by the overarching question: "How can we conceptualize the design and use of engaging interactive environments?". The dissertation is composed of a selection of publications framed by an overview. My primary area of concern is the design process, however it is also crucial that designers gain a reflective understanding of the use situation in addition to the design situation. For this reason, the included papers as well as the overview span both of these areas. In order to expand upon the understanding of the design and use of interactive environments, I develop a conceptual scaffolding on the basis of concepts from the pragmatist philosophy of John Dewey, with a particular focus on creativity and technology in inquiry.

My research approach is based upon practice-based engagement in experimental design cases supplemented by literature surveys and continuous discussions and analyses of the cases and the domain of study in various fora. Central parts of this work is reported on in the included papers, each of which presents a set of contributions related to specific areas of related work, research questions, methods, and discussions. In addition to these papers, the overview contributes with an explication and discussion of my research approach, labelled "research in and through design", and the development of a pragmatist perspective that functions as a conceptual scaffolding for addressing my research question. In this pragmatist perspective, I examine and develop the concept inquiry and the notions of dialogical and distributed creativity as well as experiential and transformative technology as means for understanding the design and use of engaging interactive environments.

The contributions of the dissertation fall into three general categories:

(1) A conceptual foundation, with regards to the development of a pragmatist perspective on interaction design on the basis of key concepts drawn from the work of John Dewey in relation to my research agenda.

(2) Means for design and design reflection, with regards to the development of specific techniques for design practice and reflection, as well as the articulation and discussion of design considerations that can inform reflective interaction design practice and research.

(3) Prototypes and installations, with regards to development of interactive systems as means for exploring the overarching research question; these prototypes and installations are in themselves manifestations of and challenges to hypotheses about the design and use of interactive environments.[1]

[1] Dette resumé indgår som Bilag A i afhandlingen, jvf. bilagslisten der følger umiddelbart efter de inkluderede publikationer.

OPSUMMERING

Denne afhandling samler tre års forskning med afsæt i spørgsmålet: "Hvordan kan man begrebsliggøre design og brug af engagerende, interaktive miljøer?" Afhandlingen består af et udvalg af videnskabelige publikationer indrammet af en sammenfatning. Mit primære forskningsobjekt er designprocesser. Imidlertid er det af afgørende betydning, at designere er bevidste om de situationer, deres produkter finder anvendelse i. Af denne grund omhandler såvel de inkluderede publikationer som sammenfatningen både design- og brugssituationer samt relationerne imellem dem. Jeg udvikler i afhandlingen et begrebsapparat til at italesætte og tilgå design og brugssituationer med udgangspunkt i begreber fra John Dewey's pragmatiske filosofi. I særlig grad fokuserer jeg på kreativitet og teknologi i forhold til Dewey's begreb om "inquiry".

Min forskningstilgang er baseret min involvering i eksperimentelle designprojekter i praksis, suppleret af studier af litteratur inden for feltet interaktionsdesign, samt løbende analyser og diskussioner af projekterne i forhold til den øvrige udvikling i feltet. De centrale aspekter af min forskning belyses i de inkluderede publikationer, der hver især udgør specifikke forskningsbidrag. Udover disse bidrager sammenfatningen med en uddybning af min valgte forskningstilgang, som jeg benævner "research in and through design", samt med udviklingen af et pragmatisk perspektiv, der begrebsliggør centrale aspekter af design og brug af interaktive miljøer. Inden for dette perspektiv undersøger og udvikler jeg Dewey's inquiry-begreb med særligt fokus på dialogiske og distribuerede aspekter af kreativitet, samt oplevelsesorienterede og transformationelle aspekter af teknologi i forhold til inquiry.

Afhandlingens bidrag falder indenfor tre kategorier:

(1) Et begrebsapparat, der med udgangspunkt i kernebegreber fra John Dewey's forfatterskab etablerer et pragmatisk perspektiv på interaktionsdesign.
(2) En række teknikker og tilgange til design og designreflektion, herunder speficikke designteknikker, reflektionsværktøjer til brug i designpraksis og -forskning, samt italesættelse og diskussion af centrale problemstillinger, der kan berige designpraksis og -forskning.
(3) Prototyper og installationer, der er udviklet som katalysatorer for skabelse af ny viden i forhold til mit overordnede forskningsspørgsmål, og som i sig selv kan anskues som manifestationer og udfordringer af hypoteser om design og brug af interaktive miljøer.[2]

[2] Dette resumé indgår som Bilag B i afhandlingen.

ACKNOWLEDGEMENTS

Though these are some of the first words that you lay your eyes upon, dear reader, writing the acknowledgements is in fact the final step on the road that I have walked for the past three years, and it gives pause to think about all of the inspiring and helpful people that I have met along the way. It has been serious fun!

First of all, thanks to family for supporting me when times got rough, and for sharing my joy when things went well. Also thanks to all of my friends who kept dragging me out of the office.

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Thanks to my friends and colleagues with the design group and at the rest of the Department of Information and Media Studies – and to all of the other great people I've met here at Katrinebjerg. I have a long list of names, but I am afraid of leaving out someone, so I'll thank you in person when I get the chance.

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Also heartfelt thanks to my friends at the research group Designing Quality in Interaction at Technische Universiteit Eindhoven who welcomed me with open arms, made me feel right at home, and challenged me to see my work in a new light: Kees, Stephan, Caroline, Oscar, Joep, Philip, Bart, Marco, Chet, Catherine, Sjriek, and Sietske – I hope to see you soon.

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DESIGNING ENGAGING INTERACTIVE ENVIRONMENTS: A PRAGMATIST PERSPECTIVE

PART 1: OVERVIEW

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1 INTRODUCTION

How can we conceptualize the design and use of engaging interactive environments?

The above question is at the core of this dissertation, which presents three years of academic inquiry into the field of interaction design. The field is rich and diverse, spanning a multitude of use domains, as well as a host of perspectives on how to design. My research is directed at gaining a better understanding of both the design situation and the use situation in order to inform the study and practice of design, and it explores and combines two evolving trends of the field: one, the emerging awareness among designers and researchers of the experiential qualities of interaction; two, the design and use of technologies that combine physical and digital properties. Designers and researchers who address these issues inevitably face what Rittel & Webber (1973) denote *wicked problems*[1] in that they deal with a complex web of interdependent issues and concerns that cannot be exhaustively analyzed prior to the design process, and whose conditions may change during the process. In order to explore how these issues can be conceptualized and addressed in design, I have been involved in a number of research-oriented, practice-based experimental design cases through the course of my PhD project. These cases share the common denominator of employing interactive technologies to facilitate or augment knowledge mediation. My involvement in these design experiments have led to findings regarding concrete cases, to the development of techniques for doing and reflecting upon design, to the articulation and discussion of broader themes within interaction design, and ultimately to the development of a pragmatist perspective on designing interactive environments, which I unfold in this dissertation. I argue that pragmatism offers a cohesive and constructive conceptual scaffolding for interaction design researchers and practitioners. In particular, I explore and develop the notion of inquiry from the pragmatist philosophy of John Dewey as a key concept for understanding the design and use of engaging interactive environments, with a special focus on the creative and technological aspects of inquiry. Deweyan pragmatism encompasses a number of considerations for exploring phenomena in the world, and as such this position scaffolds not only my understanding of the design and use of interactive technologies but also my practice-based research approach.

[1] With regards to annotation, I employ quotation marks when quoting directly from texts, and italics when referring to publication titles. I furthermore employ italics to emphasize salient concepts when they are first introduced. When words or sections in quoted texts are emphasized in italics, it is a representation of the author's emphasis. When referring to the papers included in the second part of this dissertation, I employ italics followed by a number in square brackets that designates the paper for overview purposes, e.g. *Inspiration Card Workshops [1]*. The numbers of the papers are listed in section 1.2.2.

1.1 MOTIVATION AND RESEARCH THEMES

The outset for my PhD project has been to explore the potentials of mixed reality - interactive technologies that blend physical and digital layers – in knowledge mediation situations, especially with regards to how we can design mixed reality environments that foster engaging experiences for users. Contemporary interactive technologies allow designers to incorporate computational elements and input and output devices into physical objects and surroundings in many ways, and these technologies are increasingly being employed to create environments for knowledge mediation in domains such as museums, science centres and cultural institutions. However, the conceptual and methodological tools for addressing the design and use of such interactive environments hold potentials for further development. During recent years, this field has seen an increasing interest from researchers and practitioners. It is nevertheless still a nascent field of study, in part because of ongoing technological developments that beg exploration in practical use situations, in part because the field is not yet "normal science" in the terminology of Kuhn (1962) since a multitude of competing, converging, and overlapping perspectives on the field abound.

My approach to this field of research is highly influenced by the so-called Scandinavian design tradition (e.g. Bansler 1989; Greenbaum & Kyng 1991; Bjerknes, Ehn & Kyng 1989), which is first and foremost centred on users and their practices. The Scandinavian tradition promotes a holistic perspective on interactive systems development in which user participation and the fit between system and use domain are brought to the fore. The tradition is, however, first and foremost a tradition: an assemblage of contributions that coalesces certain ways of practicing and thinking about design, rather than a unifying theoretical perspective.

The theoretical aim of my project has been to explore and formulate perspectives that can lend insights into the design situation and the use situation. Although I am primarily pre-occupied with the design process, I find it imperative that designers are reflective about the interaction situation as it unfolds once their creations are let loose on the world, as well as about their own design situation. For this reason, a theoretical framework that can address both design and use is of merit, a position shared by a number of contributors to interaction design[2]. In this dissertation, I present and discuss the proposition that pragmatism offers one such frame. I do not offer an exhaustive treatise of pragmatism, rather I point to salient tenets and concepts of the position that I find valuable in light of my over-arching research agenda: how to conceptualize the design and use of engaging interactive environments. I primarily build upon the work of John Dewey, an early contributors to pragmatism. I argue that this theoretical position offers a meaningful and productive way of understanding and doing interaction design. Indeed, Sleeper (2001) has characterized Deweyan pragmatism as a perspective in which action and reflection are "[…] means of conducting

[2] Many practitioners and researchers hold the position that reflective design should incorporate understandings of use practice; an overview of this position can be found in Rogers' *New Theoretical Approaches for Human-Computer Interaction* (Rogers 2004).

transformational transactions with the world, a means of changing or reconstructing the world" (Ibid. p 3), thus echoing concerns that are central to design. In addition yielding insights into the process of design, the pragmatist position accentuates the situated nature of human experience and inquiry and presents a frame for addressing creative and technologically mediated interactions as they occur when we encounter and use interactive systems. In my examination of the pragmatist perspective, I put a particular emphasis on the concept of *inquiry*, which denotes a processual in-situ mode of experience in which action and reflection are intertwined in our exploration of the world. Inquiry is almost always mediated by resources in our environment, be it technologies, social constructs, or other people, and we draw upon these in order to make sense of and potentially transform indeterminate situations into desired outcomes. In light of my research agenda, I focus on *technological and creative aspects of inquiry* in my examination and development of the concept. My exploration of technological aspects of inquiry is in part motivated by my attention towards the potentials of interactive technologies in use situations, in part by the understanding that technologies are crucial for defining, exploring, representing, and transforming design challenges; my exploration of the creative aspects of inquiry are motivated on the one hand by the inherently creative nature of design, on the other hand by the realization that creativity plays an important part in users' encounters with interactive environments.

Pragmatism has inspired a number of contributions to interaction design, although it is not the most prominent school of thought within the field. As such, my work is related to and inspired by e.g. Schön's treatise of *reflective design practice* (Schön 1983), McCarthy & Wright's *felt life* perspective on interaction (McCarthy & Wright 2007) and Petersen et al's work on *aesthetic interaction* (Petersen et al. 2004). As the label indicates, pragmatism is in essence a practice-centred philosophy that regards situated inquiry and experimentation as the basis for developing knowledge. In line with this notion, my research approach has been founded on practice-based engagement in and reflection upon a number of design experiments. These experiments have taken place within the frame of three successive research projects: (1) *Experience-oriented Applications of Digital Technology in Knowledge Dissemination and Marketing,* (2) *Media Façades*, and (3) *Digital Urban Living*. In parallel with these experiments, I have carried out surveys of related work, extensive literature reviews, and ongoing reflections and analyses. One reason for my practice-based involvement is that it is exceedingly hard to get insights into design processes without taking part in them - the intricate webs of interactions and transformations that often occur as designers move from initial project framing and concept development towards the final outcome are very hard to grasp from the outside. Another reason for my involvement is that it is highly invigorating for me as a researcher to establish a closeness to the field of use and to bring theories and concepts into play in practice.

In some of the experiments, my main research focus has been on the design process, exploring issues such as: how is the process framed? how do designers get an overview of the design space? how does creative action occur through design inquiries? how do design concepts emerge, what forms do they take, and how are they transformed throughout the process? In other experiments, a larger emphasis has been on the

interaction situation, exploring issues such as: how is the situation framed? how do experiential qualities emerge through interaction? what kind of explorative inquiries do people carry out in order to make sense of the encounters? These issues are explored and discussed in a series of papers that make up the second part of this dissertation. The first part of the dissertation serves as a framing of and reflection upon the themes of the papers from a pragmatist perspective, and I employ this perspective in a review and discussion of the included publications in which I explore the concept of inquiry as a central characteristic of the practice of interaction design as well as of engaging experiences in the use of interactive environments.

Most of my experimental design inquiries have taken place in design projects within the domain of knowledge mediation, e.g. museums and cultural institutions. Since I am particularly interested in exploring the potentials of interactive technologies and how to deal with them in the design process, there are a number of ways of addressing the challenges in these domains that I do not cover, e.g. how museum staff can structure guided tours, or the architectural layout of library floor plans. I am by no means discounting ways of addressing issues in these domains that do not involve interactive systems. On the contrary, it is necessary to include these in an understanding of the situation, and some of these have of course inspired and influenced my work – and hopefully, my own work can serve to inspire and influence these domains beyond the field of interaction design.

1.2 THE DISSERTATION

The dissertation is composed of two parts: an overview (part 1) and a selection of peer-reviewed publications from the PhD project (part 2). The papers have been published during the course of my PhD project, and they each have a relatively narrow focus, compared to the overarching research themes. As such, the overview in part 1 serves to frame the papers in a wider context, and to reflect upon their specific themes and findings in a theoretical perspective, namely that of pragmatism. This perspective has been developed continuously during the project, and as such there is a reciprocal interplay with the papers and the conceptual framework, in that they have inspired and fed into one another.

1.2.1 THE OVERVIEW

The overview represents a structured reflection upon and analysis of the PhD project as a whole. It positions the themes of the dissertation within a wider discourse, presents and discusses my research approach and the contributions from the project, and presents the pragmatist perspective on designing engaging interactive environments with a particular emphasis on the concept of inquiry. The overview is structured accordingly:

Chapter 1, the present chapter, serves as an **introduction** to the general themes and motivations for the dissertation. I present the structure of the dissertation and introduce the included papers. Furthermore, I summarize the **research contributions** from my PhD research project.

Chapter 2 provides an overview of the **research area and background** for my PhD project. This chapter presents the general research context for my work and situates it according to existing research discourses and practices, most prominently with regards to interaction design, theory and practice of design, the Scandinavian design tradition, and the development of interactive environments.

Chapter 3 outlines and discusses my **research approach and activities**. My research approach can be described as *research in and through design* framed by academic reflection. I present and discuss this research strategy, as well as the more specific techniques that I have employed in my work, including field studies, inspiration card workshops, sketching and prototyping, maps for design reflection, and different types of data evaluation. During the course of the over-all PhD project, I have taken part in a number of experimental design projects, and I offer a brief presentation of these projects and outline my involvement and research activities in them.

Chapter 4 outlines key tenets and themes from **pragmatist philosophy**, with a particular emphasis on the works of John Dewey. I offer a presentation of the fundamentals of pragmatism, the work of Dewey, subsequent developments, and relations to other theoretical positions. On the basis of my research agenda, I discuss key aspects of Deweyan pragmatism that are particularly salient for interaction design and the understanding of the potentials and tensions of interactive systems, namely situation, inquiry, transformation, technology, and experience.

Chapter 5 presents and discusses **a pragmatist perspective on designing engaging interactive environments**. I explore the potentials of this perspective and revisit the challenges and themes from the papers that make up the second part of the dissertation. In particular, I focus on the notion of *inquiry* as a key to understanding central challenges to interaction design. In doing so, I discuss the notions of *dialogical and distributed creativity*, as well as *experiential and transformative technology*, in the inquiries that unfold in design and use situations.

Chapter 6 contains my **conclusion** and outlines the avenues for future research in continuation of the work presented in the dissertation.

1.2.2 THE PUBLICATIONS

The included publications have been written during the course of the PhD project[3]. The individual publications are finished works in their own right and have been evaluated as such in the journals and conferences for which they have been submitted and accepted. This implies that each paper presents and discusses case- and theme-specific related work, research questions and methods, lines of arguments, and contributions. In combination, however, the publications represent an unfolding inquiry into the question of how to design engaging interactive environments.

The papers have different foci concerning their domain of study, as some focus on the design process, some on interaction and use experience, some on both, and concerning the types of contributions they offer, as some present means and techniques for doing or reflecting upon design, whereas others place a stronger emphasis on theoretical perspectives. In chapter 5, I discuss the papers from a pragmatist perspective with a particular focus on the notion of dialogical and distributed creativity as well as experiential and transformative technology in inquiry. Due to the varying themes of the included papers, I concentrate my discussion of each paper around two of the four particular aspects of inquiry that I explore in detail, i.e. dialogical creativity, distributed creativity, experiential technology, and transformative technology. Figure 1 offers an overview of the included publications:

	Design situation	Use situation	Means and techniques	Theoretical perspectives	Aspects of inquiry discussed
(1) Inspiration Card Workshops	×		×		Dialogical creativity Distributed creativity
(2) Emergence of Ideas	×		×	×	Distributed creativity Transformative technology
(3) Maps for Design Reflection	×		×		Experiential technology Transformative technology
(4) Designing for Inquisitive Use		×		×	Experiential technology Transformative technology
(5) Peepholes as means of engagement	×	×	×	×	Dialogical creativity Transformative technology
(6) Staging Urban Interactions	×	×		×	Experiential technology Transformative technology
(7: Performing Perception		×		×	Experiential technology Transformative technology

Figure 1: Overview of the included publications.

[3] In addition to the included publications, I have authored a number of other publications during the course of my PhD project that are not included in this dissertation. For a full list of publications, see http://person.au.dk/da/imvpd@hum.au.dk/pub.

Publication (1): Inspiration Card Workshops[4]

Halskov, K., Dalsgård, P. 2006, "Inspiration Card Workshops", DIS '06: Proceedings of the 6th ACM conference on Designing interactive systems, ACM, New York, pp. 2-11.

This paper introduces *inspiration card workshop* as a collaborative technique for combining findings from domain studies, represented in *domain cards*, with sources of inspiration from applications of technology, represented in *technology cards*, to create new concepts for design. The paper outlines findings from three projects in which the technique has been used, and argues that the use of inspiration cards can successfully frame and guide workshops with disparate participants and bring various sources of inspiration into the design process. Furthermore, the method is compared to four related techniques in the design process. The inspiration card workshop technique represents a concrete contribution to interaction design in the form of a mode of bringing inspirational resources into design inquiries. The technique was developed in the early phase of the PhD project, and it has been used in all of the on-going projects in some form and served as a test bed for exploring distributed and dialogical creativity in the design process.

Publication (2): The emergence of ideas

Halskov, K., Dalsgård, P. 2007, "The emergence of ideas: the interplay between sources of inspiration and emerging design concepts ", CoDesign - International Journal of CoCreation in Design and the Arts, vol. 3 no. 4, pp. 185 – 211.

This paper offers an analysis of the emergence of ideas from specific sources of inspiration as they arise through negotiation and transformation and are mediated by design artefacts during a specific inspiration card workshop. The paper is centred around a micro-analytic study of the interwoven social and artefact-mediated interactions in the workshop, and identifies essential phenomena that structure and create momentum in the development of new design concepts, namely 1) the manifest properties of inspiration cards and concept posters as physical props for encouraging and supporting design moves, 2) the semantic dimensions of the cards and posters as catalysts for discussion, derivation and ideation, and 3) ad hoc external sources of inspiration as means of supplementing and developing design concepts. The analysed design situation is characterised as being socially distributed, artefactually mediated, adaptive and emergent. Whereas *Inspiration Card Workshops [1]* offers a specific technique for design, *The emergence of ideas [2]* presents an in-depth look at design inquiries, specifically regarding how creative action unfolds in collaborative workshops through the use of inspiration cards.

Publication (3): Maps for design reflection

Dalsgaard, P., Halskov, K., Nielsen, R. 2009, "Maps for design reflection", accepted for publication in Artifact, Routledge.

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[4] The introductions to the papers presented here build upon the abstracts of the papers as they appear in publication.

This paper introduces, applies, and discusses a set of design artefacts called maps for design reflection, intended to support design researchers in capturing, analysing, and reflecting upon design processes. The maps focus on reflection with respect to the role of sources of inspiration and design materials in the emergence and transformation of design ideas. The paper revolves around a specific case, the design of media façades – i.e. displays that are an integrated part of a building's façade – as part of the development of material for a bid in an architectural competition for a new modern art museum in Warsaw, Poland. The paper presents and discusses the findings from using the maps for design reflection in this case, with a particular focus on the importance of employing artefacts to support design reflection. In a pragmatist perspective, the maps for design reflection offer a structured approach to higher-level inquiry and reflection into the design process with a particular focus on the representations and transformations of concepts.

Publication (4): Designing for Inquisitive Use

Dalsgaard , P. 2008, "Designing for Inquisitive Use", DIS '08: Proceedings of the 7th ACM conference on Designing interactive systems, ACM, New York, pp 21– 30.

This paper presents the concept of *inquisitive use* and discusses design considerations for creating experience-oriented interactive systems that inspire inquisitive use. Inquisitive use is based on the pragmatist philosophy of John Dewey and defined by the interrelated aspects of experience, inquiry, and conflict. The significance of this perspective for design is explored and discussed through two case studies of experience-oriented installations. The paper contributes to the expanding discourse on experience design on a theoretical level by exploring one particular façet of interaction, namely inquisitive use, and on a practical level by discussing implications for design prompted by insights into inquisitive use. These implications are presented as a set of design sensitivities, which provide contextual insights and considerations for ongoing and future design processes. In relation to the previous papers, *Designing for inquisitive use [4]* discusses how pragmatism can inform the design of engaging experiences from the position that inquiry occurs not only in the design process, but also in use situations, and that designers can build upon this understanding to foster engagement through the use of experiential and transformative technology.

Publication (5): Peepholes as Means of Engagement in Interaction Design

Dalsgaard, P., Dindler, C. 2009: "Peepholes as Means of Engagement in Interaction Design", Submitted for Nordes 2009: the third Nordic Design Research Conference.

This paper outlines and discusses the concept of peepholes as an approach to creating engagement in mixed reality environments. Peepholes denote interactive artefacts and environments that utilize the tension between what is hidden and what is revealed in order to foster engagement. The concept of peepholes is developed on the basis of a pragmatist conception of engagement and emphasizes reciprocal relations between users, technology, and environment. Through a range of examples from interaction design, the paper outlines characteristics of interactive peepholes, particularly how they can function as means of engaging users in interaction. In continuation of *Designing for inquisitive use [4],* this paper presents a specific

design strategy for fostering engagement based on a pragmatist understanding of the dialogical traits of creativity and the role of experiential technologies in inquiry.

Publication (6): Staging Urban Interactions with Media Façades

Brynskov, M., Dalsgaard, P., Ebsen, T., Fritsch, J., Halskov, K., Nielsen, R. 2009, "Staging Urban Interactions with Media Façades", Accepted for Interact 2009.

Exploring media façades as a subcategory of urban computing, this paper contributes to the understanding of spatial interaction, sense-making, and social mediation as part of identifying key characteristics of interaction with media façades. Through a case study of a public media façade, the paper addresses in particular a form of interaction that was framed but open-ended with regards to how users engaged with and made sense of the installation. Moreover, the paper contributes to the understanding of flexible social interaction by addressing urban interaction in relation to distributed attention, shared focus, dialogue and collective action. Finally, the paper addresses challenges for interaction designers situated in complex spatial settings in which multiple viewing and action positions must be taken into account. The paper is centred around a research-oriented design experiment which resulted in a real-life design intervention in the shape of Aarhus by Light, a huge interactive media façade that ran 24/7 for nearly two months. As an in-depth study of interaction with a large-scale public installation, the paper offers insights into how use and inquiry unfolds over the course of time, and how the interplay between space, architecture, technology, and social relations develops.

Publication (7): Performing Perception

Dalsgaard, P., Hansen, L.K. 2008, "Performing Perception - Staging Aesthetics of Interaction", ACM Transactions on Computer Human Interaction, vol. 15 no 3, pp 13:1-33.

The paper argues that in interaction design for experience-oriented uses of technology, a central facet of aesthetics of interaction is rooted in the user's experience of himself *performing his perception*. By drawing on performance theory, phenomenology, and sociology and with references to recent HCI-work on the relation between the system and the performer/user and the spectator's relation to this dynamic, the paper discusses how the user is simultaneously operator, performer and spectator when interacting. By engaging with interactive systems, the user continuously acts out these three roles and his awareness of them is crucial in the use experience. The paper argues that this 3-in-1 is always already shaping the user's understanding and perception of interaction as it is staged through his experience of the object's form and expression. Through examples ranging from everyday technologies utilizing performances of interaction to spatial contemporary artworks, digital as well as analogue, the notion of the performative spectator and the spectating performer is discussed. This discussion highlights how perception is also performative and how a focus on this aspect seems to be crucial when designing experience-oriented products, systems and services. From a pragmatist perspective, the paper focuses on experiential and transformative technologies in inquiry with a particular emphasis on how the user's engagement with the system is affected by how it is staged.

However, the models and conceptualizations developed to understand this interaction can be used both in analysis and as a conceptual background for designers.

1.3 CONTRIBUTIONS

This dissertation assembles and presents contributions on a number of levels. Since it is structured as a collection of seven publications framed by an overview, each of the publications presents distinct problem framings, findings, lines of argument, and contributions. These publications are all motivated by my over-arching research question, to which they provide partial answers. As I will lay out in chapters 3 and 5, the papers are tied together by a consistent set of research considerations, and there is a line of inquiry that runs through them; e.g. *The emergence of ideas [2]* presents an in-depth study of the design technique laid out in the earlier publication *Inspiration Card Workshops [1]*, and *Peepholes as Means of Engagement in Interaction Design [5]* expands upon pragmatist notions first presented in *Designing for inquisitive use [4]*. In addition to the contributions contained within the included publications, composing this overview has offered me the opportunity to pull together a number of strands that have run through my PhD research and establish a more coherent conceptual foundation on the basis of pragmatist philosophy. I regard this pragmatist perspective to be the main contribution of the first part of the dissertation. In addition to this, I also regard my work on research approaches in interaction design to be a contribution to the field. My contributions fall within the following categories:

Conceptual foundation: On the highest level of abstraction, the dissertation contributes with an articulation and explication of a pragmatist perspective on interaction design, outlined and discussed in chapters 4 and 5. This perspective builds primarily upon the work of John Dewey and examines key notions from his oeuvre in the light of the special challenges that apply to the design of interactive environments. In particular, I present a development of the concept of inquiry in interaction design, in the respect that I aim at not only using the concept to illuminate my own work as laid out in the publications, but also at developing the concept itself through these discussions, particularly through the articulation of experiential and transformative technologies, and dialogical and distributed creativity. This conceptual foundation offers a cohesive understanding of my PhD work through the guiding concept of inquiry, which I also employ in a discussion of the included papers.

Means for design and design reflection: The included papers present a number of means for design and design reflection. Some of these are specific techniques for design, e.g. *Inspiration Card Workshops [1]*, or for reflection upon design processes, e.g. *Maps for Design Reflection [3]*, whereas others provide conceptual articulations and models that serve to inform reflective design, e.g. *Designing for Inquisitive Use [4]* and *Performing Perception [7]*. As stated above, my main area of concern is the design process, but I find it crucial for designers to maintain a reflective stance towards their own situation as designers, as well as towards the interaction situation that unfolds once the interactive artefacts that result from the design process are taken into use. Thus, some of the included papers focus more on the use situation than on the design situation, e.g. *Peepholes as Means of Engagement in Interaction Design [5]* and *Staging Urban Interactions with Media*

Façades [6]. The studies of the use of interactive artefacts and environments presented in these papers are discussed with regards to how they may inform the design process. In addition to this, I also consider my discussion of research approaches to interaction design, laid out in chapter 3, to be a contribution as a means of design reflection.

Prototypes and installations: On a more concrete level, the interactive prototypes and installations developed during the course of the PhD project are also contributions to the field of interaction design, although of a different variety than the conceptual foundation and the means for design and design reflection. I consider the prototypes and installations to be contributions because they form a necessary part of how we (referring to the research groups of which I have been part, for none of these installations have been developed by me single-handedly) carry out our inquiries into the world, and they are essential in the lines of argument that I unfold in the dissertation. As such, these prototypes and installations are in themselves manifestations of and challenges to hypotheses about the design and use of interactive environments In chapter 3, I will explicate in greater detail how these prototypes and installations are part of the research process.

2 RESEARCH AREA AND RELATED WORK

In this chapter, I draw an overview map of the research area that my work is positioned in. The starting point is an exposition of interaction design, its relations to human-computer interaction (HCI), and the Scandinavian tradition of information systems design. I then describe the growing interest in experiential and aesthetic dimensions of interaction design, which has also greatly influenced my work. Finally, I outline existing work related to the technological aspects of my work, primarily regarding mixed reality and augmented spaces.

As an introductory comment, it should be noted that this dissertation treats two further domains of study, namely design research and pragmatism. For the sake of clarity and to present a coherent line of argument, I will present and discuss related work within these two domains in the following two chapters, dedicated to interaction design research and pragmatism, respectively.

2.1 INTERACTION DESIGN AND HUMAN-COMPUTER INTERACTION

My PhD research is first and foremost positioned within the field of interaction design. This is a broad field influenced by, and in some respects overlapping with, HCI, computer science, information systems, and partially digital aesthetics, among others. Because of the expansive and evolving state of the field, some clarification on how I see my own work within this frame is needed.

Winograd coined the term interaction design in the oft-cited *From Computing Machinery to Interaction Design* (Winograd 1997), defining it as a shift in perspective: "Successful interaction design requires a shift from seeing the machinery to seeing the lives of the people using it. In this human dimension, the relevant factors become hard to quantify, hard to even identify. This difficulty is magnified when we try to look at social consequences… There is a complex interplay among technology, individual psychology, and social communication, all mixed in an intricate chaotic system." (Ibid. 160)

This shift in perspective can be seen as an extension of Grudin's observations in *The Computer Reaches Out: The Historical Continuity of Interface Design* (Grudin 1989). Here, Grudin outlines the historical trajectory of interfaces, starting from the interface as part of the hardware itself and gradually moving outwards and broadening in scope towards interface as programming, terminal interfaces and interaction dialogues, ultimately resulting in a focus on the shared work setting.

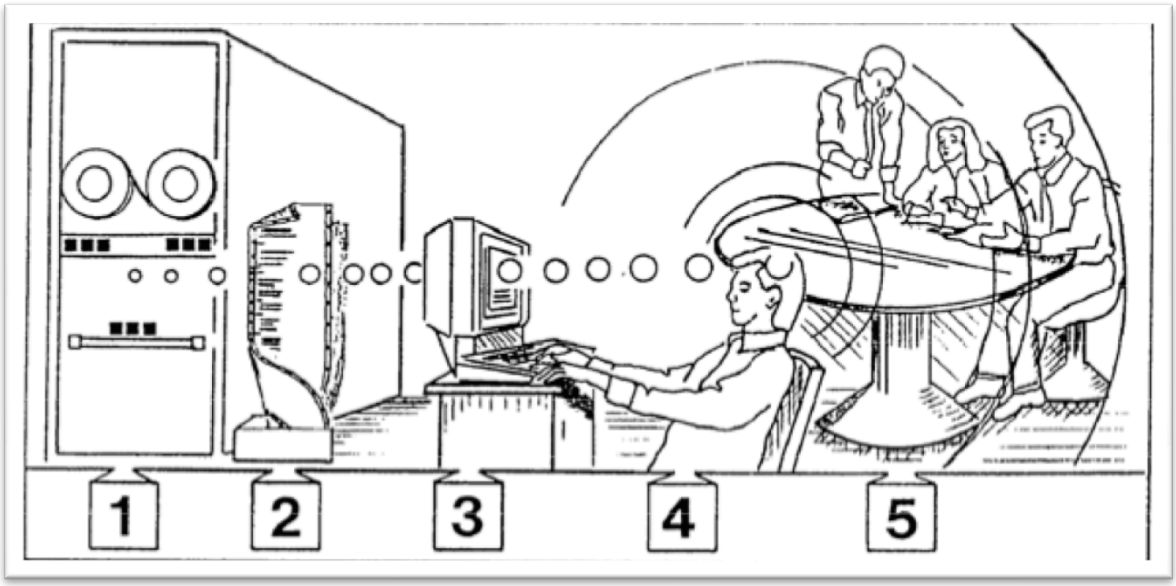


Figure 2: Shifting foci of interface design, reproduced from (Grudin1990 p 262)

A noteworthy facet of Grudin's analysis is the emphasis placed on functional and work-oriented aspects of computing across the five foci – the shifts occur with regards to how the interface evolves, rather than with regards to the ultimate role of technology which remains the same: a means for getting work done. Briefly after Grudin's paper, Weiser presented an assemblage of visions for *The Computer for the 21st Century* (Weiser 1991). This paper presents the notion of *ubiquitous computing*, namely that computational technologies would be so pervasive that they would be taken for granted and fade into our surroundings: "[…] we are trying to conceive a new way of thinking about computers in the world, one that takes into account the natural human environment and allows the computers themselves to vanish into the background." (ibid. unpaginated[5]). On an interface level, this can be construed as a sixth focal point in addition to those outlined by Grudin. More importantly, in my view, is the shift in domains of use which moves out of the office and into the home setting and beyond. This departure brings with it a multitude of new concerns and issues - recapitulated by Winograd as the intermingling of technology, individual psychology, and social communication – and furthermore shifts attention away from computational technology and hardware and towards interaction. One way of addressing interaction is to focus on the development of the technological artefact as a facilitating and mediating entity for human interaction, rather than on human-computer interaction, as described by Buchanan: "We call this domain "interaction design" because we are focusing on how human beings relate to other human beings through the mediating influence of products. And the products are more than physical objects. They are experiences or activities or services, all of which are integrated into a new understanding of what a product is or could be. " (Buchanan 2001 p 11).

[5] I have had access to the unpaginated online version of the journal paper, rather than to the paginated print version.

In line with these developments, the focus of my PhD research has been not so much on the *artefact* itself, but rather on the *interaction* that it facilitates. This may be interaction between people facilitated by interactive artefacts as in Buchanan's use of the term interaction design, but it may also be interaction between an individual and one or more artefacts, or even an environment of interaction established in the interplay between multiple users and multiple technologies in an interactive environment. Although I am preoccupied with the encounter between people and technologies and the interaction that occurs during this encounter, the nature and potential of interactive technologies is still a crucial concern. This is so because interaction design is characterized not only by the focus on *interaction*, it is also a *design* discipline. Hallnäs and Redström define this reciprocal interest in interaction and design concisely with regards to interaction - "Interaction design is design of acts that define intended use of things" (Hallnäs & Redström 2006 p 23) - and with regards to the material by which interaction is framed and shaped - "Interaction design is product- and systems design where computational technology is a basic design material". (ibid. p 23). In continuation of these propositions, it should be noted that although interaction is a focal point for my inquiries, I have studied it in concrete instantiations, e.g. through shaping and studying interactive environments.

In my perspective, this emphasis on *design* is what sets interaction design apart from the historically more well established tradition of HCI. There are ongoing discussions about the intersections and divergences between interaction design and HCI: is interaction design a subset of HCI? Is HCI a subset of interaction design? Are they co-existing domains? Or can the two definitions be used interchangeably, as does e.g. Stolterman (2008). My position is that in many respects, it is exceedingly hard to distinguish the two disciplines, and given the focus of this dissertation, I will not go into any prolonged discussion of this question. I will, however, briefly outline how I see my own work in relation to current discussions about the focus of the field. Firstly, I do not see the two as fixed disciplines, but rather as evolving and related traditions. HCI, having a longer history, is seemingly the most stable and well-established tradition of the two. Principles and methods from engineering, behavioural psychology and human factors were very influential in early developments of HCI, and a number of methods have been adopted and adapted from these disciplines. At least historically, HCI gave prominence to the measurement and evaluation of interaction parameters, and in time, these were brought to bear upon the systems development process, as evidenced in e.g. design heuristics (e.g. Nielsen & Molich 1990) based mainly on quantitative studies of interaction with existing systems. The legacy from the natural sciences shines through in parts of traditional HCI terminology, in the use of terms such as usability *labs* – the setting in which characteristics can be studied in isolation through careful methods and controlled experiments - and *laws*, e.g. Hick's law (Card, Moran & Newell 1983) and Fitts's law (Ibid.) – a form of knowledge that is generalizable and applicable beyond the individual experiment. However, the field can hardly be characterized as stable, and a many researchers and practitioners within the field have argued for alternative foundations and approaches. The rapidly expanding interest in new domains, such as those outlined by Weiser, implies that "the study of HCI

is now effectively a boundless domain," in the words of Barnard et al. (2000 p 223). This expansive scope renders comparisons between HCI and interaction design difficult, especially given the fact that interaction design is also somewhat loosely and employed by a heterogeneous group of practitioners and researchers, many of whom employ the terms HCI and interaction design interchangeably. When I employ the term interaction design to denote my own work, it is because I consider the *fundamental prominence of design* to be a crucial characteristic in my work. In addition, many practitioners and researchers dedicated to interaction design do not readily accept the legacy from engineering and natural sciences that was prevalent in early HCI developments as the only, or indeed the best, foundation for understanding and addressing the particular challenges of designing interactive systems. This is a position that I share, and which I consider to be a second crucial characteristic. It should be stated, however, that many who refer to themselves as HCI researchers and practitioners also share this position. Indeed, a number of new theoretical strands have influenced HCI and interaction design in recent years, a tendency that I will discuss in the following.

2.2 THEORY AND PRACTICE OF DESIGN

Chapter 3 is dedicated to an explication and discussion of my research approach activities, as well as a discussion of the challenges of doing interaction design research. For this reason I shall not yet go into a detailed account of my own approach or the intricacies of design-research relations; however, I consider it necessary to expand a bit more at this stage on what is implied by interaction design as a *design discipline*.

In *Interaction Design: Foundations, Experiments* (Hallnäs & Redström 2006), Hallnäs and Redström describe the fundamental concern in design as overcoming a *hermeneutical gap*. By this, they refer to the gap between the existing situation and the product of the design process, and between designers' current understandings and the crystallization of ideas and concepts embodied by the product itself. The gap is hermeneutical because it is through the designer's interpretation that it is bridged in the movement from the problem setting the designer is presented with and the outcome of the design process. This notion is analogous to the oft-quoted "dialectics between tradition and transcendence", as coined by Ehn (1988). When attempting to bridge the hermeneutical gap, there are two fallacies that should be considered and circumvented. These are *the empirical fallacy* - "… the idea that use is an activity open for empirical investigations and not a concept we define." (Hallnäs & Redström 2006 p 66) and *the interactivity fallacy*: "…the idea that the objective of interaction design is to design 'interactive' systems where the user is yet another component." (Ibid. p 69) Given non-trivial design problems, it is not possible to fully grasp the problem and its solution in advance. By designing, we are defining intended interaction; however, the future use situation cannot be exhaustively understood on the basis of the present; and we cannot assume to understand what people will make of what we give them. As Henry Ford was famously quoted for saying after the introduction of the Model T: "If I had asked people what they wanted, they would have said faster horses." This is not to say that users should not be considered, asked, or involved in the design process, but

there are different ways of considering, asking, and involving. According to Hallnäs and Redström, accepting the hermeneutical gap and the fallacies as immanent aspects in design leads to the conclusion that "Design is not science; its practice is not scientific. Designing things can never be a deductive correlate to empirical investigations. As design involves basic elements of interpretation and aesthetical choices there will always be hermeneutical gaps in all attempts to build a web of quantifiable science covering the design process." (Ibid. p 63).

A remark that I feel compelled to make with regards to their conclusion is that even if one accepts the statement that design is not science, design research may well be *inspired* by science, which I will address in greater detail in the next chapter. The second remark is that the problem of not readily accepting the legacy from the natural sciences, of course, is that one faces the challenge of putting something else in its place. In interaction design and HCI, there are a number of potential candidates. In *New Theoretical Approaches for HCI* (Rogers 2004), Rogers provides a comprehensive overview of theories in the field. With regards to early theoretical formations in HCI, inspired by e.g. cognitive psychology, Rogers classifies the attempts to use theory in three ways as *informative* with regards to providing findings from existing research that could be imported into HCI, *predictive* by providing tools to model user behaviour, and *prescriptive* with respect to how to design and evaluate systems (Ibid. p 96). In contradistinction, a number of theoretical strands of a different nature have since come to influence the field. These have been employed in diverse ways, e.g. to provide *analytic conceptual frameworks*; to offer *rich, descriptive accounts* and *explain user behaviour*; to be *generative* with respect to informing design; and to be *formative* in terms articulating design concerns and establishing a lingua franca of design (Ibid. p 127). Among these theoretical strands, Rogers count the following:

- *The ecological approach* developed primarily on the basis of Gibson's concept of ecological psychology, of which the notions of constraints and affordances have had a wide uptake in HCI through the work of Norman (Norman 1988).
- *The activity theory approach*, based on cultural-historical psychology developed by Vygotsky, Luria, and Leontiev; the focus on activity as the primary unit of analysis has inspired numerous developments of the theory within HCI, including (Bødker 1990) and (Kuutti 1996).
- *Distributed cognition* developed by Hutchins, which explores cognition as a phenomenon that occurs among assemblies of agents and artefacts rather than as a purely individual property (Hutchins 1995).
- *Situated action,* developed by Suchman, which offers a critique of prescriptive models of action and presents as an alternative account based on people's resourceful and emergent action in response to given situations (Suchman 1987); and ethnomethodological approaches, building on the work of e.g. Garfinkel and Sacks (Garfinkel & Sacks 1970; Garfinkel 1989), which strive for rich bottom-up descriptions of ethno-methods, the practical accomplishments carried out by people in order to make sense of and act in a world that is inherently contingent.

To this list, I will add Dourish' work on *embodied interaction* (Dourish 2004), which proposes that phenomenology can serve as a unifying philosophical foundation for addressing the emerging fields of tangible and social computing. My work is primarily inspired and influenced by these new theoretical developments. As will be clear in my exposition of pragmatism in the latter parts of the dissertation, there are at least three affinities between my pragmatist perspective and these positions: the objective of presenting a conceptual foundation, the generative use of theoretical positions to inform reflective design, and the holistic understanding of the interaction situation.

As these positions have gained foothold, there has been a mounting attention towards what constitutes design: how may we understand the bridging of the hermeneutical gap, and what implications or lessons does design lend to other fields of inquiry? Several contributions have treated the issue that design constitutes a specific type of inquiry, so-called *designerly inquiry*. In *Designerly Ways of Knowing*, Cross (2007) argues that "design practice does indeed have its own strong and appropriate intellectual culture… we must avoid swamping our design research with different cultures imported either from the sciences or the arts." (Ibid. p 55) According to Cross, this tradition of designerly knowing, thinking, and acting constitutes a third paradigm of inquiry besides science and the arts. As such, it should be understood and treated on its own terms, rather than through the lenses of the other paradigms. The major challenge in addressing this field as a researcher is that it is only marginally articulated, whereas the other paradigms have well-developed vocabularies. A number of writers have since touched upon the need for formulating what constitutes designerly inquiry, including Buxton (2007), Ludvigsen (2006), and Stolterman (2008), who states that "… design disciplines such as interaction design have to develop and *foster their own designerly approach for education and practice*." (Ibid. p 63). In *Dispelling design as the black art of CHI*, Wolf et al. (2006) make the case that this lack of theoretical development should not be mistaken for a lack of structure within design; on the contrary, they argue that good design is in fact characterized by discipline and rigor and has its own cohesive structure and logic, and that an explication of these dimensions of design will enable designers to better enter into discussion with other paradigms of inquiry. Stolterman summarizes this and other discussions, including (Cross 2007), (Krippendorff 2006), and (Schön 1983), and offers further explication of designerly inquiry in *The Nature of Design Practice and Implications for Interaction Design Research* (Stolterman 2008). Firstly, designerly inquiry is characterized by a deliberately iterative process of moving between the whole and the parts: "a rational designer works on many alternative designs in parallel in an iterative way, while going back and forth between the whole and the details. This way of doing design is not a choice. It is at the core of what it means to act in a *rational, disciplined, designerly* way." (Ibid. p 61) Secondly, it is characterized by *design judgment,* a crucial competence that can be honed through building up "a *heightened sensibility of quality and composition*." (Ibid. p 61). Thirdly, designerly inquiry must offer *design argumentation* by making these judgments "visible and open for critique." A unique challenge to designerly inquiry, Stolterman argues, is that "the design itself becomes a vital part of the argument" (Ibid. p 62). I bring these properties of designerly inquiry to the fore because they pose special challenges to interaction design

research, and I will discuss them in greater detail in chapter 3. Before doing so, I will outline further contributions and developments that have influenced my PhD research.

2.3 THE SCANDINAVIAN TRADITION AND PARTICIPATORY DESIGN

A research tradition that has greatly inspired and influenced my PhD work is the so-called *Scandinavian tradition* of information systems design. This tradition has been pervasive in both in my educational background from Information Studies at Aarhus University and in my PhD project, which has also been anchored in this department. The Scandinavian tradition emerged in the 1970s in a number of projects in workplace settings. It was characterized by involving blue-collar workers and trade unions in the development of the technologies that would be part of their future work, in contrast to management-led systems development. This has been described as an approach based on democratic ideals of worker emancipation, and researchers involved in these early projects have openly expressed that their agenda was politically biased towards intervention and change, thus bearing many resemblances to action research[6]. In addition to adopting workers' perspective within the systems development team, researchers developed methods to involve workers directly as a resource in the design process. Ehn has described the tradition as follows: "This kind of politically significant, interdisciplinary, and action-oriented research on resources and control in the processes of design and use has contributed to what is often viewed abroad as a distinctively Scandinavian approach to systems design. This Scandinavian approach might be called a work-oriented design approach. Democratic participation and skill enhancement, and not only productivity and product quality, are themselves considered objective of design." (Ehn 1993 p 96) An exemplary case from this tradition was the UTOPIA project, in which design techniques such as mock-ups, low-fidelity prototypes, future workshops, and organizational toolkits were developed and employed to foster participation. (Bødker et al. 1987)

The Scandinavian tradition is in many ways closely related to participatory design (e.g. Greenbaum & Kyng 1991), reflected in the fact that many researchers with a background in the Scandinavian tradition have contributed to – and continue to contribute to – participatory design. Although it has a strong following in Scandinavia, participatory design is not limited to these countries and it has had large uptake in e.g. North America. Participatory design is inspired by the encouraging findings from involving users in the design process, which in many cases resulted in systems that fit well into the practices that they were developed for. A major point of departure with regards to the Scandinavian tradition is that it has to a large degree left behind the political agenda. In the words of Greenbaum (1993), this agenda has given way to a more pragmatic perspective, to the extent that the use of participatory design methods and approaches are

[6] I will address action research in more detail in section 3.3.6.

motivated by the intention of designing successful systems. In other words, if the methods of involving future users result in better systems, they might as well be employed in a wider range of design projects.

The methods and techniques employed in participatory design include, but are not limited to, those developed in the Scandinavian tradition. They span from what may be denoted empathic methods by which designers seek insights in the domains of future users, e.g. ethnographically inspired methods such as field studies, participant observation, and qualitative interviews, towards direct user involvement in the design process, e.g. in the development and trial of mock-ups. An overview of these techniques can be found in e.g. Muller et al.'s *Taxonomy of PD Practices: A Brief Practitioner's Guide* (Muller et al. 1993). In the experimental design cases that are part of my PhD research, the Scandinavian tradition and participatory design have been very influential:

On a concrete level, we (meaning the group of interaction design researchers that I am part of) have adapted and made use of a number of techniques and methods from these fields, including ethnographically inspired field studies and low-fidelity prototyping, as well as developed new techniques such as *Inspiration Card Workshops [1]*; a more comprehensive list of these activities will follow in section 3.4.

On a conceptual level, the notion of involving various stakeholders and potential users has, implicitly or explicitly, framed our work in all of the cases. The latter is a retrospective observation: it is upon subsequent reflection during the writing of this dissertation that it becomes apparent how these traditions have been manifest in our general approach when faced with new problem settings. Practitioners develop knowledge, habits, and skill over the course of time, and these inexorably frame the way they see and address new problem settings. Since participatory methods have featured strongly in our past work, as well as in the institutions of which we are part, there has been an inclination to approach the cases with a strong focus on how to get a rich understanding of the use domain, and on how to involve present and future stakeholders as resources in the design process.

The expanding scope of interactive systems in domains outside of the workplace poses numerous challenges to participatory design, similarly to HCI and interaction design[7]. On the basis of my research, I consider the following challenges to be the most prominent with particular regards to the focus of my PhD project and the experimental design cases that I have partaken in:

Rapidly evolving technologies: Technological innovation shows no signs of slowing down, and the ubiquity of computational devices is moving closer (although it takes on a different form than Weiser had envisioned). This results in small-scale components embedded into objects and clothing, large-scale installations integrated into architectural structures, and networking capabilities that connect devices.

[7] For in-depth discussions of recent challenges to participatory design, one may look to e.g. Bødker et al. (2000) and Iversen (2005).

Ecologies of systems and artefacts: As these technologies and devices are inter-connected, they begin to form what may be considered ecologies of systems, in which the potential of the ecology as a whole may be larger than the sum of its parts. Some ecologies are closed and proprietary by design, while others are open and adaptable; however, as people increasingly employ these devices and systems, ecologies tend to emerge whether planned for in advance or not.

Potentials for customization: Many systems are being designed with end-user customization in mind, and trends such as Web 2.0 are built around new models of user participation. Furthermore, as some groups of users become increasingly proficient, they adapt and transform interactive technologies in ways that designers did not anticipate or intend. Although adaptation and transformation is an integral part of technological history (## adaptive design references), different technologies require different skill-sets, and a mounting number of users of digital technologies are developing the skills needed to make these transformations.

Wider uptake of digital technologies: Technologies pervade ever-more spheres of public and private life. These technologies not only provide new functions on an instrumental level, they also transform subjective and social practices and experiences[8]; on a societal level, this is popularized in memes and tropes such as being a "netizen" (Hauben & Hauben 1997) and having "grown up digital" (Tapscott 2008).

Experience-oriented applications of digital technologies: The spread of interactive technologies into non-work domains has sparked a growing interest – in research as well as in practice - in experience-oriented potentials of digital technologies. This correlates to societal trends such as the notion of the so-called experience economy, which has prompted investigations into the design and evaluation of various experiential qualities in digital artefacts. The wider uptake of digital technologies is also evident in the arts, for which reason there is a growing awareness of cultural and aesthetic dimensions of interactive technologies.

In order to position my own work, I will address how these developments have influenced my research with specific attention to related research contributions addressing *experience-oriented aspects of interaction design* and *mixed reality and augmented spaces*.

[8] I will attend to this in greater detail in section 5.2.1.

2.4 EXPERIENCE-ORIENTED ASPECTS OF INTERACTION DESIGN[9]

The increasing focus on experience-oriented aspects of interaction design can be seen as a result of a combination of trends: on a societal scale, researchers and consultants have been exploring the impact of the *experience economy* (Pine & Gilmore 1999) for a number of years, and companies as well as public institutions and governments are increasing their endeavours to reap the benefits of this trend; on a technological scale, *new technologies* with the potential to expand and enrich user experiences are constantly being developed, and the experience-oriented potentials of existing technologies are being re-examined; on a use-level scale, interactive technologies are being employed in ever-more *domains* that transcend the workplace, moving into public spaces, the entertainment industry, cultural institutions, leisure activities, and not least into users' homes, as outlined in the preceding section.

With this diversity in mind, it comes as no surprise that the research community's response to addressing experience-oriented aspects of interactive technologies is highly varied; being an emergent field of study, the approaches to exploring user experience in interaction design are thus without a persistent formal body of knowledge. On the one hand, this is due to the fact that the subject matter – i.e. experiential aspects of interaction - can be addressed from a number of perspectives. On the other hand, it stems from the issue that researchers and practitioners are aiming at a moving target: the field is continuously evolving as new technologies emerge and are brought into use in previously unseen ways.

Given the intrinsic complexity of the field, Davis (2003) contends that "experiential systems design must be radically interdisciplinary" (Ibid. p 45) and combine efforts and insights from psychology and the arts and humanities, as well as engineering and computer science. On an over-arching level, one can outline at least three approaches to the field by distinguishing between those contributions that focus on products, aesthetics, and theories of experience, respectively. First, approaches such as those of Jordan (2000) and Norman (2004) take as their starting point the notion of *pleasurable products* and their design. Such product-centered approaches often have their main focus on the features and qualities of the interface itself, that which can be described and studied in ostensibly objective terms. A rather different approach is to take as a starting point the notion of *aesthetics.* This can be undertaken in various ways, e.g. by exploring what constitutes an aesthetics of interaction, as do Petersen et al. (2004); how to engage in aesthetic criticism of interfaces, as do Bertelsen and Pold (2004); or to examine what might come from designing post- or suboptimal technologies with special regards to aesthetic qualities, as do e.g. Dunne and Raby (2001). A third approach is to establish *theories of experience* as it unfolds in interaction, either by drawing on existing theories from psychology, by radically expanding or modifying these theories, or by defining new ones

[9] This section builds on the introductory parts of (Dalsgaard 2008b).

altogether. Proponents of this approach include Alben (2004), Forlizzi and Battarbee (2004), and Forlizzi and Ford (2000). With regards to the latter approach, Forlizzi and Battarbee (2004) provide a somewhat more fine-grained outline of research contributions by distinguishing between different ways of modelling experience: *Product-centered models* focus on the qualities of the interface, such as those explored in Desmet & Hekkert's 'Framework of Product Experience' (Desmet & Hekkert, 2007) which examines the interrelations between aesthetic, meaningful and emotional experiences of products. *User-centered models* seek to establish general understandings of human capabilities and motivations, as exemplified by Hassenzahl's exploration of the user-product relation (Hassenzahl, 2003). *Interaction-centered models* seek a systemic perspective on the interrelations between artefacts and users; examples of this approach include Forlizzi and Battarbee's studies of experience (Forlizzi & Battarbee, 2004)

This is evidently a very broad categorization. Firstly, there are obvious overlaps between the three, as e.g. in most situations it would make little sense to discuss experience of interaction without taking into account the interactive product. Secondly, the categorization may be established in a different manner to bring to the fore other aspects.[10] I employ these schemata and categorizations to establish an early and general overview of the field, well aware that they may be contended. However, it will dilute the focus of this dissertation to offer a more detailed critique of them at the present, since I present them here mainly to outline the field that my research has been influenced by. A brief note on terminology is required with regards to the terms *experience* and *aesthetics*. The two are obviously closely related, and in some domains they are used indiscriminately. However, there seems to be some reluctance to embracing the term aesthetics in interaction design and HCI, in which *experience-oriented* is more widely used; *aesthetics* brings with it different connotations, since aesthetics has traditionally been approached from the arts and humanities, and HCI researchers seem less at ease when confronted with the term. In my work, I primarily employ the term experience, and at times *experiential design,* in order to demark my position in relation to the more common term *experience design*, which in some instances seem to lend the belief that the experience itself can be designed. This is far removed from my own position on the experience, which I lay out in more detail in chapters 4 and 5. In this dissertation, I present and employ a pragmatist perspective on experiential design that, in relation to the above-mentioned typologies, may best be characterized as an interaction-centered perspective. In contradistinction to the notion that experiences may be designed, a pragmatist perspective stresses that designers may design interactive installations and systems with certain experiential qualities in mind, but that experience is ultimately a subjective encounter in which the experiencing user is a co-creator. This is not to say that designers cannot design with the intent of bringing

[10] An example of a different schemata is that offered by Udsen and Jørgensen in *The Aesthetic Turn* (Udsen & Jørgensen 2005), in which the authors outline four different research approaches to aesthetics of interaction: "the cultural approach", stemming from humanities and new media studies; the functionalist approach, encompassing researchers from traditional HCI; "the experience-based approach", consisting of researchers from interaction design; and "the techno-futurist approach", with a basis in philosophy.

about specific kinds of experience, rather it is an echo of Petersen et al's proposition that "aesthetic is not something a priori in the world, but a potential that is released in dialogue as we experience the world." (Petersen et al. 2004 p 271)

My experiences from engaging in experimental design cases throughout my PhD project has made clear that traditional participatory design, with its roots in workplace challenges and concerns, is indeed challenged by the emergence of experiential design. In particular, methods and techniques for involving users and gaining insights into use domains conventionally employed within the participatory design tradition are in need of revision or replacement. This sentiment is shared among a number of practitioners and researchers. A well-known example of this is Gaver, Dunne and Pacenti's *cultural probes* (Gaver, Dunne & Pacenti1999), intended to provide designers with user-centered inspiration. Cultural probes is a promising recent method for gaining experiential insights that can be seen both as an expansion of participatory design as well as a reformulation of the role of users and designers. Gaver, Dunne and Pacenti propose that user inputs are best regarded as one of several sources of inspiration that designers draw upon, somewhat downplaying the importance of specific user inputs and instead emphasizing the role of the responsible and reflective designer whose job is to coalesce a number of experiential concerns and resources in the final design. In contrast, early participatory design techniques developed for the workplace had a stronger emphasis on existing practice, and drew upon the existing knowledge of involved users who were considered experts within their own domain. I address the challenges of addressing experience-oriented aspects of use in to varying degrees in all of the papers included in this dissertation, as well as in the pragmatist perspective laid out in chapters 4 and 5.

2.5 INTERACTIVE ENVIRONMENTS, MIXED REALITY, AND AUGMENTED SPACES

My PhD research is to a large extent founded on participation in concrete experimental design cases in the three large-scale research projects *Experience-oriented Applications of Digital Technology in Knowledge Dissemination and Marketing, Media Façades*, and *Digital Urban Living*. Within the frames of these projects, the experimental design cases have all, in different ways, been situated in *knowledge mediation* domains. Knowledge mediation can be roughly defined as processes by which one or more parties convey a message or theme intended to resonate with or influence other parties. The cases in my PhD research have spanned quite a wide array of situations, ranging from presentations of concrete product information in business-to-business trade shows to ambient atmospheric installations in a centre for children's literature.

In the three projects, we have developed and explored a number of installations that I have broadly labelled *interactive environments*. This label is chosen since, on a technical level, we have made designerly inquiries into the potentials of embedding digital technologies into our surroundings, and since, on a conceptual level,

we have explored not just the interactive installation or interface in isolation, but the whole environment of which it is part. This is described by Winograd (1997) as a trajectory "from computing machinery to interaction design". In this shift, the central challenge to the field, according to Winograd, is not the design of the individual *interface*, but rather the design of *interspaces*, assemblages of interfaces, environments and users. Most of the design cases that are outlined in this dissertation can rightly be construed as interspaces, and in my research, I have been pre-occupied with interaction situations in their totality as assemblies of dialogues and encounters between people and technology.

A more widely recognized term for such environments is "mixed reality", first defined by Milgram and Kishino (1994) as the mix of physical elements with digital and virtual elements. Milgram and Kishino establish a reality-virtuality spectrum, spanning from real environments to virtual ones. In my PhD project, I have primarily focused on environments in which digital elements have been placed or embedded in physical surroundings, and in which a user's physical presence and action is the pivotal point of interaction with digital elements. The focus of my work in relation to Milgram and Kishino's definition is illustrated in figure 3

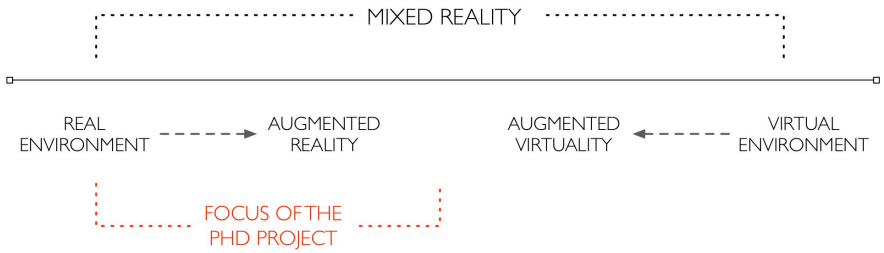


Figure 3: Focus of my PhD research on Milgram & Kishino's reality-virtuality spectrum.

In most of my experimental design cases, there has been a strong emphasis on the integration of interactive components into existing physico-spatial environments with the intention of enriching it and opening up for new types of experiences in the environment. One of the most comprehensive surveys of existing mixed reality installations is presented by Bullivant in *Responsive Environments: architecture, art and design* (Bullivant 2006), which presents cases of iinteractive building skins, responsive artworks, intelligent walls and floors, exhibition spaces, visitor attractions, embodied interfaces for dance, and interactive domestic spaces. At the present time, research spans an even greater spectrum, ranging from explorations of large-scale interactive environments as evidenced by e.g. the *Urban Screens* conference (Struppek 2006) and the Digital Urban Living research project that I partake in, to intimate body-space artefacts such as intelligent textiles with skin-galvanic sensors. These emerging fields bear names such as pervasive computing, tangible user interfaces, wearable computing, intelligent architecture, smart spaces, ambient intelligence, and context-aware computing.

Manovich (2006) addresses the domain of adding layers of data to the environment, dubbing it *augmented spaces.* Interestingly, Manovich highlights two cases that reflect sensibilities of augmented spaces, namely Cardiff's *audio walks* (Pinder 2001) and Liebeskind's *Jewish Museum* in Berlin (Schneider & Liebeskind 1999), but which are in fact not interactive in themselves. The audio walks exemplify the potentials of interplay between different spaces and temporalities, constituted in Cardiff's work by the physical surroundings in which the user is present and the augmented audio space that evokes the past. The Jewish Museum, in contradistinction, does not add a new dataspace to the existing environment; rather it uses a dataspace (constituted by addresses of previous Jewish family residences) to drive the design of a new physical space. It is striking that Manovich employs these non-interactive environments to exemplify potentials and qualities of augmented spaces when taking into account the optimistic visions that were plentiful in the early discourse in the field. Weiser, for instance, envisioned that "Machines that fit the human environment, instead of forcing humans to enter theirs, will make using a computer as refreshing as taking a walk in the woods." (Weiser 1991 unpaginated) In a similar vein, Mitchell, formerly Dean of the School of Architecture and Planning at MIT, foresaw a seamless integration of interactive artefacts: "Now by embedding intelligence and interconnectivity in material products and creating systems of tags and sensors... we can construct spatially extended smart spaces from collections of interacting smart objects. Real desktops, rooms, and other settings – rather than their electronically constructed surrogates – can begin to function as computer interfaces ... As a result, our actions in physical space are closely and unobtrusively coupled with our actions in cyberspace. We become true inhabitants of electronically mediated environments rather than mere users of computational devices." (Mitchell 2000 p 43) An interesting underlying assumption in these early visions is that transparency is seemingly considered a property of technology: even though computational systems and devices will change our lives, they will do so unobtrusively if properly designed. A contrasting perspective, such as that presented in (Dourish and Bell 2007), is to consider transparency as a relational feature in which it is not technology itself that is transparent, but rather that as it becomes part of our everyday life and practice, it will fade into the background or become part of a taken-for-granted infrastructure.

When Manovich (2006) employs two non-digital cases to exemplify the qualities of augmented spaces, it can be taken as a testament to the fact that our encounters with pervasive technologies are not (yet) as smooth and unobtrusive as Weiser and Mitchell envisioned[11]; many would argue that the opposite is the case, that as computational devices multiply, so do the complexities of interaction. The present complexities need not necessarily imply that integration is impossible, but it does give interaction design practitioners and researchers pause for thought. In *Moving on from Weiser's Vision of Calm Computing*, Rogers (2006) suggests a shift in perspective by "moving from a mindset that wants to make the environment smart and proactive

[11] This is my reading of Manovich (2006); to specify Manovich' precise line of argument, it is an exploration of the genealogy of augmented spaces prior to the advent of the digital with the proposition that although the dynamics afforded by digital technologies is new, the concept of augmented spaces has been around for millennia.

to one that enables people, themselves, to be smarter and proactive in their everyday and working practices." (Ibid. p 418) This is a more modest endeavour, based on understanding and designing for specific settings and practices; it is also one that emphasizes the resourcefulness of human users, rather than the power of computational devices. My approach to the experimental design cases presented and discussed in this dissertation mirrors that suggested by Rogers: on one hand because the interactive installations and environments have been developed for a specific situation with the particular practices and qualities of that situation in mind; on the other hand because I have had a keen interest in the ways people make sense of, adapt in response to, and appropriate technologies in their environment. This attention to situated practice and reciprocal human-technology interrelations is reflected in the pragmatist perspective developed in the latter part of this dissertation. As stated above, the specific settings for the experimental design cases may broadly be labelled knowledge mediation environments. They are quite diverse, and rather than recounting related work with regards to each of these settings, I will point to the included papers, in which work related to the specific situations is accounted for and discussed. The common denominator among the cases is that they have aimed at developing installations and environments to convey information, either in a concrete sense, e.g. the presentation of specific products and services at a sales convention, or in a more abstract sense, e.g. by establishing moods or atmospheres to underscore narratives in a literature centre.

2.6 SUMMARY

In this chapter, I have laid out how my research is positioned in relation to existing research concerning the design of interactive systems. In summary, my work can be seen as a response to a series of trajectories and developments that are intertwined in my research:

From human-computer interaction to interaction design, in that my focus is directed at the interaction facilitated and instigated by interactive systems, rather than on the systems themselves; furthermore, my work relates specifically to the design process, and for this reason I am interested in exploring and articulating what constitutes designerly inquiry.

From a focus on work-related concerns to spheres of human interest and activity beyond the workplace, in that the domains in which I have carried out my experimental design research are knowledge mediation environments of varying sorts, spanning a range from public knowledge institutions to business-to-business trade shows. A corollary trajectory designates the movement beyond the Scandinavian tradition, in which new foundations for involving and understanding users and stakeholders are being established.

From desktop computing to interactive environments, in that the systems I explore employ novel means of interaction that go beyond traditional interfaces; I employ the term interactive environments to denominate these systems, in part because they often encompass larger assemblies of interactive artefacts, in part because I am interested in the entire interaction situation, including socio-cultural, physico-spatial, and temporal concerns, in addition to the user-system interaction.

From a focus on functional aspects of computing towards experience-oriented ones, in that I am concerned with the experiential potentials and effects of interactive environments in addition to the instrumental functions they afford; this includes studies and articulations of experience in use, as well as ways of integrating experiential values and concerns into the design process.

My interest in exploring these recent developments does not imply that prior concerns and insights are discarded of, on the contrary: it is on the basis of earlier insights that new ones emerge. With regards to these trajectories, I have chosen to focus the design process, and the implications that these expansions hold for the development of engaging interactive environments. As a consequence, many inspiring contributions and perspectives will only be touched upon cursorily or not at all in order to maintain clarity and coherence in my present exposition.

3 RESEARCH APPROACH AND ACTIVITIES

This chapter presents and discusses my research approach and the activities that I have been engaged in as part of my PhD project. First, I introduce the frame within which the PhD project has been carried out. I then outline the broader context of interaction design research and in relation to this I present my own research approach, which I characterize as *research in and through design* framed by an overarching research question. My focus in this chapter is in particular on practice-based and explorative ways of doing research informed by design, and on the merits and limits of this type of research. This includes a discussion of the criteria by which research contributions such as my own can be evaluated. Finally, I sketch out the activities undertaken in the course of the PhD project and describe the design cases that have informed this dissertation.

3.1 THE FRAME OF THE PHD PROJECT

An introduction to the general framing conditions of my PhD project is a necessary outset to the discussion of my research approach and activities since it has co-determined these in two ways: in a concrete way because it has designated a set of initial design cases; in an abstract way, certain assumptions and conceptions of the practice and research of interaction design have been embedded within this frame and have, implicitly and explicitly, influenced and informed both my practical and analytical work.

My PhD research has been anchored in *CAVI*, the Centre for Advanced Visualisation and Interaction at Aarhus University. The centre brings together practitioners and researchers from disciplines including computer science, visual arts, 3D graphics, architecture, and Information Studies, the humanistic field of study from which I have my background. My PhD has in part been funded by the research project *Experience-oriented Applications of Digital Technology in Knowledge Dissemination and Marketing*, which ran from February 2005 to July 2006 (although some of the sub-projects extended beyond this time-frame). The objective of the project was to explore innovative applications of interactive technologies in the areas of knowledge dissemination and marketing. This research project was collaboration between CAVI and a diverse group of external parties, including *The Danish Electricity Museum*, *7th Heaven*, a centre for children's literature, *Salling*, a large department store, and *Gumlink*, a chewing gum research and manufacturing company. As a result, my initial research was directed at the challenges facing these stakeholders in development of design concepts, prototypes and interactive installations that would enable and improve knowledge mediation within their respective domains.

Insights from this project was carried into a subsequent project at CAVI that I participated in, namely *Media Façades*, which focused on the potentials of interactive media façades as integrated elements of architectural interiors and exteriors. In the frame of this project, the installation *Aarhus by Light* was developed in

collaboration with *Concert Hall Aarhus*, *Martin Professional A/S*, a developer and manufacturer of intelligent lighting systems, *The Animation Workshop*, a school for animators, and *Wall of Pixels*, an animation company. The Media Façades project has subsequently been integrated into *Digital Urban Living*, a research centre that I am now part of. Digital Urban Living explores new forms of digital urban living reflected by the societal and technological development of the experience economy. In this project, we have collaborated with the architectural firm *Bjarke Ingels Group* (BIG) in the development of a competition proposal for the new *Museum of Modern Art* in Warsaw[12].

As this assemblage of projects and collaborators makes clear, my research has by no means taken place in a vacuum. All of the experimental design cases that I have been involved in have been collaborative efforts in which the perspectives and inputs from fellow researchers and outside stakeholders have influenced my own work and vice versa. Another general characteristic is that all of the experimental design cases have been directed at addressing real-life challenges. In the best of worlds, there is a harmonious confluence between that which benefits the interests of stakeholders as well as those of academic researchers. However, this is not always the case in practice. Some projects turn out to be of great value to external parties, yet they yield few insights for researchers. Other projects turn out to be of little or no value in stakeholders' practice, but yield highly interesting findings for researchers. This is an inherent condition in collaborative interaction design research projects. The position of being a researcher can at times feel quite privileged, since projects that fail in practice can often generate as much, if not more, interesting input than those that succeed in practice.

In the following, I will present different perspectives on design research and lay forward the research approach that I have chosen in order to address this rather complex domain of study. I will focus in particular on issues regarding complexity, knowledge, involvement, experimentation and criteria for evaluating research.

3.2 DESIGN COMPLEXITY AND WICKED PROBLEMS

In *The Nature of Design Practice and Implications for Interaction Design Research*, Stolterman (2008) presents and contrasts the types of complexity faced by scientists and designers respectively. Scientists confront an incredibly complex world from which they seek to formulate universally generalizable and reproducible knowledge; however, this massive endeavour is remedied by (1) reliance on a scientific method which allows for them to tackle a distinct phenomenon in isolation, and (2) the huge number of collaborators – past, present and future – whose work can be stitched together with their own, since they speak the same

[12] In addition to these collaborations, I have taken part in a number of projects and experiments that are not addressed in this dissertation. For a full list of publications addressing these projects, see http://person.au.dk/da/imvpd@hum.au.dk/pub.

fundamental language. In juxtaposition to this, the complexity that designers face is of a different nature: "[…] design deals with the *specific, intentional* and *non-existing* […] the goal is all about creating something *non-universal*. It is about creating something in the world with a *specific* purpose, for a *specific* situation, for a *specific* client and user, with *specific* functions and characteristics, and done within a *limited time* and with *limited resources*." (Stolterman 2008 p 59) Stolterman's line of argument is that research undertaken in order to inform or improve the practice of design has to build upon an understanding of this fundamental complexity; and since complexity in science and complexity in design are of a different nature, design research may have to formulate and rely upon different methods and approaches than those of science.

The complexity that designers face manifests itself in a specific type of problems, namely that which Rittel and Webber (1973) in *Dilemmas in a General Theory of Planning* denote *wicked problems*. The natural sciences have developed highly refined methods for solving problems that are definable and observable, *tame problems* in the terminology of Rittel and Webber. Wicked problems, however, are of a different essence, and the coining of the phrase denotes the fact that such problems cannot be solved through traditional analytical problem solving. Although Rittel and Webber deal with social policy problems in their paper, their characterization of wicked problems can be extended to those facing interaction designers, as noted in numerous contributions to the field, eg. (Stolterman 2008; Zimmerman, Forlizzi & Evenson 2007; Hallnäss & Redström 2006). Rittel & Webber list ten characteristics of wicked problems (and propose that there may be more), including the following four:

- "There is no definitive formulation of a wicked problem" – i.e. the problem cannot be exhaustively defined, and different attempts at articulating solutions will change the understanding of the problem.
- "Solutions to wicked problems are not true-or-false but good-or-bad" – i.e. the evaluation of the resolution of to the problem cannot be unambiguously determined on the basis of fixed criteria; the evaluation is instead situated and context-dependent and dependent on whether different stakeholders can agree that it is satisfactory or "good enough".
- "Every wicked problem is essentially unique" – i.e. although a wicked problem can have similarities to previously encountered problems, they always have individual traits that make it impossible to determine in advance the solution to it.
- "Every solution to a wicked problem is a one-shot operation" – i.e. once a certain hypothetical solution is applied to a wicked problem in practice, the situation changes; and since every wicked problem is unique and involves a multitude of interdependent phenomena, you can never try out the same solution to the same problem twice to determine which was unequivocally best.

Interaction design practitioners face wicked problems in their work, constantly finding themselves in situations in which trade-offs and compromises are a part of their work, and in which the problems are not solvable in the traditional sense of the word; yet, we can recognize that some designers do excellent work,

transcending challenges and unifying concepts in creative and meaningful ways, while less competent designers achieve poor or mediocre results within the constraints of a project.

Given the wickedness of the problems in the design situation, the outcome of a design process is, in the words of Nelson and Stolterman (2003), the *ultimate particular*: a response to the fundamental distinctiveness of the situation which is by consequence also fundamentally distinct itself. This is the opposite of the intended outcome of science, the definition of universal facts. In continuation, Stolterman (2008) notes that the outcome of the scientific process is always evaluated on the basis of whether or not the scientist has adhered to a priori determined methodological standards, whereas the product or outcome of the design process is primarily evaluated in its own right, and not on the basis of the design process and the rules and methodologies that influenced it. Note that these discussions pertain to the differences between science and design practice, not design research. Design research entails further complexities to which I now turn.

3.2.1 INTERACTION DESIGN RESEARCH COMPLEXITY

At the highest level of abstraction, design research can be characterized as "[…] the study, research, and investigation of the artificial made by human beings, and the way these activities have been directed either in academic studies or manufacturing organizations." (Bayazit 2007 p 16). This is a tremendously broad and encompassing definition, pointing out that design research can be many things indeed. In *Experimental Design Research: Genealogy – Intervention – Argument* (Binder & Brandt 2008), Binder and Brandt narrow the field down by identifying two different uses of the term design research:

"… design research as a label is used both to point to a particular aspect of professional practice, as reflected for example in publications on how to conduct research in a professional design setting (Laurel 2003) and as a particular designerly mode of scholarly inquiry often called practice-based research, that accommodates artistically oriented explorations of scholarly themes (Biggs 2004). The two are not contradictory but indicates an interesting ambiguity: design practice may involve research, and design research practice may involve design, without the present day discussion giving any formal or practical handles to distinguish between research in the former and the later case." (Binder & Brandt p 2).

Whereas design research in the first definition of the term first and foremost implies questions and concerns regarding research methodology, the second definition, in which designers are themselves employing design as a mode of inquiry, poses wicked problems regarding both design practice and research practice.
In exploring the relation between design and research, Fallman (2005) offers a distinction between *research-oriented design* and *design-oriented research*, which is related to, although not entirely analogous with, the distinction made by Brandt & Binder. Research-oriented design denotes a design situation in which research is employed as a means of generating insights that will feed into the design of a product: "While research-

oriented design may relate to, seek influence in, and even contribute to research (i.e. the generation of knowledge) in different ways, it has the production of new artifacts as its main motivation and goal." (Fallman 2005 p 4). Design-oriented research, on the other hand, denotes a research situation in which design serves as a means for generating insights and knowledge for use in research: "In design-oriented research, the knowledge that comes from studying the designed artifact in use or from the process of bringing the product into being should be seen as the main contribution—the 'result'—while the artifact that has been developed becomes more of a means than an end." (Fallman 2003 p 3). This distinction is important, for just as Stolterman (2008) has distinguished between the complexities of design and science, there are also challenges distinct to the practice of research as compared to the practice of design, as I will now discuss.

3.2.2 RESEARCH ON, IN, AND THROUGH DESIGN

Frayling, whose paper *Research in Art and Design* (Frayling 1993) has inspired many of the recent discussions that I have outlined, describes research as a practice, on par with other types of practice: "Research is a practice, writing is practice, doing science is practice, doing design is practice, making art is a practice." (Frayling, 1993 p 4). Of note here is that not only is research mentioned as one practice and design another, science is a third practice outside of research. In the paper, Frayling makes a distinction between different types of research pertaining to arts and design, specifically *research into art and design*, e.g. historical studies of art; *research through art and design*, e.g. investigations into properties of physical materials employed in design; and *research for art and design*, research where the end result is "embodied in the artefact" (Frayling 1993 p 5). In his research on designing for social interaction, Ludvigsen (2006) explores and develops the distinctions proposed by Frayling within the frame of current interaction design research. This leads Ludvigsen to articulate of three types of research pertaining to interaction design, namely *research on design*, *research in design,* and *research through design*:

Research on design has as its focus the product of design and the consequences that the product has in the setting into which it is introduced. The design process is of little interest in this type of research, which can be carried out through e.g. art historical or sociological approaches.

Research in design, on the other hand, explores the design process and the events that unfold in it. The outcome of the product is of minor significance, rather the creative process and the practice and methods in it are in focus. This is to some extent analogous to Brandt & Binder's first notion of design research.

Research through design, analogous to Fallman's design-oriented research, is research in which a designerly approach and perspective is employed by the researcher. The objective here is to address a research question or theme, and "through" implies that design serves as a model for how to explore the subject

matter. A particularly interesting facet of this approach is that the iterative, explorative and constructive modes of inquiry that characterize designerly reflection and practice is presented as a valid research strategy.

Each of these approaches, Ludvigsen argues, poses different challenges to researchers, requires different skill sets and results in the production of different types of knowledge. The approaches are not mutually exclusive, rather they may often overlap in research practice; e.g. it would be hard to consider a research in design process in which the product of design was not of some interest and vice versa.

Regarding the tensions and relations between design and research offered in these distinctions, it is not only interaction design *practitioners*, but also interaction design *researchers*, who face wicked problems, for the practice of doing research in this area is also highly complex. I argue that researchers often deal with *multiple levels of wickedness*: There are wicked problems in the practice of interaction design, there are wicked problems in the practice of doing research in and on interaction design, and there are yet more wicked problems in the practice of doing research through design. Researchers are exploring a field that is in itself complex, and each research initiative, e.g. exploring how a design event unfolds, poses a complexity beyond that of the design event, e.g. how to gain access to the design event, how to collect data, how to determine the degree to which the research interferes with the design, and how to evaluate the data. When the researcher employs a designerly approach to exploring a research question through design, the wicked problems from the two types of practice are conflated. This, I believe, is one of the reasons that interaction design researchers at times find it difficult to explain their research approach, both to researchers from fields with well-established research approaches, and to people outside of academia.

3.3 MY APPROACH: RESEARCH IN AND THROUGH DESIGN

On the basis of the above distinctions, my research approach can be construed as *research in and through design* framed by an overarching research question. It combines research in and through design in that (1) it is directed at improving the understanding and practice of interaction design (primarily with regards to experiential issues in knowledge mediation settings through the use of mixed reality) and thus includes inquiries into the design process itself, and (2) it employs involvement in design experiments as a key catalyst for knowledge generation, in which designerly thinking plays an important part. My engagement in these design experiments encompasses the components laid out by Zimmerman, Forlizzi and Evenson (2007) in *Research through design as a method for interaction design research in HCI* in that it involves "grounding—investigation to gain multiple perspectives on a problem; ideation— generation of many possible different solutions; iteration— cyclical process of refining concept with increasing fidelity; and reflection." (Ibid. p 494). These experiments are framed by academic reflection in light of my overarching research question, not solely in the traditional sense of the word reflection – that of individual deliberations upon phenomena in the world - but also through readings and discussions of related academic contributions, and furthermore in the sense that it is reflected through exposing my own work in various

iterations in academic fora, e.g. in publications, seminars and conferences. In order to frame and discuss my research approach, I will build upon the framework of *question*, *program* and *experiment*, presented in the following.

3.3.1 QUESTION, PROGRAM, AND EXPERIMENT

The approach underpinning my PhD research can be understood in terms of *question*, *program* and *experiment*, as presented in Binder and Redström's *Exemplary Design Research* (Binder & Redström 2006) and Binder and Brandt's *Experimental Design Research: Genealogy – Intervention – Argument* (Binder & Brandt 2007). *Question*, in this regard the most abstract entity, refers to the over-arching research question guiding a research project. *Program* is a concept adopted from design practice, in which "program typically defines an area of exploration setting goals for what is to be achieved by the design, but leaving it open how this is accomplished." (Ibid. p 3). In design, the program is developed as design work progresses and understandings of what constitutes the design space are gained. A research program, however, departs from a design program in a crucial way, namely that a designer fortifies and refines the design program through the development of a product, whereas a researcher aims at challenging the assumptions of the research program: "… where the ordinary design work proves its relevance through what the program can accomplish in terms of finished design, design research has to show the strength of the program beyond the individual experiment… where the program is a means for the designer to be able to pursue a particular line of design, the program is to the design researcher the suggestion that must be substantiated through experiments." (Ibid. p 3). *Experiment*, the most concrete entity among the three, denotes the more specific inquiries undertaken within the space laid out by the program. Binder and Brandt describe the design research experiment in the following manner: "We think of the design experiment in design research as on the one hand the result of a truly designerly engagement with possible form that can be appreciated and evaluated as design and on the other hand as a deliberate attempt to question what we expect from such design."(Ibid. p 3). Figure 4 illustrates the relations between question, program and experiment.

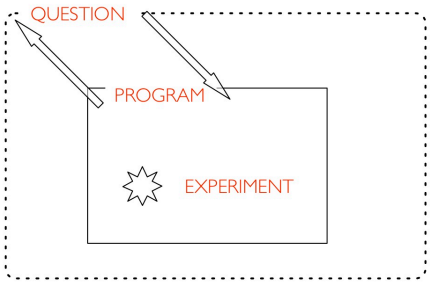


Figure 4: In design research, the experiment is undertaken to challenge and develop notions set forth in a research program, which in turn is framed by an over-arching research question (Adapted from Binder & Brandt 2007).

Although *question* is at the most abstract level, this does not imply that research has to spring from a well-articulated question; it may as well spring from an experiment which opens the researchers eyes to a new research agenda, or from the definition of a program to guide experiments, which may later on be scrutinized in a more general perspective. The relations between the three entities are not set in stone, since developments in one may cause transformations in the others – experiments may develop the program, and the development of the program may influence a revision of the question.

In my case, the question can be formulated as in the opening lines of this dissertation: "*How can we conceptualize the design and use of engaging interactive environments?*" This question has provided direction and momentum for most of the activities that I have undertaken as part of my PhD. Within this framing question, I have engaged in not one, but multiple programs. Each of these programs has in turn consisted of multiple experiments. In my understanding of the term experiment, it is a flexible concept, in that it may consist of a number of smaller experiments. I have illustrated this approach in figure 5:

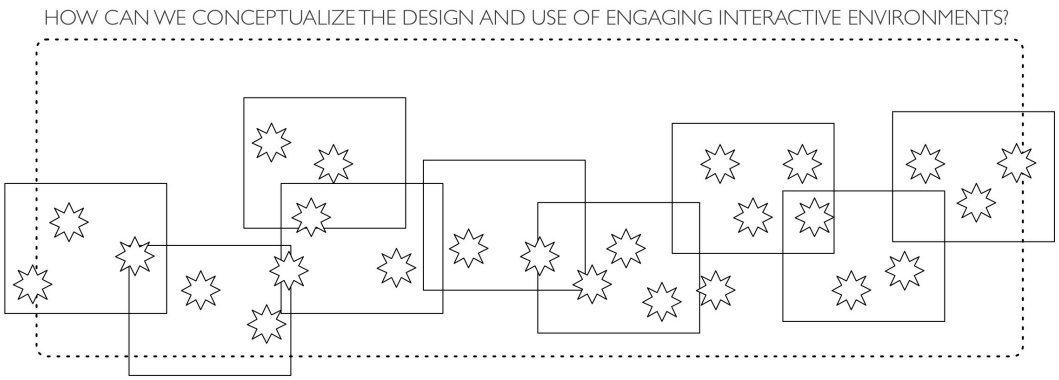
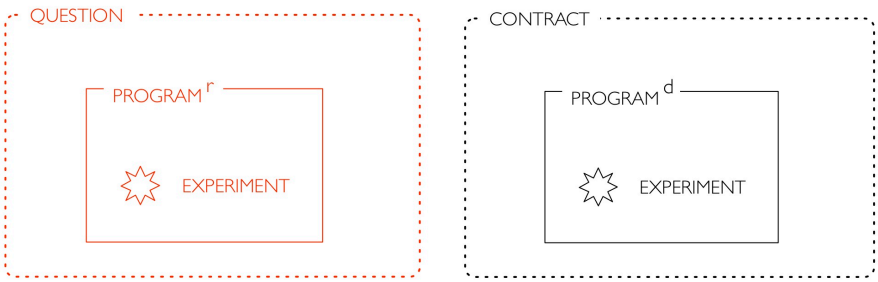


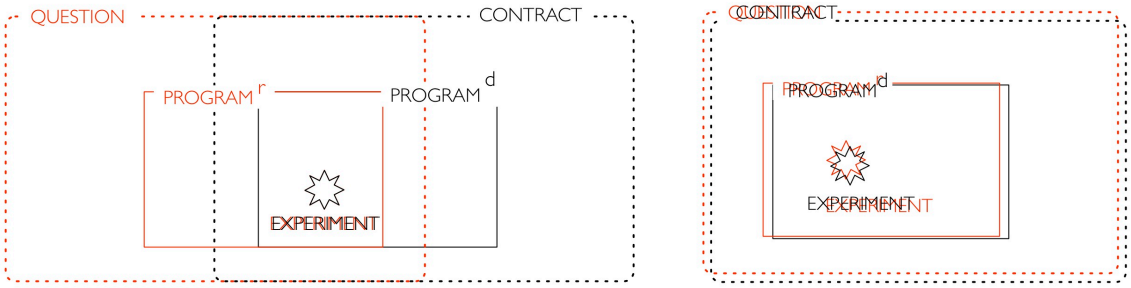
Figure 5: My research approach is framed by the question "How can we conceptualize the design and use of engaging interactive environments?" Driven by this question, I have partaken in a sequence of programs, some overlapping, in which a number of experiments – also overlapping to some extent - have been carried out. Some programs and experiments have been more central to my research question, illustrated by entities breaching the frame of the question.

Since most of my design experiments have been carried out as part of collaborative projects involving stakeholders outside of academia, I will develop Binder and Brandt's model to elaborate on the interrelations between programs in design practice and design research. As outlined, within the framework of question-program-experiment, design practice is set apart from design research in two respects: first, design practice is not driven by an over-arching research question, but rather by an assignment, often explicated in a contract; second, design practice strives to fortify the design program, whereas design research must challenge its design research program.



Figures 6 and 7: The design program (Program[d]) is framed by contractual obligations, whereas the research program (Program[r]) is framed by research questions.

However, designers and researchers must find ways to combine their efforts in collaborative projects, and at times this leads to tensions and misunderstandings. I propose that these tensions often pertain to the different agendas of either fortifying or challenging the program, and that an explication of these differences at an early stage in the collaboration may go some way to resolving or remedying the tensions. If designers and researchers are to collaborate in design experiments, there has to be some overlap between their programs – but there must also be an awareness that the two programs are not the same; otherwise, misunderstandings and tensions are inevitable.



Figures 8 and 9: By articulating the differences between the design program (Program[d]) and the research program (Program[r]), designers and researchers can negotiate converging interests and experiments as well as pursue different objectives; otherwise, the picture tends to get blurry as designers and researchers have diverging motivations for developing a program and carrying out experiments. This is evidently a simplified account of processes that are in practice much more complex, but nevertheless an aspect of collaboration that tends to be overlooked.

To clarify, I will sketch out the design case in which I, in collaboration with researchers from CAVI and Media Façades, worked with BIG Architects to develop a competition proposal for the new Museum of Modern Art in Warsaw. My engagement in this project was motivated by my main research question: "How can we conceptualize the design and use of engaging interactive environments?" The research program, in this case, can be outlined as the exploration of the potential of interactive media façades in the specific context of the future museum; this was developed in the research group. The design program was

developed by BIG, in relation to specific parameters laid out in advance in the competition rules, e.g. building size, location and requisite facilities such as exhibition spaces, restaurants, museum shops etc. Some aspects of the design program were developed in discussions between the research group and BIG; in this part, the research program can be construed as overlapping with and influencing the architectural design program developed by BIG for the entire museum. In the research group, we did not deal with this entire program, but with interactive media façades specifically. In order to explore the research program, a number of experiments and sub-experiments were carried out. An example of one experiment was the exploration of the visual expression of colour-changing concrete. This exploration was composed of numerous sub-experiments in which we, through different visualisation experiments, approximated how colour-changing concrete would appear in different architectural configurations, from varying angles and distances etc. This design case is presented in more detail in the included paper *Maps for design reflection [3]*. These experiments were well aligned between the design and research programs. However, there were also divergences with regards to the research and design programs. As researchers, we had a keen interest in breaking new ground, both with regards to exploring new technologies and with regards to employing existing interactive technologies in new and innovative ways. Whereas the architects shared our interest in breaking new ground, they ultimately had to answer to contracting authority and abide by the deadline and the rules of the competition; furthermore, they were driven towards the end product, the museum building, rather than by research questions. For this reason, we were initially frustrated by the decision to focus on exploring the potentials of employing colour-changing concrete in interaction since we felt it cut off a number of alternative and interesting avenues for research. However, through subsequent design events and discussions we identified a number of interesting research opportunities within this seemingly restrictive frame and we were able to align our interests with those of BIG in further experiments.

The program and experiments in this specific design case clearly did not provide an exhaustive answer to my general research question, indeed I doubt that any single program can do so. However, it did provide valuable insights that, combined with other programs that I have explored, led me closer to a response to the question. I must state the research question that I have posed is not intended to generate a concrete and exhaustive answer, rather the question is there to guide and frame research inquiries that can result in insights and contributions on several levels. Borrowing from the notion of wicked and tame problems, my research question can be construed as a *wicked question*, which in return is more likely to result in wicked answers, rather than tame ones. The wickedness of my research question stems from the fact that it encompasses the interplay between a number of concepts that are in themselves complex, i.e. conceptualization, design, use, engagement, interaction, and environment. In research, these concepts can be addressed individually and in combination in a number of ways, accentuating different aspects of the components and their interrelations.

I also wish to note that the question-program-experiment constellation is used first and foremost to clarify my work; my PhD project has not been guided by it from the outset, rather I have brought it into play in

the latter phases as a way of making sense of and explaining the interconnected projects, initiatives and reflections in my work. To some degree, programs and experiments in my work have been overlapping, and to an even larger degree, they have inspired each other, such that insights from one program or experiment have been brought into subsequent programs and experiments.

3.3.2 RESEARCH THROUGH DESIGN: ITERATION AND EMERGENCE

Within this frame of question-program-experiment, I will now address the notion of research through design in my PhD work, focusing on the type of activities it entails, and what the research perspective implies with regards to the role of the designed interactive installation or environment. In order to elucidate this, I will draw upon a model of research through design developed in the paper *Staging Urban Interactions with Media Façades [6]*. In the case reported on in this paper, CAVI and Media Façades collaborated with *Concert Hall Aarhus*, *Martin Professional A/S*, *The Animation Workshop* and *Wall of Pixels* to develop *Aarhus by Light*, an interactive media façade for Concert Hall Aarhus. In my PhD project, I regard this project in light of my overarching research question, and the specific case can be seen as one instance of a research program. Beyond my own research question, our research interest in CAVI and Media Façades was also driven by a series of questions that could be more specifically addressed in the project, among these "how can the introduction of a playful media façade facilitate social interaction?" and "how does the introduction of a media façade alter the impression of a well-established architectural landmark?" These questions guided our design process, which can be represented as iterations between carrying out design research activities and developing and refining design artefacts, illustrated in figure 10:

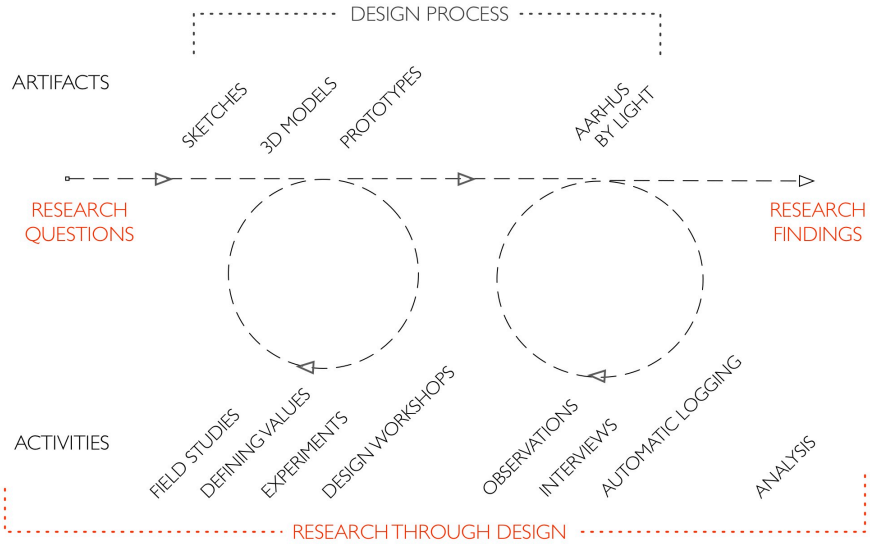


Figure 10: Research through design as iterations between activities and design artefacts in the Aarhus by Light case (Adapted from *Staging Urban Interactions with Media Façades [6]*).

In the early phases of the project, activities such as field studies, discussions about the experience of interaction, material and technological experiments, and design workshops drove the development of artefacts including sketches, 3D models, prototypes, and eventually the final installation, Aarhus by Light. When the installation was put into use, we then collected a number of qualitative and quantitative data through observations, interviews and automatic logging and analyzed the entire project on the basis of our research questions. Although the general structure of the process was planned, it was non-linear in the sense that emerging realisations and findings derived from the exploration of design artefacts would influence design activities and vice versa. As made clear from the model, the product of the design process, the Aarhus by Light installation, was not the end of the research project; rather it was a catalyst for knowledge generation related to the framing questions. Also, in the light of my larger research agenda (and the agenda of CAVI and Media Façades), Aarhus by Light was not a clean research slate, it was influenced by findings from preceding projects such as the Warsaw MoMA case, which had led us to insights regarding e.g. the importance of understanding viewing angles and distance, multi-user challenges, social interaction, the level of complexity of large-scale public installations etc. An important point to stress by way of this example is that although the research process was guided by a set of research questions and objectives, it was developed and refined in response to themes and insights that emerged through the process.

3.3.3 RESEARCH IN DESIGN: INVOLVEMENT AND PARTICIPATION

Returning to the definition of my approach as being research in and through design, I have to a large degree undertaken the "research in design" part through involvement in design processes, such as was the case in the two above-mentioned cases, the Warsaw Museum of Modern Art and Aarhus by Light. In this respect, my approach merges the "in" and "through" parts, i.e. "in" denotes that I am interested in the design process, and "through" denotes an involved and participatory approach inspired by designerly thinking.

On a practical level, one of the main reasons for my involvement in design cases is that the most efficient way of gaining access to empirical data from design processes is to be involved in them; in addition, this involvement establishes a closeness to the case, potentially yielding very rich insights. It is exceedingly hard to get access to such empirical data if one is not part of a design project, on the one hand because stakeholders in design projects may not be willing to divulge information, on the other hand because the nature and scope of the information would be very different from that obtained through participation. A further argument for involvement revolves around the fact that since the design processes that I am interested in deal with wicked problems it is not possible to predict how they will unfold in practice. Being part of a project enables me to frame and to a certain extent guide events on the basis of my research agenda. This approach presents ongoing dilemmas as to what one degree should try to steer the process. As an example, if I along with fellow interaction design researchers participate in a concept development design event alongside external stakeholders, e.g. architects in the two cases outlined above, we will have an

interest in exploring the potentials of interactive technologies. We will bring this to the table in the concept development phase and try to move towards the development of concepts that allow us to pursue this research agenda. I have found no unambiguous and general response to this dilemma, since it is highly project-dependent. There are, however, ways to remedy the issue. First of all, we (my fellow interaction design colleagues and I) never enter into these activities with subterfuge, we clearly state our research interests upfront and throughout in an attempt to align our research program with the design program of our collaborating partners. Second, we reflect upon the potential consequences both in advance (as far as possible), during and after the events. Third, we lay forward this involvement in our subsequent accounts, such as in academic publications and presentations. In general, we strive for rich descriptions of our involvement in these processes. Since a design process can be considered an ultimate particular, there are always tensions and issues that stand out and which we try to capture in these accounts.

3.3.4 ACADEMIC REFLECTION: THEMES AND CONVERSATIONS

In addition to the reflection that take place in relation to specific experiments and cases, such as the Aarhus by Light case, my overarching research question has served to frame reflections that go beyond the program or case in itself, and which point to broader themes. When I use the word reflection in this context, I do so in a two-fold manner: (1) it refers not only to solitary deliberations and analyses of findings and concerns, or to intra-research team discussions; (2) I also use it in the sense that by taking part in larger academic conversations and presenting my work in various fora, my findings and concerns can be reflected back through the prisms of other researchers' perspectives and positions. This reflection can occur within or with regards to specific design cases. However, the time-frame of a PhD project such as mine allows for the iterative exploration of a question through a series of research-through-design experiments from which themes can be derived, explored, and reflected through wider discussions. In the case of my work, such discussions have been directed at the different contributions in my project, i.e. case studies of design processes and resulting installations, methods and techniques for doing and reflecting upon design, and the pragmatist perspective that has been developed. Some of the reflections from the course of my PhD research are presented in the form of the publications included in the second part of the dissertation. The publications do not encompass the entirety of reflections - e.g. they have been supplemented by discussions following their publication and presentation, and there are a number of publications that have not been included - but they do constitute the core of my work, together with the discussions and reflections of the pragmatist perspective presented in chapters 4 and 5. Figure 11 illustrates the relations between design cases and themes in the question-program-experiment constellation:

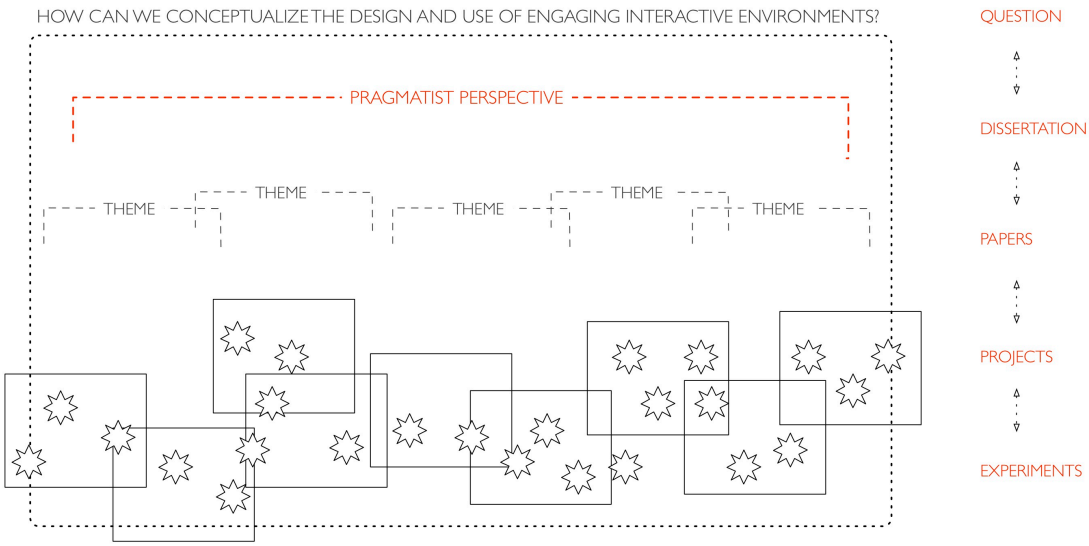


Figure 11: The elements and contributions of my PhD research project framed by an overarching research question.

In relation to my over-arching research question, the figure serves to show research inquiries into specific cases, as well as themes across cases. The exploration of themes across cases are not comparative studies as such, although some of them are 1) explorations of similar methods and techniques across design cases, 2) studies of either the same or related interactive systems in different settings, or 3) studies of different systems in the same or similar settings.

3.3.5 CRITERIA FOR DESIGN RESEARCH

The research approach that I have chosen may not be the easiest approach to represent, in the sense that alternative approaches from more established disciplines require less presentation and argumentation. Binder and Brandt lay forward this challenge: "Compared with other research fields the field of experimental design research is relatively new and at present many seem to be concerned with finding new directions to go with design. The easiest way to go for each researcher may appear to be to adopt 'conventional' strategies borrowed from research communities outside design research. The question is if this is the most powerful research strategy to chose?" (Binder & Brandt 2007 p 15). I have chosen differently, but in opting for an approach that is not yet well established, it is crucial to outline the criteria by which it – and the knowledge that springs from it – can be challenged, criticized and evaluated.

The main criterion for a research approach is ultimately that it should generate knowledge about the field of inquiry. Turning to Binder and Brandt, they argue that the knowledge that springs from experimental design research inquiries should be of a type that makes it accessible to and arguable among peers: "… knowledge production in experimental design research involves a traceable *genealogy*, an *intervention* in the world and the articulation of an *argument* for others to engage with." (Ibid. p 3, my emphasis). I regard this triad,

genealogy – the history or process of the case or experiment – *intervention* – the transformation of a situation as a consequence of the case or experiment – and *argument* – the resulting knowledge in a form that is contestable to argument from outside parties – as necessary components of research contributions within my chosen approach; they can, however, be presented in numerous ways and be of different weight, dependent on the type of project and forum in which they are laid out. It is the combination of these three components that make it possible for peers in the community to which the researcher contributes to understand not only what argument is being made, but also how and why the argument has come about. This allows for peers to make informed evaluations and criticisms of the contribution. It also allows for past contributions to be re-examined in the light of more recent findings as the field evolves and more research inquiries are carried out. To these criteria, I will add that *discipline* and *rigor* are also serious concerns in my research approach. Although I have positioned my approach as an alternative to hypothetico-deductive approaches such as those in natural sciences, the disciplined documentation of experiments, as well as the rigor of repeated experiments, should not be naïvely discarded because they spring from a different paradigm of inquiry. Indeed, I find that a foundational understanding of the nature of experimental design research will allow for interaction design researchers to enter into fruitful conversation with other disciplines, e.g. engineering-oriented HCI, and incorporate insights from those fields into their own work in an informed and reflected manner. Ludvigsen states that "Doing a scientific investigation from a research-through-design point of departure thus means to change the thesis as one engages the subject-matter context and possibly only have a general notion of direction instead of a solid research question or hypothesis before entering the context of investigation. In some scientific traditions, like ethno-methodology, this is the acknowledged way of conducting a scientific study, as the researcher instead enters with a field of interest and a basic curiosity" (Ludvigsen 2006 p 109). I agree with this understanding of the nature of research through design, but if anything, this only increases the need for disciplined accounts of the research process if one is to be able to straightforwardly present genealogy, intervention and argument.

A further type of criteria apply with regards to grounding and reflecting upon findings from doing research in and through design, namely that which Mackay and Fayard label *triangulation* in *HCI, Natural Science and Design: A Framework for Triangulation Across Disciplines* (Mackay & Fayard 1997). Triangulation refers to the application of several research strategies to the same subject matter in order to get a multi-perspective and – hopefully – more comprehensive understanding of it. In addition to getting richer insights into the field of study, triangulation may also serve to overcome blind spots among researchers and strengthen the credibility of arguments put forward. Thus, Mackay and Fayard propose that within an HCI research project, theoretical, empirical and design oriented perspectives could be combined to overcome the limits of each individual strategy. In some of the cases presented and discussed in this dissertation, this type of triangulation has been applied, e.g. in the Aarhus by Light case introduced above in section 3.3.2. Here, design-oriented strategies were supplemented by both quantitative and qualitative data collection and theoretically founded discussions concerning the research questions addressed. In addition to case-internal triangulation, I have

also strived for triangulation on a higher level of abstraction in my PhD project, namely in addressing themes across individual experiments and cases. This is arguably more in line with Goldkuhl's notion of *multi-grounding* (Goldkuhl 2004). Goldkuhl distinguishes between three types of grounding in the development of design theory: *theoretical grounding* refers to how a developed theory may be grounded conceptually by relations to other existing theories which may inform or substantiate the new theory; *empirical grounding* refers to how the new theory can be developed from and prove its worth in relation to practice; *internal grounding* refers to how the new theory can have an internal logic and cohesion that fortifies it. Whereas I do not claim to present a new design theory proper in this dissertation – rather I am developing and expanding upon an already existing body of work in pragmatism – I argue that I have sought both theoretical, empirical and internal grounding, and that this is demonstrated in the included publications in combination with this first part of the dissertation. The notions of multi-grounding and triangulation are echoed in Harrison, Back, and Tatar's *"It's Just a Method!" - A Pedagogical Experiment in Interdisciplinary Design* (Harrison, Back & Tatar 2006), which describes the teaching of multi-methodology in design education. Harrison et al. return to the discussion of science and design that has framed this chapter: "Scientific investigation does not and would not employ methods that are at variance with underlying principles. Designers have no problem doing just that if it solves the problem at hand. Each view of "methods" is correct in its own realm; however, this fast and loose treatment of theory can raise ethical concerns […] The instrumental drive of design should not be a license to use any process for any purpose. Therefore, it is essential that designers understand *reflection is not just a method, but an underlying principle*. At one level, reflecting on process is the ethical cost of pragmatic use of methods from very different paradigms. At another level, reflection is the essential integrator of knowledge." (Ibid. p 269). This account of reflection aptly expresses my own final position on the criteria for good design research: that methods and strategies should be chosen and applied on the basis of informed reflection upon the over-arching research agenda and the nature of design practice and research, and that reflection is the crucial component in integrating findings into knowledge.

3.3.6 POTENTIALS AND LIMITS OF MY RESEARCH APPROACH

The specific methods employed in the included papers have each been subjected to peer review and discussions in academic fora such as conferences and journals. In this light, I will use this dissertation to consider my own research approach – research in and through design – and the results it has yielded in my PhD project instead of addressing the papers individually. My approach, which relies to a large degree on involvement in experimental design cases, is a methodological choice. Although it is evidently responsive towards the framing conditions of my PhD grant, my choice has not been made on the basis of practical necessity but is rather in line with the pragmatist position that I outline and discuss. There are a number of ways to approach the study of interaction design, of which research in and through design is but one. Just as it holds specific potentials, e.g. with regards to generating deep insights into the design process through

engaged participation, there are also limitations to the approach which require attentive reflection. I will reflect on all of the above in the following.

From the outset, my research question is phrased in a certain way, which in turn affects the ways in which one can reply to it and the type of answers it can lead to. Borrowing from the notion of wicked problems, my question can be construed as a *wicked question*, in that it is very expansive and to some degree unfinalizable. For this reason, it invites wicked replies, rather than tame answers, in the sense that it is nearly impossible to imagine an exhaustive answer as to how to design an engaging interactive environment –the specific design is always ultimately dependent upon the distinct design situation. It is often the case in interaction design research that researchers intentionally construct wicked questions, especially in long-term projects. In a pragmatist understanding, this is akin to establishing tension and conflict in order to spur inquiry and engagement and as such wicked questions act as catalysts for knowledge generation.

Even though I address wicked questions and explore distinct cases, it is possible to identify patterns and general themes across cases and I have sought to do so in this dissertation. There are, however, limits to the specificity of these replies when addressing a wider range of cases. For this reason I have in many cases articulated design considerations and sensibilities, rather than design dictums. In addition to addressing general themes, there is value in presenting rich examinations of particular cases. In part, this can lead to deeper insights among authors as they construct meaningful accounts for others to digest, and in part, this can become part of the repertoire of the readership.

My approach of practicing research in and through design can be seen as a variant of case-study research. One obvious reason for carrying out case-based research within the field of interaction design is that in some instances, researchers such as myself seek to explore new technologies, or the use of existing technologies in new situations; this makes it hard or impossible to do large-scale comparative studies. Another reason – highly salient in my own understanding of experimental design cases as catalysts for knowledge generation – is that case-based research can lead to particular types of insights that are valuable in understanding complex situated practices, such as that of designing engaging interactive environments. In *Five Misunderstandings About Case-Study Research*, Flyvbjerg (2006) dissects what he labels "the conventional wisdom about case-study research" (Ibid. p 220), which holds that "a case and a case study cannot be of value in and of themselves; they need to be linked to hypotheses, following the well-known hypothetico-deductive model." (Ibid. p 220). In contrast, and in line with my own position, Flyvbjerg commends "the closeness of the case study to real-life situations and its multiple wealth of details", stating that this closeness is important not only because it offers a *nuanced perspective* on situated practices, but also because it furthers the *researcher's competence*. The second point is central to my situation, considering the fact that a PhD project is in essence an educational process of becoming a researcher. Flyvbjerg's position is that case studies hold less esteem than they should in comparison to other types of research, especially when dealing with ultimate particulars: "Predictive theories and universals cannot be found in the study of human affairs.

Concrete, context-dependent knowledge is, therefore, more valuable than the vain search for predictive theories and universals." (Ibid. p 224). Two further points made by Flyvbjerg are worth bringing to light. First, that "The case study contains no greater bias towards verification of the researcher's preconceived notions than other methods of inquiry. On the contrary, experience indicates that the case study contains a greater bias towards falsification of preconceived notions than toward verification." (Ibid. p 225) This tendency towards falsification plays into an observation I mentioned in the introduction, namely that the position of being a researcher in a collaborative design project can be a privileged position, since the products from design processes may fail in practice, yet still yield important insights for the researcher. This has been the case in my own experience, for instance in the design and analysis of a department store window installation, reported on in *Dynamically Transparent Windows* (Dalsgaard & Halskov 2009), which, due to its lack of success in practice, led to numerous challenges to and reflections upon our initial hypotheses. Second, that case studies may not be easily condensed: "It is correct that summarizing case studies is often difficult, especially as concerns case process. It is less correct as regards case outcomes. The problems in summarizing case studies, however, are due more often to the properties of the reality studied than to the case study as a research method. Often it is not desirable to summarize and generalize case studies. Good studies should be read as narratives in their entirety."[13] (Flyvbjerg 2006 p 241). Whereas I agree with Flyvbjerg's position that there is value in considering the good case study on its own merits, I also find that it is of great value to have a research question whose frame expands further than the program of the individual case study and thus invites academic reflection on broader themes. This prompts the researcher to explore recurrent patterns and may result in richer and more multi-faceted understandings of the subject matter of research.

In addition to presenting an argument that is well documented and contestable to others, one of the key challenges is to maintain a *critical, reflective stance* towards one's own work, to challenge the program, and potentially the framing questions. This is the responsibility of the individual researcher, as well as the research community, and this critical stance is strengthened by triangulation and documentation. I have already outlined and discussed the criteria of genealogy, intervention, and argument, however they deserve a further comment in parallel with the notion of triangulation. As stated, I find it both necessary and enlightening that interaction design researchers make clear the process by which they reach their findings, as indicated by the notion of genealogy and argument, and the position that the argument should be contestable. One argument for such transparency, in combination with triangulation of research methods, is to counter or eliminate bias. On the basis of my own work, I am, however, not of the conviction that this

[13] Within the field of interaction design, Dourish has recently examined a similar line of argument in *Implications for Design* (Dourish 2006).

fully eliminates bias, neither that elimination of bias is feasible given the nature of research in and through design, as the researcher's active involvement in design projects is always motivated and guided by a research agenda.

Instead of considering elimination of bias to be the main concern, I regard the value of triangulation, combined with clear documentation and argumentation, to be (1) that it openly presents the research agenda, (2) that it alleviates the problems of blind spots that result from adopting one specific perspective, and, in continuation, (3) that multiple perspectives offer opportunities for gaining and presenting richer understandings of the field of inquiry. One way of triangulating is to employ alternating research methods in the same project. As an example, in the abovementioned Aarhus by Light case, we combined quantitative data from e.g. data logging and interaction heat maps with qualitative data from e.g. interviews and in-situ observations in order to address our research questions. Another way of performing triangulation is to employ different strands of theory to illuminate different aspects of a subject of inquiry. An example of this from my own work is found in *Performing Perception [7]*, in which we combine theoretical insights from HCI, phenomenology, sociology, and performance theory in order to establish an understanding of the experience of interaction. As I will argue in the following chapters, I present a pragmatist perspective that offers a coherent conceptual position for addressing key concerns for interaction design. This perspective has emerged through my ongoing involvement in and reflection upon the experimental design cases in light of my framing research question; as such, it has been both informed and challenged by the insights from the individual cases and publications. Given the scope and frame of this dissertation, I have chosen to focus on and develop the pragmatist position; however, it is not an exclusive position, and just as it has been influenced by the multitude of perspectives in the cases that I have been involved in, it could be interesting to explore further how it can be supported, supplemented, and challenged by other positions.

3.4 EXPERIMENTAL DESIGN CASES IN THE PHD PROJECT

During the course of my PhD project, I have been engaged in a number of diverse experimental design cases, most of them framed by the three research projects *Experience-oriented Applications of Digital Technology in Knowledge Dissemination and Marketing*, *Media Façades*, and *Digital Urban Living*, although I have also partaken in experimental prototype design outside of these during the three years. In the following, I will account for a selection of these experimental design cases[14]. The cases have been selected on the grounds that they exemplify the broad scope of interactive environments that I have studied during the course of the PhD project. The selected cases are all discussed in the included papers and are as follows:

[14] My presentation of the cases borrows from descriptions first presented in the book chapter *Experiential Design: Findings from Designing Engaging Interactive Environments* (Dalsgaard 2008b).

- The Gum Façade
- Balder's Funeral Pyre
- Silence and Whispers
- Aarhus by Light
- Warsaw Museum of Modern Art

Three of the cases, the Gum Façade, Balder's Funeral Pyre and Aarhus by Light, have been produced and put into use as final products; Silence and Whispers was developed and tested at a mock-up / prototype level; the Warsaw MoMA was developed as part of a comprehensive proposal for an architectural competition. Due to these incongruences, as well as the very diverse scope of the installations and environments, no directly comparable evaluations have been carried out. Rather, each installation has been evaluated on its own terms. This notwithstanding, understandings from early projects have informed my inquiries in later projects. An overview of the cases is presented in figure 12:

	GUM FACADE	BALDER'S PYRE	SILENCE & WHISPERS	AARHUS BY LIGHT	WARSAW MOMA
SCALE	Medium: Wall	Medium: Corridor	Large: Tunnels	Large: Facade	Huge: Building
DOMAIN	Trade show	Literature center	Cultural heritage site	Concert hall	Art museum
NUMBER OF USERS	1-10	1-5	1-10	1-15	1-1000
DURATION OF USE	30 sec - 5min	30 sec - 5 min	5 - 30 min	1 - 15 min	1 min – 3 hr
SITUATION	Passing by	Obligatory exhibition passage point	Lingering in park	Concert hall visit or lingering in park	Museum visit or passing by
INTERACTION INPUT	Facial camera tracking	Floor pressure sensors	Audio / Speech	Silhouette-based camera tracking	Movement-based camera tracking
INTERACTION OUTPUT	User-controlled spheres in 3D space	Multiple video projections (of fire engulfing users)	Audio / Speech	Silhouettes rendered on large-scale LED facade	Thermo-chromatic concrete
INTENTIONS FOR DEVELOPING THE INSTALLATION	Grab attention Stand out	Convey solemn atmosphere Give pause for reflection	Convey atmosphere and richness of place Promote story sharing	Alter perception of architecture and place Social interaction	Alter perception of architecture Seamless yet outstanding integration of IT
CONTENT	Simple: Spheres in 3D gum universe	Simple: Visualization of fire	Complex: Place-specific stories	Medium: Creatures Cityscape	Complex: Navigation Artwork and data visualalization

Figure 12: Overview of cases reported on in this dissertation. Adapted from (Dalsgaard 2008b)

Before I offer a more detailed account of these cases, I will briefly introduce the most prominent methods and techniques that I have relied upon in my research in and through design. I will not offer descriptions of

how these techniques were applied in the individual cases; to the extent that these methods and techniques have been employed to generate research findings and knowledge, they have been treated in the papers in the particular context in which they have been used. Instead, this overview suggests the general approach to experimental interaction design that I (or in many cases we, referring to myself and my collaborators in the respective cases) have employed in light of my over-arching research agenda. Most of the techniques are well known within the field of interaction design; however, a subset of the techniques have been developed or refined in my work. These are inspiration card workshops, maps for design reflection, and the micro-analytical transcriptions employed in the publication *The emergence of ideas [2]*.

Domain studies: These studies were typically carried out either in the early stages of design processes in order to gain an understanding of the frame for design, or after prototypes and installations were put into use in order to evaluate the outcome of these interventions. Some of the techniques employed in these studies were in-situ observation and qualitative interviews.

Ideation and concept development workshops: This covers an array of early design events set up to facilitate idea and concept development, often with the participation of collaborating stakeholders and/or potential users. The inspiration card workshop technique belongs to this category and has been developed as part of my research.

Experiential value discussions: In additional to more traditional design discussions, we have in many cases set up focused discussions about experiential qualities and values with stakeholders and/or users. These discussions have been directed at formulating intentions and values for guiding design decisions. We have not employed a specific method for doing so, though this would definitely be worth exploring in the future.

Sketching: This refers broadly to activities in which imagined future designs are visualized and iterated upon if deemed interesting and valuable. In addition to traditional pen and paper sketching, this also encompasses 3D renderings, animations, and virtual video prototypes (Halskov & Nielsen 2006).

Mock-ups and prototyping: The development of mock-ups and prototypes, by which a concept are made manifest in the design process, typically occur after exploring a design concept through sketching, and allows for inquiries into material properties and interaction types. There are also instances in which these techniques are employed before or in parallel with sketching, e.g. when employing technologies with hitherto unexplored properties.

Design interventions: This refers broadly to instances in which prototypes and installations have been introduced into use domains with the agenda of generating knowledge in relation to my research agenda.

Maps for design reflection: This refers to three types of maps, namely overview, strand, and focus maps, developed as instruments to support design researchers' exploration of design processes. These are treated in detail in the eponymous paper.

Micro-analytical transcriptions: Employed in subsequent investigation of design processes, this refers to the detailed documentation and analysis of ideation events, particularly inspiration card workshops; this technique is treated in more detail in the paper *The emergence of ideas [2]*.

Having outlined these techniques, I will now introduce the primary experimental design cases of my PhD research project.

3.4.1 GUM FAÇADE

The Gum Façade (also treated in *Performing Perception [7]*) is an installation developed for and in collaboration with Gumlink, a large, international chewing gum research and manufacturing company, for their booth at the world's largest annual candy and sweets trade show in Cologne, Germany.

The gum façade is placed along one of the exterior walls of the booth. It consists of four screens connected to form one large display. Above the display, a camera tracks people who approach or walk past the stand. The video feed from the camera is processed by software that identifies faces. The images of faces of passers-by are then captured and represented live, in the shape of orbs on the display. The orbs exist in a 3D space showered by small gum tablets. By moving around in front of the display, users control the orbs that interact with the showering tablets and other orbs. The purpose is to create attention and attract visitors who may otherwise not notice the stand, and the intended use-time for the console is 30 seconds to 5 minutes. The main intentions for creating the installation were to catch the attention of bypassing convention visitors while providing a brief an introduction to Gumlink products and services.

Figure 13: The Gum Façade in use at a trade show.

The use context for the installations, the sweets convention, can be characterized as being simultaneously bustling and somewhat serious and restrained: A large number of visitors are present, however they are all there for business purposes (the convention is professional and not open to consumers), and as such observe certain formal behaviours, both relating to dress-codes and behaviour. The users and the use context, coupled with the Gumlink company values, thus put certain constraints on the type of installations that would fit into the domain, and the experiential values defined as conveying an image of a serious company while emphasizing Gumlink's standing as hi-tech company driven by innovation. The means of engaging users were fairly straightforward, namely mirroring the face of passersby in the spheres, providing a simple gameplay, and inviting social interaction among passers-by. The Gum Façade was moderately successful in that it functioned quite well technically and served well as an ornamentation of the Gumlink stand; however, few visitors engaged in interaction, likely due to concerns about losing face in a professional business environment.

My involvement in this case encompassed domain studies at the convention one year prior to the launch of the installation, preparation of and participation in several concept development workshops, various meetings with stakeholders, sketching of design ideas, evaluation of mock-ups and prototypes, and observations of the Gum Façade in use at the convention.

3.4.2 BALDER'S FUNERAL PYRE

Balder's Funeral Pyre (also treated in *Designing for Inquisitive Use [4]*) is an interactive environment designed for and in collaboration with 7th Heaven, an organization whose objective is stimulate reading among children. The environment was custom designed for a centre for Scandinavian children's literature as part of a series of interactive installations in which visitors experience settings and moods of the stories from Norse mythology. The Balder's Funeral Pyre installation is a 7 meter long and 1.5-meter wide corridor, in which one of the sides is a 6 meter long and 2 meter high rear projection of fire. The fire is digitally produced using a particle system with hundreds of bit map images of fire, which together with 14 on/off pressure sensors in the floor enable interaction with the fire. When no one is in the corridor, the flames glow low above the floor, but when someone enters the corridor, a lager fire erupts where the person is standing. As the person proceeds down the corridor, more explosions erupt near them, and eventually the person is immersed in flames.

Figure 14: Users explore Balder's Funeral Pyre

The main intention of the environment is to convey the story and mood of Balder's funeral at sea. Balder is a god figure from Norse mythology, in which his death marks a dramatic narrative event: Balder is killed, and this spells the beginning of the end of the mythological world, culminating in the apocalyptic Ragnarok that lays waste to the heavens and the earth. At his funeral, Balder's body is placed upon a ship that is ignited and set off to sea.

In collaboration with 7th Heaven, we explored and developed a set of experiential values to underscore this story: Convey an atmosphere that instils a solemn mood to emphasize the importance of the story and provide room for reflection upon what it means in the broader context of Norse mythology. The most direct means of engagement is the concrete experience of being slowly immersed in flames when entering and moving through the corridor. 7th Heaven operate with a general strategy of conveying moods and atmospheres and hinting at story elements rather than retelling stories word by word; this is intended to encourage children to read the stories themselves. Thus, the environment creates a link to users' pre-existing knowledge and experiences, partly by employing the imagery and evoking the mood of the specific story, partly through placing the installation as a passing point at the middle of the children's' movement through the literature centre, mirroring how the story is in the middle of the over-arching narrative of Norse mythology. The environment was moderately successful: users responded very well to the final concept in testing, however the final production was marred by a limited budget for which reason it was perceived as somewhat unfinished.

My involvement in the development of Balder's Funeral Pyre consisted of preparation of and participation in concept development workshops, experiential value discussions with stakeholders, sketching of design ideas, and evaluation of mock-ups and prototypes.

3.4.3 SILENCE AND WHISPERS

Silence and Whispers (also treated in *Designing for Inquisitive Use [4]* and *Peepholes as Means of Engagement in Interaction Design [5]*) is a conceptual mixed reality installation created in 2006 as a cross-disciplinary collaboration between four interaction design researchers, including the author. Silence and Whispers was developed and located on Suomenlinna, a series of islands in the Helsinki harbour entrance. Suomenlinna served as a naval fortress and 1748 until the end of World War I, and simultaneously the islands housed detention camps. Today, there is a close-knit community of inhabitants on the islands that also serve as one of the most popular public recreational area in Finland. Furthermore, Suomenlinna hosts an open prison facility. The primary intention underlying the design of Silence and Whispers is to collect and convey stories that reflect this multi-layered cultural history. Near King's Gate on the southern island of Gustavssvärd, faint whispers emanate from a shadowy cave. When visitors step inside the cave, they hear audio fragments of ominous stories and folklore from Suomenlinna. These stories, collected from resident islanders and visitors with strong relations to Suomenlinna, tell of events and myths not presented in official historic documentation. In addition to the audio fragments, stories and rumours are written in chalk on the cave walls. Some written fragments retell the same stories as the audio snippets.

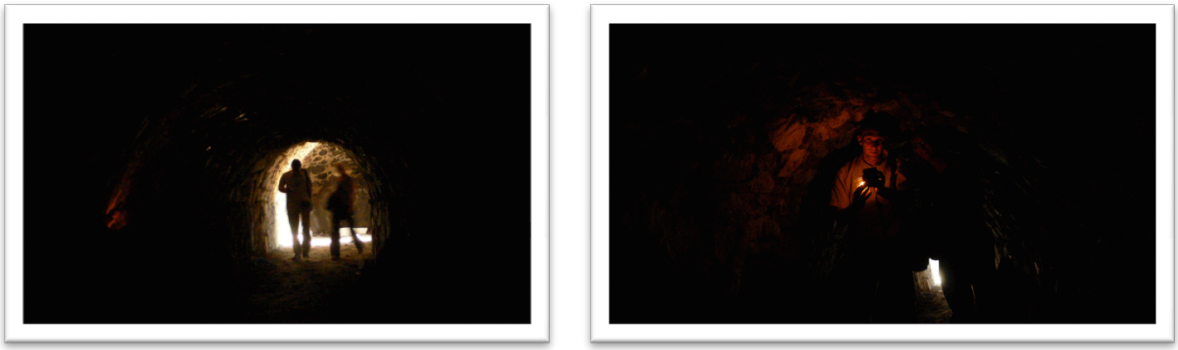


Figure 15: Visitors explore Silence and Whispers

The values underlying the design were to bring about a brooding atmosphere, to evoke a sense of respect for the history of the place, and to bring about a sense of co-participation. A primary way of engaging users is to play on curiosity through the fragmented unfolding of narratives - the further visitors move into the darkness of the cave, the more disturbing the stories, and in order to view the gloomiest stories, visitors can light matches to reveal them in short glimpses. Another way of involving users is the option for visitors to contribute themselves: Pieces of chalk are left in the cave, and visitors can write down their own stories. In this way, the installation evolves and expands over time as old stories are erased or washed away and new ones are added to the cave walls. It was planned but not implemented to include an audio input option for visitors to tell their own stories, which would then also be fragmented and spread throughout the caves. My involvement in this case consisted of domain studies on Suomenlinna as part of a PhD course, concept

development in collaboration with three other PhD students, and the setup and pilot test of the concept in the caves.

3.4.4 AARHUS BY LIGHT

Aarhus by Light (treated in *Staging Urban Interactions with Media Façades [7]*) was an interactive façade developed by CAVI for Concert Hall Aarhus, Denmark, in use in February and March 2008. The interactive façade consists of 180 m2 LED displays that are highly transparent and can be arranged in 2x2 meter sections. The displays form an organic shape that becomes part of the distinct architecture of the concert hall. Luminous creatures live in the façade on the backdrop of an ever-transforming skyline that mirrors Aarhus. On the path towards the concert hall, a number of sensors capture the movements of passers-by and transform them to silhouettes on the façade. In this way, users can contact and play with the luminous creatures, e.g. they may push them around or wave to them, and the creatures may respond by kicking or waving back. The tracking and animation software has been programmed from the ground up for the occasion. The character animation (done by animation company *Wall of Pixels*) as well as the skyline was made in Flash.

Figure 16: Aarhus by Light in use at Concert Hall Aarhus

The intention behind Aarhus by Light was to alter the perception of Concert Hall Aarhus (which has traditionally appealed to either children or middle-aged and old people, demographic groups which the concert hall seeks to expand) and the surrounding park (primarily used as a transit zone in the city rather than a place for resting and relaxing), as well as to experiment with the newly developed LED displays. The intended values were to promote playfulness and participation, which was primarily addressed through the possibility of interacting with the luminous creatures in the façade. In continuation of this, the primary means for engaging users were the gameplay and the social interaction in the interaction zones. Furthermore, the mirroring of users as large silhouettes on the façade served as a prominent and straightforward ways of catching the attention of passersby. Aarhus by Light was very successful in several respects: almost all visitors interacted with it, and a large majority enjoyed it, it generated a lot of attention and press of benefit for the

involved stakeholders, and finally it served as a fruitful research experiment both with regards to technical and user-oriented concerns. My involvement in this case consisted of domain studies in the Concert Hall park, preparation and participation in concept development workshops, 3D sketching and animation of design ideas, evaluation of mock-ups and prototypes, and observations and interviews of Aarhus by Light in use, and subsequent analyses of quantitative data.

3.4.5 WARSAW MUSEUM OF MODERN ART

This concept (treated in *Maps for Design Reflection [3]*), which contains three interactive elements, was developed by CAVI as part of a complete proposal for an architectural competition for a new modern art museum (MoMA) in Warsaw, Poland developed by BIG (Bjarke Ingels Group), a Danish architectural firm.

The interactive components of the museum all make use of thermo-chromatic concrete (TCC), a material that has the property of enabling a concrete façade to become a display in its own right. Simply put, this is a type of concrete that slowly changes colour as it is heated, and through controlling heating elements the building itself can act as a display. Three concepts were developed for the use of TCC in the Warsaw MoMA: (1) Visualization of exhibited artwork on ceilings and floors, (2) traces on ceilings and floors of visitors' movements throughout the museum, and (3) schematic visualizations on walls of visitor data and statistics. The concepts are illustrated in figure 17:

Figure 17: TCC used in three way in the Warsaw Museum of Modern Art

The intentions for the concepts were to examine the properties of TCC to create a seamless yet innovative and outstanding integration of interactive systems to visualize exhibition contents and to guide visitors through the traces, which would indicate the most popular exhibitions as well as "hidden treasures". The main values guiding this process was to present subtle transformations of the building though the use of TCC to alter the perception of architecture, and ultimately to convey the feeling of a living and mutable museum building responding to what goes on inside of it in terms of exhibitions and visitor actions. The BIG/CAVI proposal entered the final round of selections for the MoMA competition, but ultimately another proposal was selected; the TCC concept is however being refined in collaboration between CAVI and BIG. For this reason the environment may be considered a moderate success, however on the basis of the

information available at the present time, it is not possible to determine how well the final product would be received. My involvement in the Warsaw MoMA case consisted of preparation of and participation in concept development workshops, sketching of various interaction scenarios, including visual experiments regarding TCC, and the development of maps for design reflection on the basis of the design process.

3.5 SUMMARY

My PhD project has been conducted within the frames of three successive large-scale research projects, *Experience-oriented Applications of Digital Technology in Knowledge Dissemination and Marketing, Media Façades*, and *Digital Urban Living*. In these projects, I have been involved in the development of experimental design prototypes and installations in collaboration with external partners in order to explore my overarching research question. These successive projects have been carried out with a relatively stable core of interaction design researchers, for which reason we have been able to pursue and develop findings across projects and cases. I have carried out my research on the basis of an approach which I denote *research in an through design* framed by an overarching research question, which can be summarized as follows:

It is **research in design** in that my main locus of inquiry is the design process, particularly with respect to how the concerns treated in the preceding chapter challenge designers to integrate and reflect upon aspects such as experiential qualities and physico-spatial environments,

It is **research through design** in that I have been engaged in design processes and carried out designerly interventions in order to illuminate and tentatively reply to my overarching research question.

It is **framed by an overarching research question** in that my involvement in said projects have been tied together, and challenged by, ongoing reflections informed by existing research contributions, as well as developed by articulating key concepts and themes, which have again been subjected to reflection and discussion in the research community.

I have formulated and expanded upon my approach in some length in the chapter, since it appears that different approaches and foundations are still matters of debate in the interaction design research community, and that these debates have not ultimately been crystallized into a fixed set of research strategies. There are, however, a number of fruitful, recent contributions upon which I have built my approach, in particular the notions of question-program-experiment and genealogy-intervention-argument developed by Binder, Brandt and Redström, Stolterman's examination of the nature of design practice and research, and the notion of triangulation as presented by Mackay and Fayard. In laying out my research approach, I have also discussed the merits and limitations of this approach, including the nature of the contributions that it leads to. Finally, I have presented the major experimental design cases in which I have taken part, spanning in scale from wall-mounted reactive displays to large-scale, multi-user urban installations.

4 PRAGMATISM

This chapter introduces pragmatist philosophy with a special emphasis on the works of John Dewey. I lay out the fundamentals and key tenets of this school of thought and present selected themes from Deweyan pragmatism that are of particular importance for my research agenda, namely situation, inquiry, transformation, technology, and experience. My objective is to establish a conceptual foundation for understanding the design and use of interactive environments, and I explore these particular notions since they are at the core of Deweyan pragmatism, as well as being central to my own research. In the final part of the chapter, I outline how pragmatism has influenced the field of interaction design, particularly with respect to studies of reflective design practice, aesthetics of interaction, and philosophy of technology.

4.1 THE ROOTS OF PRAGMATISM

Pragmatism denotes a shared body of assumptions and perspectives that originated in the United States around the end of the nineteenth century. The founding fathers and major early contributors to pragmatism include Charles Sanders Peirce (1839-1914), William James (1842-1910), and later on John Dewey (1859-1952) and George Herbert Mead (1863-1931). Although pragmatism is often construed as one school of thought, there have been a number of different and to some extent incongruent interpretations of even fundamental assumptions in the field from the very beginning. As evidence of these debates, the very term pragmatism has been disputed from an early stage, and Peirce, James, and Dewey at various points objected to being labeled as pragmatists. James was first to use the term pragmatism in print, but attributed the coining of the term to Peirce. Peirce, however, described his own position as pragmaticism. In his own claim, this term was so unattractive that nobody else would be tempted to use it, "ugly enough to be safe from kidnappers" (Peirce 1931-58 vol 5 p 414), which would allow for Peirce to demarcate his own position as different from James'. Dewey used various terminologies over the course of time to describe his position, most notably "instrumentalism". Perhaps more important than the disagreements about the pragmatist label is the fact that core concepts within pragmatism also carry with them different meanings, depending on the strand of pragmatism one subscribes to. An example of special relevance here are the differences in Peirce's and Dewey's conceptualization of inquiry, as treated by Talisse (2002) in *Two Concepts of Inquiry*[15]. Besides these disparities, the early contributors addressed different subject matters in their work: Peirce contributed extensively to the study of semiotics and logic, James to philosophy and psychology, Mead to social

[15] Specifically, these differences relate to whether inquiry is directed towards the discovery of an antecedent, fixed reality (Peirce's position, according to Talisse (2002)) or whether it is the controlled reconstruction of existing condistions (Dewey's position).

psychology, and Dewey to a number of areas, including education, art and democracy. These different foci add further to the complexity of comparing their positions.

In order to clarify my own position, I will build on the work of Dewey, unless otherwise stated. With regards to terminological disputes, I will employ the term pragmatism, in part because this is a broadly recognized term, in part because terms such as instrumentalism today bear with them connotations that are somewhat at odds with Deweyan core assumptions. With the scope and focus of the dissertation in mind, I will not go into detailed accounts of differences and incongruences between Deweyan pragmatism and other strands. However, I find it prudent to initially outline some of the fundamental assumptions that are broadly shared by proponents of pragmatism, before moving on to a more thorough treatment of Deweyan pragmatism.

4.1.1 THE PRAGMATIC MAXIM

Pragmatism is so labelled due to the *pragmatic maxim*, sometimes referred to as the *primacy of practice principle*, a foundational proposition stating that the meaning of our conceptualizations of the world – ideas, theories, assumptions etc. - are evaluated on the basis of their consequences and implications in practice: our experience in practice-based action takes precedence over doctrines. This is a tenet that unites pragmatism in opposition to rationalist philosophy. Peirce describes the maxim in the following manner:

"In order to ascertain the meaning of an intellectual conception one should consider what practical consequences might conceivably result by necessity from the truth of that conception; and the sum of these consequences will constitute the entire meaning of the conception." (Peirce 1931-58 vol 5 p 9)

The maxim merges theory and practice in the sense that theories stem from practice – they do not exist in a separate and impermeable sphere of abstraction - and in that the value of theories rely on the ways they help us grasp and act in the world. In this light, theories are instruments for practice and must continuously be evaluated on this basis. The notion of "truth" (although a somewhat contested concept in different strands of pragmatism) is thus a mutable concept. Theories that are meaningful in present practice may not be so under alternative and future circumstances, and the concept of transcendental truth outside of that which we can explore in practice is without meaning. Since meaning and value of ideas are explored and evaluated through practice, the term *warranted assertability* is often used instead of truth in order to highlight their tentative nature. Although theories are tentative and relative and formed through subjective experience, not all theories are equally valid. On the contrary, theories are formed in relation to specific situations and circumstances; they are not grasped from thin air. Revisiting the themes from the preceding chapter, it is evident that in addition to serving as a theoretical perspective for analysis and discussion, pragmatism has also inspired my research approach.

4.1.2 EMERGENCE AND INTERACTION

Pragmatism can be construed as a philosophy of flux, in the sense that it regards the world as emergent and never fully finalized. The existence of the external world is very real, and the basic premise of our existence. However, this neither means that the external world is fixed and stable, nor that it will ever be so. On the contrary, Shalin, a contemporary sociologist, vividly describes it as "brimming with indeterminacy, pregnant with possibilities, waiting to be completed and operationalized." This marks another departure from rationalist philosophy, recognized by James: "… For rationalism reality is ready-made and complete from all eternity, while for pragmatists it is still in the making." [Shalin 1986 p 10]

Coupled with the pragmatic maxim, the notion of emergence implies an experimental view of and approach to the world: We cannot rely solely on given conceptualizations, for they will likely change their meaning in time. We can, however, establish temporary stability through inquisitive conduct in given situations. In other words, the world and phenomena in it are emergent, and it is in our nature to make sense of it in practice and form transient constructs in the attempt to attain stability. Pragmatism thus presents a highly situated perspective on human interactions, in which our reciprocal capabilities of action and reflection form the basis for sense-making. We often seek to reify sense-making; sometimes it is done through the formation of habits and recognition of patterns of experience; sometimes it is shared in communication; and sometimes it is externalized implicitly or explicitly in documents, artefacts, practices or social structures and constructs. Just as we are situated and draw upon our repertoire of habits and experiences, so are other phenomena around us situated, most notably other human agents, but also technologies and spaces which have also been shaped as tools and instruments for coping with the emergent phenomena of the world.

Pragmatism is highly influenced by Darwinism, as it puts to the fore these ongoing interactions between agent and environment. *On the Origin of Species* (Darwin 1859) was released in 1859 and was beginning to influence various strands of thought when pragmatism emerged, and as such pragmatism in itself can be seen as a situated formation of theory in response to emerging phenomena in the world. The influence is evident in that pragmatism dispenses with the rationalist subject-object dichotomy in favour of a reciprocal and dialogical understanding of the subject's dynamic relation with the environment through ever-evolving interaction in order to adapt to and transform his conditions.

4.2 THE PRAGMATISM OF JOHN DEWEY

John Dewey (1859-1952) is widely recognized as one of the most influential philosophers of the past century. This is in no small part due to his massive productivity (his collected works comprises 36 volumes) and his involvement in societal affairs beyond teaching and writing. Receiving his PhD from Johns Hopkins University in 1884, he moved on to a faculty position at the University of Michigan until 1894, after which he took up the position as head of the department of philosophy and psychology at the University of

Chicago. He resigned from this position in 1904 after disputes with the university administration and moved on to a professorship at Columbia University, where he taught until 1930. He remained a professor there until his death. During his years at Columbia, he served terms as president of the American Psychological Association as well as the American Philosophical Association. Outside of academia, he was, among other things, involved in the National Association for the Advancement of Colored People (NAACP) and the women's rights movement. His societal engagement managed to bring him at odds with both conservatives and communists within the United States, as well as with the Soviet Union, and to this day, his views continue to foster controversy[16].

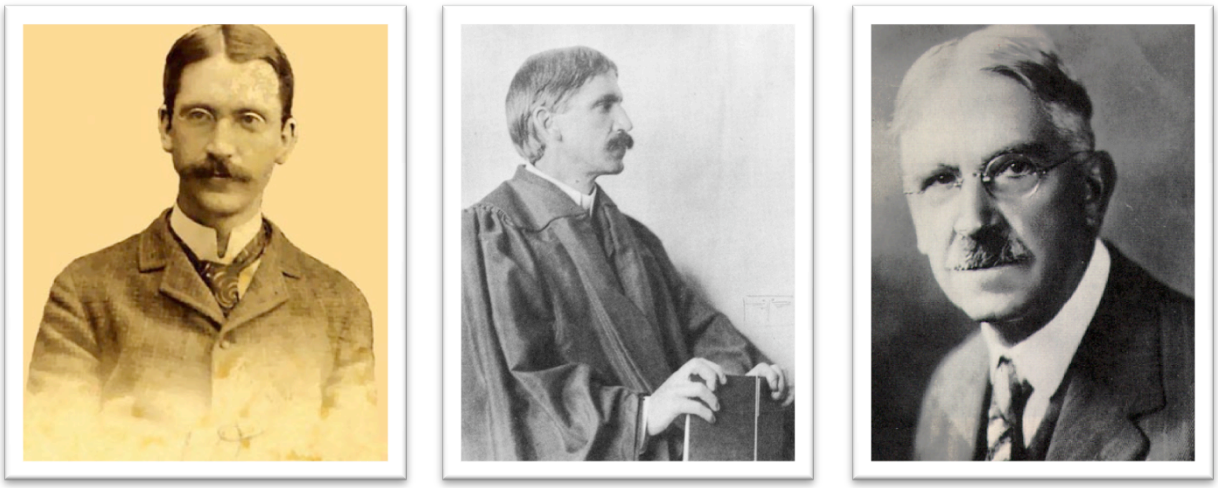


Figure 18: Portraits of Dewey circa 1885, circa 1902, and circa 1935[17].

Dewey's prose is often dense and complex to the modern-day reader; even in his time, this was a perception shared by a number of readers. As a cause for some amusement (and consolation, in so far as I am not alone in being challenged by the intricacies of Deweyan exposition) one Dewey's contemporaries, O. W. Holmes, a United States Supreme Court justice, described Dewey's' as "incredibly ill-written", however also conveying an "[unequalled] feeling of intimacy with the inside of the cosmos . . . . So methought God would have spoken had He been inarticulate but keenly desirous to tell you how it was." (Fisch 1951 p 8).

Dewey's most influential legacy is arguably his work on education, laid out comprehensively in *Democracy and Education* (Dewey 1916). His work in this area established his position as a major proponent of

[16] As an example, the conservative American newspaper Human Events in 2005 listed *Democracy and Education* (Dewey 1916) as one of "Ten Most Harmful Books of the 19th and 20th Centuries" - http://www.humanevents.com/article.php?id=7591

[17] Images retrieved from http://www.siu.edu/~deweyctr/, http://www.lib.uchicago.edu/e/spcl/centcat/fac/fac_img18.html , and http://hdl.loc.gov/loc.pnp/cph.3a51565

progressive education in the American school system. In continuation of the pragmatist principles laid out in the previous sections of this chapter, progressive education favours critical experimentation over rote learning, stressing individual development on the basis of motivation and interest in felt problems.

However, Dewey treated a number of other issues on the basis of his pragmatist principles, including democracy, psychology, morals and ethics, logic, experience and art. My objective for bringing Deweyan pragmatism to bear on interaction design is to gain understandings into the design of interactive environments that foster engaging and meaningful experiences. This focus has three evident implications for my reading and presentation of Dewey: one, that I am deliberately eclectic in drawing upon a selection of his works and concepts; two, that my work is influenced by and developed upon Deweyan pragmatism rather than being a direct application of it, since my subject matter is removed from Dewey both temporally and conceptually; three, that I introduce a selection of concepts and perspectives from the field of interaction design and put them into play with parts of Dewey's work, with the intention of both enriching interaction design practice and research and re-examining Deweyan concepts in light of contemporary challenges. In doing this, I seek to respect the core principles of Deweyan pragmatism, not only in presenting and treating the selected concepts in a forthright manner, but also by acknowledging the critical examination that all theoretical positions, including that of pragmatism, must be subjected to in order to understand their meaning and value in practice. In the following, I will lay out the Deweyan concepts that scaffold my pragmatist perspective on interaction design, namely situation, inquiry, transformation, technology, experience, and aesthetics. These concepts are interrelated and overlapping, as will be clear in their exposition. I have selected these concepts on the grounds that (1) they constitute core aspects of his position, and (2) they are interrelated and serve to form a cohesive conceptual scaffolding for addressing my research question. I treat the concepts in varying levels of detail in order to lay out the aspects that are most salient in light of my research agenda. As an example, I treat the notion of experience and the relations between artist, spectator, and work of art in some detail because these understandings from Deweyan pragmatism hold insights that may be brought to bear when conceptualizing the experience of interactive systems and the relations between designers, user, and system. In the remainder of this chapter, I will draw strongly upon Dewey's definitions of the concepts. Then, in chapter 5, I will unfold and develop my pragmatist perspective, and in particular the notion of inquiry, as it relates to my research into the design and use of interactive environments.

4.2.1 SITUATION

All human activity is situated. This may seem a common-sense statement, but Deweyan pragmatism follows this assumption further than most by stating that neither the subject, nor phenomena in the world, can be understood outside of a situation. For this reason, human thought and action as well as objects and events must always be understood in the larger context of the situation. A situation is constituted by the subject

and the surrounding environment, including others, artefacts and physico-spatial surroundings as well as social constructs. A crucial consequence of this proposition is that the situation does not exist outside of the subject, neither does the subject exist outside of the situation: the two are implicitly and reciprocally co-constitutive:

"What is designated by the word 'situation' is not a single object or event or set of events. For we never experience nor form judgments about objects and events in isolation, but only in connection with a contextual whole. This latter is what is called a 'situation'." (Dewey 1998 pp 66-67).

Situations may be perceived as more or less stable and comprehensible. To the extent that there is fit between the components in a situation, i.e. subject, artefacts, socio-cultural constructs and physico-spatial surroundings, a situation can be experienced as stable. In Deweyan terminology, this is a determinate situation. On the other hand, an indeterminate situation is one in which the assemblage of components is somehow mal-aligned, or in the words of Dewey, a situation in which "its constituents do not hang together" (Ibid. p 109). Situations can be very dynamic in nature. Since the world is inherently in flux, few, if any, situations remain determinate over the course of time due to the changes in the constitutive components of a situation or in their relations. When we find ourselves in indeterminate situations, we may experience them as being problematic and seek to transform them into determinate situations. The terms indeterminate and problematic are not interchangeable, for it is only when the subject articulates or relates to the indeterminacy of the situation that it becomes problematic: "The indeterminate situation becomes problematic in the very process of being subjected to inquiry." (Ibid. p 111) This leads to the presentation of a concept central to this dissertation: *Inquiry*.

4.2.2 INQUIRY

Inquiry is the mode of experience by which the subject approaches the indeterminate situation in order to transform it. In Dewey's wording, "Inquiry is the controlled or directed transformation of an indeterminate situation into one that is so determinate in its constituents distinctions and relations as to convert the elements of the original situation into a unified whole." (Ibid. p 108).

Our initial comprehension of a situation is based on our past experiences through which we have formed knowledge and habits. It is on this backdrop that situations may appear problematic when our habitual response does not lead to the expected outcome, and in that respect, the indeterminacy of a situations is what gives rise to thought. Dewey elaborates on this notion, stating that "Conflict is the gadfly of thought. It stirs us to observation and memory. It instigates to invention. It shocks us out of sheep-like passivity, and sets us at noting and contriving. Not that it always effects this result; but that conflict is a sine qua non of reflection and ingenuity." (Dewey 1899-1998 vol 14 p 207) In other words, a perceived tension or conflict is a prerequisite for initiating the process of inquiry, although it does not always have this effect.

The process of inquiry unfolds in the following manner: at the outset, the subject recognizes the problematic nature of the indeterminate situation. This instills the motivation for transformation of the situation. The subject then tries to identify the elements of the situation that causes indeterminacy. This can be seen as a tentative articulation of what constitutes the problem as well as the framing of the boundaries or parameters for the inquiry. Having some idea of the problem space, the subject then forms conceptualizations – ideas, theories and hypotheses - of how to transform the situation. The final and critical part of the process is to try out these conceptualizations in practice in order to see if they can move the indeterminate situation towards resolution. To the extent that the conceptualizations prove to move the situation towards determinacy, they are transformed from hypotheses into facts of existence. If they fail to do so, they are inadequate, and the subject must form and try out new hypotheses, though this time informed by the failure of previous assumptions.[18]

This description outlines the process of inquiry in the most general of ways. Due to the composite nature of situations, it is rare that problematic situations are resolved in such a straightforward manner. Often, the resolution of a problematic situation is an ongoing, iterative process that cycles between problem framing and articulation, hypothesis generation and practical evaluation. Addressing one component of the situation may cause other components to change in unforeseen ways, necessitating a reformulation and reframing of the problem. The resolution of a problematic situation may come about through the transformation of one, more or all of the components that it is comprised of. I shall return to this in the subsequent section, *Transformation*.

It must be noted that the terms conflict and problem are, in a Deweyan understanding, not inherently negative in the sense of being destructive, it may well be the opposite. In a more contemporary terminology, conflict and problem could in many situations be labeled tension and conflict. There are different degrees and types of conflict, spanning from minor inconveniences to the highly precarious. The process of addressing tensions and challenges through inquiry can be very rewarding. Partly because of the intended outcome of inquiry, namely the transformation of a problematic situation into "a unified whole" which leaves the inquirer with a feeling of fulfillment. Equally important because the process of inquiry in itself can be exhilarating and invigorating: "Such happiness as life is capable of comes from the full participation of all our powers in the endeavor to wrest from each changing situations of experience its own full and unique meaning."[19]

The use of the term subject must in this respect also be clarified, for it is not the case that the subject is passively subjected to the problematic situation. People often seek out these situations for themselves in

[18] This summary of inquiry is based on (Dewey 1938)

[19] This quote is frequently attributed to Dewey, however I have been unable to locate this exact phrasing in his writings.

many walks of life, for in many situations, it can be fruitful to cultivate conflict in order to move people to wider apprehension of the world through inquiry. One domain in which this is apparent is in problem-oriented education, e.g. in the education of design students who are confronted with problematic design challenges in order to spur reflection and learning. Another example is in the world of art, in which the balance between tension and resolution is of great substance: "Since the artist cares in a peculiar way for the phase of experience in which union is achieved, he does not shun moments of resistance and tension. He rather cultivates them, not for their own sake, but because of their potentialities, bringing to living consciousness an experience that is unified and total." (Dewey 1934 p 15-16)

By implication, pragmatism moves beyond the theory-practice dichotomy and proposes instead an understanding of knowledge as an active phenomenon formed through experimental action. Rorty, a present-day pragmatist, states that we should not "[…] view knowledge as a matter of getting reality right, but as a matter of acquiring habits of action for coping with reality". (Rorty 1991 p 1). Dewey himself shunned what he labeled the *spectator theory of knowledge* - the idea that knowing comes from passive observation of phenomena outside of the subject – and much of his work on education is a response to this view. Dewey's view, in contradistinction, is based on participation, formed in and through interaction with the situation. This transformative relationship is directed towards understanding and acting in response to the situation, and though we draw upon past experience and knowledge, this repertoire is challenged through inquiry, and may evolve or be expanded in the process. This insight has influenced the formation of my research approach as described in chapter 3. I will elaborate further on the notion of inquiry in chapter 5, as it is central to my pragmatist perspective on interaction design.

4.2.3 TRANSFORMATION

Transformation is the motivation for situated inquiry, turning indeterminate situations into determinate ones: "Situations are an intimate, interconnected functional relation involving the inquirer and the environment. The resolution of a problematic situation may involve transforming the inquirer, the environment, and often both. The emphasis is on transformation." (Dewey 1925-1953 vol 10 p 33).

Since the situation is constituted of subject, physico-spatial surroundings, others, artefacts and social constructs, it may be transformed through changes in one, more or all of these components and their relations. For instance, the subject may gain a better understanding of the situation through inquiry to the extent that he/she no longer experiences it as problematic; in this respect, it is the expanded horizon of the subject that is the main reason that the situation is no longer indeterminate. But it might as well be the case that the subject subjugates the other components in the situation to fit his/her intentions and thus resolves the situation.

Regarding the first instance, the transformation of the inquirer, Dewey states that "The self is not something ready-made, but something in continuous formation through choice of action."[20] In the present, I bear with me a personal history of past experiences and formed habits that guide my current experiences and actions, but who I am is not fixed and stable over the course of time, since my ongoing transactions in situations will change and expand upon my habits and repertoire of experiences. The Darwinian influence is evident here, in the sense that thinking is seen as the process by which the inquirer evolves and adjusts to the environment.

According to Dewey, this process of interaction is inherent to our being in the world: […] Interaction is a universal trait of natural existence" (Dewey 1925-53 vol 4 p 195). It is also through interaction that it becomes possible to examine the properties of self, others, surroundings, artefacts and social constructs: "Everything that exists in as far as it is known and knowable is in interaction with other things." (Dewey 1925-53 vol 1 p 138). Our interaction with these components is reciprocal and dialogical. Since it is not only the subject who brings with him a history of interactions, but also the other components in the situation, this interaction can be recalcitrant: people, things and places resist and object, and transformation is emergent and iterative. In transformative inquiry and interaction, technology plays a special role.

4.2.4 TECHNOLOGY

Dewey's definition of technology is more inclusive than the general conception of the term, in that he treats technology broadly as the use of instruments or means to reach an intended outcome. Technology is thus central to the transformation of a situation through inquiry. Technology has a dual nature in this regard, since it is at the same time constitutive of experience and a means of altering experience – it frames our understanding of the situation and at the same time supports our reconstruction of it. It supports our thinking and learning through doing, and as such play a role in constituting our selves.

Technology justifies and proves itself to be meaningful if it works in the way that we hypothesized it to. Although technology is defined relationally on the basis of situation, technologies are also understood as instruments that have a past and to which socio-culturally attributed meanings may be attributed - they are themselves situated and part of a larger context. Instruments gain meaning through use, and some evolve over the course of time, potentially in complex and specialized forms. Complex and specialized technologies allow for different ways of experiencing the world, expanding what we can understand and achieve.

This inclusive definition includes not mere physical tools, as well as semantic constructs. Most importantly, Dewey describes language as a meta-instrument, a "tool of tools", in the sense that it is the primary

[20] This is another oft-quoted saying from Dewey that I have been unable to precisely locate in his writings.

instrument for establishing meaning. Language is instrumental in the respect that it is not primarily concerned with correct representation, but with managing and controlling the conditions of the situation and steering it towards transformation. Inquiry, then, can be understood as a technological activity, where artefacts and other technological constructs serve as situated tools for experience and interaction. Instruments gain meaning for us through this use and are integrated into our habits and our repertoire of knowledge and experience. This applies to everyone's use of technology, and the social is inherently intertwined with the technological since technology frames and supports social interaction. I will elaborate further on the notion of technology in chapter 5, particularly with regards to the experiential and transformative traits of technology in inquiry.

4.2.5 EXPERIENCE

Experience is an emergent phenomenon that consists of both passive and active elements. The experiencing subject is dialogically undergoing the influences of the situation while acting upon them, and the connection between passive and active elements of the experience are key to understanding the nature and qualities of an experience. Experience occurs in a continuous process, however we make distinctions between various instances and may thus distinguish between *experience* – the ongoing flow and *an experience* – the specific instance:

"In an experience, flow is from something to something. As one part leads into another and as one part carries on what went before, each gains distinctness itself. The enduring whole is diversified by successive phases that are emphases of its varied colors." (Dewey 1938b p 45)

It is on the backdrop of a subject's habits and repertoire of knowledge and past experiences that something stands out as an experience – it is that which is different. Things may stand out because they are problematic and mark a situation in which the components do not hang together, but they may also stand out as being particularly fulfilling, giving the subject a sense of completion or resolution. There is no objective measure to the scope and duration of an experience. It is established in situated and embodied practice by the experiencing subject to the extent that when "[…] the material experienced has run its course to fulfillment" (Dewey 1934 p 206), we may speak of an experience. Those experiences that are unified and fulfilling, i.e. in which the components of the situation seem to fall into place and seem to hold a special meaning, are labeled *aesthetic experiences* by Dewey, and "In such experiences, every successive part flows freely, without seam and without unfilled blanks, into what ensues" (Ibid. p 206). Not all distinct experiences end in consummation, and those that do not form a completed whole are labeled *inchoate*, i.e. ambiguous or unfinished.

There is a potential interplay between aesthetic and problematic experiences, since some experiences that are problematic at the outset may turn out to be aesthetic through transformation. In this way, the subject

plays an active role in the formation of an aesthetic experience by overcoming or reconciling the misalignments of the situation through transformative inquiry. This underscores the active nature of experience: "Experience in the degree to which it is experience is heightened vitality. Instead of signifying being shut up within one's own private feelings and sensations, it signifies active and alert commerce with the world; at its height it signifies complete interpenetration of self and the world of objects and events. Instead of signifying surrender to caprice and disorder, it affords our sole demonstration of a stability that is not stagnation but is rhythmic and developing.." (Ibid. p 19).

Aesthetic experiences carry great importance in human existence, and Dewey dedicated himself to exploring this phenomenon in *Art as Experience* (Dewey 1934). He saw aesthetic experience as "pure experience" and suggested that the best way to understand and explore experience was to look to the experience that is art. In *Art as Experience*, Dewey makes a marked distinction between *art object* – a product – and *work of art* – a process. A work of art in its finest form is a heightened and refined form of experience. This experience emerges in making (as artists do) or encountering art (as e.g. an engaged audience does). If art is removed from this process, it is separated from the experience of felt life. Meaning, action and emotion meet in aesthetic experience: disturbances in a situation lead to emotional responses, initiating inquiry and action, through which meaning is established in the consummatory phase. Objects, including art objects, are significant to the extent that they serve as means for realising harmonious consummation.

This emphasizes the aforementioned notion that things and events gain meaning and significance through interaction. It is not the art object in itself, but rather the experienced art object, that constitutes the work of art. By which Dewey's pragmatist aesthetics can be characterized as processual and situated, as a property that emerges in interaction: "A work of art no matter how old and classic is actually, not just potentially, a work of art only when it lives in some individualized experience…[It] is recreated every time it is esthetically experienced." (Ibid. p 212) The potential for aesthetic experience exists for us exactly because the world is in flux, since our most intense experiences come from the reconciliation of problematic situations into harmony: "There are two sorts of possible worlds in which esthetic experience would not occur. In a world of mere flux, change would not be cumulative; it would not move toward a close. Stability and rest would have no being. Equally it is true, however, that a world that is finished, ended, would have no trails of suspense and crisis, and would offer no opportunity for resolution. Where everything is already complete, there is no fulfillment." (Dewey 1925-1953 vol 10 p 22).

Depending on the type of art, this interaction can take on different forms. It does not have to involve overt externalized action. It can work through imagination in the sense that the art object manifests an assemblage of meanings that an audience is challenged to reassemble through imagination. In this respect, the work of art on the part of the audience becomes a creative process in its own right: "Without an act of recreation the object is not perceived as a work of art. The artist selected, simplified, clarified, abridged and condensed

according to his interest. The beholder must go through these operations according to his point of view and interest." (Dewey 1934 p 54).

We may distinguish analytically between the artist as the producer of an art object and the audience as perceiver, but even though the artist can experience fulfillment through the process of bringing forth the art object, he should also be mindful of how the audience will perceive his art; otherwise, the result may be flat and meaningless. Artist, art object and audience are thus intrinsically connected, also in the artist's domain, for the artist himself is not just producer, but also vicariously audience. Dewey disposes of strict boundaries between the world of art and everyday experience. Rather, there is continuity between the two, and experiences in everyday life and work can have aesthetic qualities when engaged interaction in situations lead to consummation. Artistic production is also itself tied to the basic existential fact of being situated, since the artist responds to experiences of and in the world, and reworks it through material in the world: "The material out of which a work of art is composed belongs to the common world rather than to the self, and yet there is self-expression in art because the self assimilates that material in a distinctive way to reissue it into the public world in a form that builds a new object." (Dewey 1925-1953 vol 10 p 112)

4.3 PRAGMATIST CONTRIBUTIONS TO INTERACTION DESIGN

Before I fully unfold my own pragmatist perspective on the design of interactive environments, I will attend to other contributions to the field of interaction design that build upon pragmatism in order to position my own work and bring attention to additional sources of inspiration for my work on inquiry. As laid out in section 4.2, Deweyan pragmatism has influenced a number of domains such as education, aesthetics, and psychology. For obvious reasons, Dewey never brought his concepts to bear on the field of interaction design, however his influence is felt in the field, either directly or indirectly, in a number of contributions. Some of these reference Dewey explicitly, whereas others bear marks of his legacy intermixed with thinking from other strands. I will focus on three strands of influence from Deweyan pragmatism, relating to the design process, aesthetics, and the philosophy of technology.

Arguably, the most widely recognized proponent of pragmatist principles in the area of design research is Donald Schön. Schön's exploration of designers as competent practitioners in *The Reflective Practitioner* (Schön 1983) has been highly influential in understanding the design process and the competencies of skilful designers. This is also the case in my work, in which I bring a number of concepts and understandings from Schön into play in my analyses and discussions. For this reason, I will briefly introduce the most salient of these concepts. Schön developed the notion of "reflection-in-action" to describe the reciprocal process that occurs in design practice: "The practitioner allows himself to experience surprise, puzzlement, or confusion in a situation which he finds uncertain or unique. He reflects on the phenomenon before him, and on the prior understandings which have been implicit in his behaviour. He carries out an experiment which serves to generate both a new understanding of the phenomenon and a change in the situation." (Schön 1983 p

68) "Reflection-on-action", Schön argued, is another characteristic of the practice of competent practitioners, denoting the evaluation of what occurred in the design situation, why actions were carried out, and to what effect. To the extent that reflection is part of competent design practice, the design process can be understood as a learning process, in which both the designer and the design problem evolve. One of the key competences of design practitioners is "problem setting", which denotes process of establishing what constitutes the design problem and how it may be approached. In addressing design problems, designers make use of a number of "design representations", materials or media by which designers can explore potential design solutions before implementing them. Through practice, designers build up a "repertoire" of ideas and examples that they can draw upon in subsequent projects. When designers draw upon their repertoire, Schön denoted it "seeing as": "When a practitioner makes sense of a situation he perceives to be unique, he *sees* it *as* something already present in his repertoire. To see *this* site as *that* one is not to subsume the first under a familiar category or rule. It is, rather, to see the unfamiliar, unique situation as both similar to and different from the familiar one, without at first being able to say similar or different with respect to what." (Schön 1983 p 138) These influential conceptualizations in Schön's work can be understood as the application of pragmatist principles on the field of design, particularly with respect to the reciprocal relations between reflection and action, the experimental and iterative transformation of practice, and to the establishment and ongoing development of habits and knowledge. My work is clearly related to Schön's with regards to my keen interest in the design situation. Whereas Schön developed his own set of conceptualizations of design in general, I draw more directly upon Deweyan concepts and articulations and examine their implications with regards to interaction design. In particular, I explore the notion of inquiry in detail. In addition to the design situation, I also bring the pragmatist perspective to bear on the use situation and explore the process of inquiry in the encounter between people and interactive environments.

As recent years have seen an increasing interest in experiential aspects of interaction design, Dewey's pragmatist aesthetics have served as inspiration for a number of contributions. The most expansive treatment of the topic is McCarthy and Wright's *Technology as Experience* (McCarthy & Wright 2004), in which the authors build explicitly upon Dewey and Russian scholar Bakhtin to develop a "felt life" understanding of how technology is experienced. McCarthy and Wright identify four "threads" that make up experience, namely the compositional, the emotional, the sensual, and the spatio-temporal thread. In exploring these interwoven threads, they explore how people make sense of technologies in their life. The Deweyan understanding of experience has also featured explicitly in a number of papers in the interaction design research community, among these (Forlizzi & Battarbee 2004; Forlizzi & Ford 2000; Jacucci et al 2005). In particular, the distinction and interplay between ongoing experience and distinct experiences seem to inspire interaction designers who seek definitions and understandings of the concept of experience. More specifically, Dewey's notion of aesthetic experiences has featured in discussions within the field (e.g. Löwgren 2006; Petersen et al. 2004). Petersen et al. (2004) explicitly define their subject

matter as *Aesthetic Interaction – A Pragmatist's Aesthetics of Interactive Systems*. In doing so, they draw in part on Dewey, but more prominently on the work of Shusterman, a contemporary American pragmatist who has written extensively about aesthetics, e.g. in *Pragmatist Aesthetics: Living beauty, Rethinking Art* (Shusterman 1992) and *Body Consciousness: A Philosophy of Mindfulness and Somaesthetics* (Shusterman 2008). Among other things, Shusterman is known for his work on somaesthetics, which addresses the body-mind duality of aesthetics. Petersen et al. also highlight the unity of mind and body in aesthetic experience, which they – in line with Deweyan aesthetics – consider part of everyday life rather than removed from it; in continuation hereof, they position aesthetics as an integral part of artefacts rather than an decorative coating on a functional object.

Thirdly, Deweyan pragmatism is treated in strands of philosophy of technology. In particular, Hickman has explored Dewey's concept of technology in *John Dewey's Pragmatic Technology* (Hickman 1992) and *Philosophical Tools for Technological Culture: Putting Pragmatism to Work* (Hickman 2001). However, the uptake of these works, and to some extent of philosophy of technology in general, is limited within interaction design. This can appear paradoxical in the face of calls for common foundations within the field. When I nevertheless bring this third strand of influence to the fore, it is because of my interest in the role of technology in inquiry, a topic that Hickman has explored in length, and one that I will expand upon in the following chapter.

4.4 SUMMARY

In this chapter, I have introduced pragmatist philosophy and laid out the key tenets of the pragmatism of John Dewey in relation to my overarching research agenda. As a paradigm of inquiry, pragmatism presents a situated world-view that rests on the pragmatic maxim, asserting that practice is the essential test bed in which conceptualizations prove their value. The world of practice is emergent, in the making, through the ongoing interactions between subjects and surrounding environments. This position has influenced my own research approach, presented in the preceding chapter.

Dewey developed his strand of pragmatism, or instrumentalism as he often referred to it himself, within a number of fields, spanning education, democracy, art, experience, and logic. Given my focus, I have drawn out central concepts that can guide and illuminate inquiries in the field of interaction design:

Situation, the assemblage of subject and surroundings, including people, socio-cultural constructs, physico-spatial surroundings, and artefacts, which constitutes the frame and ground for human experience.

Inquiry, the reciprocal process of reflection and action by which we seek a unified and meaningful resolution of situations that appear to us as indeterminate and challenge our habitual understandings and behaviour.

Transformation, the shifts and changes that occur within and across the components of a situation over the course of time as inquiry progresses.

Technology, the instruments that are drawn into inquiry to scaffold it, acting in this respect both as constitutive of experience and as means of altering it.

Experience, a two-fold concept denoting on the one hand the ongoing flow of encounters that we take in, and upon which our horizon of meaning and habit is formed, and on the other hand the distinct occurrences that stand out on the backdrop of the ordinary.

In addition, I have cursorily accounted for ways in which pragmatism has influenced the field of interaction design, focusing on Deweyan influences in the Schön's work on reflective design practice, the development of a pragmatist perspective on experience and aesthetics of technology as treated by e.g. McCarthy and Wright and Petersen et al., and the understanding of technology as a core philosophical concern as explored by e.g. Hickman. In the following chapter, I will combine the concepts presented here in a pragmatist perspective on interaction design, which focuses on the notion of creativity and technology in inquiry, and employ that perspective in a discussion of the publications included in the second part of the dissertation.

5 A PRAGMATIST PERSPECTIVE ON DESIGNING ENGAGING INTERACTIVE ENVIRONMENTS

In this chapter, I employ a pragmatist perspective to discuss my research into designing engaging interactive environments on the basis of the papers included in the second part of dissertation. In some of the papers, pragmatism plays an explicit role, e.g. *Designing for Inquisitive Use [4]* revolves around a pragmatist understanding of inquiry, and *Peepholes as Means of Engagement in Interaction Design [5]* develops a pragmatically founded understanding of interactive resources that support and foster engagement. In other papers, pragmatist concepts are not explicitly presented or discussed, e.g. in *Inspiration Card Workshops [1]*. However, I will argue that pragmatism can serve as a common conceptual foundation for the body of my work. I rely on Deweyan pragmatism, as laid out in the previous chapter, in my discussions. In particular, I focus on the notion of *inquiry* as I find it to be a central unifying concept across the included publications. The chapter is structured accordingly: First, I introduce and outline my argument for pragmatism as a valuable perspective on interaction design, in addition to the prior chapter's outline of how strands of pragmatism have already been brought into and inspired the field. This leads me to address why I regard inquiry to be a pivotal concept in relation to my overarching research agenda. In doing so, I draw upon the pragmatist understandings laid out in the previous chapter on pragmatism. I identify two dimensions of inquiry of particular salience to interaction design, namely *technology* and *creativity*. In discussing the pair, I emphasize the *experiential and transformative nature of technology in inquiry*, and the *dialogical and distributed nature of creativity in inquiry*. These concepts serve to guide my discussion in the remaining parts of the chapter. I then discuss the three included publications that deal specifically with *inquiry in design situations*, namely *Inspiration Card Workshops [1]*, *The emergence of ideas [2]*, and *Maps for design reflection [3]*. This is followed by discussions of the papers that address *inquiry in use situations*: *Designing for Inquisitive Use [4]*, *Peepholes as Means of Engagement in Interaction Design [5]*, *Staging Urban Interactions with Media Façades [6]*, and *Performing Perception [7]*. Finally, I summarize the discussions in the chapter by outlining how the themes of the papers relate to the notions of experiential and transformative technology as well as dialogical and distributed creativity in inquiry.

The contributions of the chapter are:

1) A discussion of pragmatism as conceptual scaffolding for interaction design.
2) An examination of the included papers in a pragmatist perspective, offering a cohesive understanding of my PhD work through the guiding concept of inquiry.
3) A development of the concept of inquiry in relation to the design and use of interactive environments, in the respect that I am not only using the concept to illuminate my own work as laid out in the publications, but also re-examining and developing the concept per se in these

discussions, particularly through the articulation of experiential and transformative technologies, and dialogical and distributed creativity.

5.1 WHY ADOPT A PRAGMATIST PERSPECTIVE ON INTERACTION DESIGN?

In the previous chapters presenting the field of interaction design, research approaches, and core concepts of Deweyan pragmatism, there is a convergence of themes and concepts. I have refrained from weaving together these overlapping strands thus far in order to lay them out clearly and succinctly. However, it should also shine through that I regard pragmatism as a valuable perspective on the practice of and research into interaction design, and in the following I will outline my main arguments for this position.

First and foremost, pragmatism brings to the foreground the primacy of situated practice and the existential condition of being placed in a world of emerging and unfolding phenomena, a "world brimming with indeterminacy, pregnant with possibilities" (Shalin 1986 p 10). This is simultaneously a situation that challenges us and inspires us to transform it. At its core, interaction design is an interventionist discipline, one that seeks to bring about changes by developing and staging artefacts and environments that alter how we perceive and act in these volatile conditions. This is evident in e.g. (Binder & Brandt 2007) and (Binder & Redström 2006) in which intervention is emphasized as a key component in designerly inquiry. As such, pragmatism and interaction design coincide on a fundamental level; one might say that pragmatism is very amenable to designerly thinking, as presented in section 2.2. The interventionist and transformative agenda of interaction design seems well-aligned with the tenet of pragmatism that practice-based action takes precedence over doctrines. To re-iterate Harrison's broad characterization: "Scientific investigation does not and would not employ methods that are at variance with underlying principles. Designers have no problem doing just that if it solves the problem at hand." (Harrison, Back & Tatar 2006 p 269). This is well-aligned with Deweyan pragmatism insofar as it regards ideas and theories as tools for action; it is by putting them to work in practice that we can know their value and meaning.

Intervention is very closely related to experimentation, another confluent theme in interaction design and Deweyan pragmatism. In experimentation, reflection and action are intertwined as hypotheses and conceptualizations are informed by, directed at, and tried out in practice. This intentionality (in the sense of directedness towards the environing conditions) goes beyond immediate action; it also frames the evaluation of the hypothesis-action-transformation constellation. In pragmatism, evaluation of experiments is not based on immutable criteria. Experimentation affects not only things outside of an experimenting subject, such a designer or a user, it changes the whole situation including the subject; as a consequence, the subject may gain richer understandings of the situation and rethink the evaluation criteria. This mirrors the oft-used description of design as an iterative process in which designers move towards a better understanding of the problem through loops of interventions and experiments (e.g. Löwgren & Stolterman 2004).

One of my theoretical concerns, as outlined in the introduction, is that interaction designers should be reflective of both their own process as well as the interaction situations that unfold when the products of the design process are put into use in the world, and that a theoretical foundation that could provide insights into both of these situations would be valuable. By including and discussing publications that deal with the width of the design-use spectrum, my intention is to show that pragmatism offers such a perspective. Seen in relation to the frame of my PhD project – exploring the potentials of interactive technologies to foster engaging experiences in knowledge mediation environments – it is of particular interest to me that pragmatism offers rich descriptions of the interactive nature of experience and creativity, as well as of the role that technology plays as a tool for thought and inquiry. With regards to the design situation, I have addressed these notions in a number of studies regarding ideation and the various manifestations and transformations of design concepts throughout the design process. This is reported on in the included publications *Inspiration Card Workshops [1]*, *The emergence of ideas [2]*, and *Maps for Design Reflection [3].* With regards to the use situation, my research question has led me to explore in particular the notion of *engagement*. The notion of engagement is in itself a highly complex concept, and given the scope and frame of my PhD project, I have chosen to address aspects of it through the development of inquiry, which illuminates specific façets of engaging interaction.[21] Two of the included publications, *Designing for Inquisitive Use* [4] and *Peepholes as Means of Engagement in Interaction Design [5]*, deal directly with how an understanding of inquiry in a pragmatist perspective can inform the design of interactive environments that foster engagement.

With regards to the notion of engagement, Dewey's pragmatist aesthetics offers insights into the relations between artist and audience, and presents a distinction between art objects and works of art. The insights can be productively employed in understanding the relations between designers, users, interactive artefacts and environments. As introduced in section 2.2, a crucial dilemma in interaction design is the dialectics between tradition and transcendence (Ehn 1988). This tension between the existing and the potential is also central to the pragmatist understanding of creative action, in the sense that the subject's habits, repertoires and predispositions are persistently exposed to the flux of the environing conditions, prompting reflection and action that may establish a new, provisional equilibrium – potentially in ways that transform not only the environing conditions, but also the repertoire and predispositions of the subject itself. This process is inquiry.

[21] For a more encompassing and focused treatment of the concept of engagement in interaction design see e.g. Rozendaal's recent dissertation, *Designing Engaging Interactions with Digital Products* (Rozendaal 2007).

5.2 INQUIRY AS A PIVOTAL CONCEPT IN INTERACTION DESIGN

I consider inquiry to be the pivotal pragmatist concept for exploring my guiding research question: How can we conceptualize the design and use of engaging interactive environments? This is the case because inquiry is the creative and transformative process we undertake in order to change an incoherent or undesirable situation into a meaningful and unifying one by employing our own repertoire of knowledge and competences as well as resources in the situation. As an exercise, "inquiry" in this description can be substituted with "design", and it would be an equally fitting description. Moreover, the description can also apply to situations in which we experience engaging encounters with interactive environments, as e.g. the *Aarhus by Light* installation described in the included paper *Staging Urban Interactions with Media Façades [6]*. In other words, inquiry is a unifying concept in that it can be employed in analyses of both design and use situations.

In addition to the specific relevance of inquiry in my research project, there is also a broader argument to be made for a focus on inquiry, since it can be construed as a prototypical human mode of productive behaviour: "It is no overstatement to say that for Dewey properly controlled inquiry exhibits the most general traits of all other types of productive skill and that its artifact, knowing, exhibits the most general traits of all other successful artifacts." (Hickman 1992 p 19). This statement implies that insights from the study of inquiry in the design and use of interactive environments may inspire explorations of other types of productive behaviour, however it is beyond the scope of this dissertation to address this issue in detail. Restating Dewey's definitions of inquiry from this work, it is defined in the following manner:

"… the controlled or directed transformation of an indeterminate situation into one that is so determinate in its constituents distinctions and relations as to convert the elements of the original situation into a unified whole... The resolution of a problematic situation may involve transforming the inquirer, the environment, and often both. The emphasis is on transformation." (Dewey 1938 p 108).

Looking more closely at this definition, the first component of inquiry is indeterminacy, an experienced tension that instigates inquiry. Salient examples of indeterminate situations are design problems and constraints that interaction designers face, or users' challenging and surprising encounters with interactive systems. Inquiry unfolds in a creative manner as various resources and means are employed to resolve these tensions, e.g. interaction designers employ design materials to sketch out concepts and experiment with prototypes, or users explore the ways in which interactive installations respond to their actions. Converting the elements into a unified whole can e.g. occur as interaction designers establish a viable fit between the use situation, the physico-spatial form and the interactive characteristics of a product, or when users discover how to interact with an installation in ways they find meaningful and fulfilling in their context.

Dewey's most comprehensive treatment of inquiry, from which the above definition is quoted, is found in *Logic: The Theory of Inquiry* (Dewey 1938). Again, Dewey's non-standard terminology[22] requires a brief note to clear up any potential misunderstandings regarding the book's title: Just as one of the aims of inquiry is to establish actionable understandings rather than fixed representational knowledge, what Dewey seeks to present in *Logic: The Theory of Inquiry* is not a formal logical schemata to which inquiry adheres. Quite the opposite, it is an undertaking to define that there is a different and non-formalist logic to inquiry in practice. In *Pragmatism and Symbolic Interactionism,* Shalin (1986) describes this position accordingly: "What pragmatists and interactionists decried was the undisciplined use of abstract reasoning - the situation where, in the words of Rucker (1969 p 166), "fixed logics and formal systems of any sort become strait-jackets instead of tools for inquiry."" (Shalin 1986 p 12)

Following this position, what I try to accomplish in this chapter is not to pry from Deweyan pragmatism a formal model of inquiry that can be applied in a strait-jacket manner to the practice and research of interaction design. Rather, I employ a pragmatist understanding of inquiry as an inspiration to explore and discuss my work as laid out in the included papers. I do so in order to generate insights that respond to my research question. In doing so, I also seek to expand on the understanding of *technology* and *creativity* in inquiry. My reasons for addressing technological and creative aspects of inquiry are multiple: With regards to the concept of technology, I have an particular interest in the potentials of interactive technologies in knowledge mediation environments; however, it has also become clear through my PhD work that technology plays a crucial role in the design process, both in terms of initial project framing and in mediating, explorative, and transformative functions throughout. With regards to creativity, designing interactive environments is in essence a creative endeavour. Moreover, creativity also unfolds in users' encounters with interactive environments, and I argue that an understanding of the technological and creative traits of inquiry illuminate important aspects of engaging interaction. My focus on the aspects of technology and creativity in inquiry has emerged as prominent themes in ongoing and reciprocal processes of design experiments and reflection throughout my PhD work. My exploration of technology and creativity in inquiry can thus, in Schön's (1983) terminology, be seen as building up a "repertoire" that will scaffold "seeing as" in design and research situations, both for myself and for others. Lastly, curiosity is an important motivation for exploring these concerns, since the interrelations between technology and creativity are not yet fully developed and illuminated within the field. As will be clear in my exposition, the notions of creativity and technology in inquiry are interrelated and to some extent overlapping. E.g. some types of technologies can shape a designer's perception of a design challenge and guide his inquiries in certain directions, leading to design experiments in which transformative technologies facilitate the designer's creative dialogue with facets of the design problem.

[22] Dewey's non-standard terminology makes his work somewhat prone to misunderstandings and ambiguous interpretations.

5.2.1 EXPERIENTIAL AND TRANSFORMATIVE TECHNOLOGIES IN INQUIRY

In the design and use of interactive environments, inquiry is technological, and technology in inquiry is experiential and transformative.

Inquiry is technological: In a Deweyan understanding, technology is a broad and expansive concept, referring to the use of an artefact or a construct to carry out a task or to achieve an objective. Since we draw upon numerous resources – be they semantic, social or physico-spatial – that serve as instruments in the directed transformation of a situation, inquiry is innately a technological activity. This is one of the principal reasons why Dewey employed the term instrumentalism, rather than pragmatism, to denote his work. Hickman has explored the role of technology in Deweyan thinking in detail in *John Dewey's Pragmatic Technology* (Hickman 1992) and *Pragmatism as Post-Postmodernism: Lessons from Dewey* (Hickman 2007). In these works, Hickman emphasizes the role of technology, as well as the desired end result of inquiry which is not an answer as such, but a clearer understanding of the problem at hand: "At the conscious level, inquiry takes its start in situations that are doubtful, from which it seeks to shape well defined problems. It then uses tools of all sorts, abstract as well as concrete, to form hypotheses which it tests in the very existential arena from which the motivating difficulty arose" (Hickman 2007 p 37). Dewey makes no inherent distinction between physical and mental instruments, e.g. both an abacus and a memorized multiplication table are technologies. Although an instrument is defined as that which is employed by the subject in inquiry, technology extends beyond the individual and into physico-spatial environments and the social sphere. Architecture is technology to the extent that it facilitates certain types of practice and inquiry, and as well as many other technologies, it is social in that it is shaped by – and in return shapes – shared interests and practices. Also less tangible shared constructs can function as technologies, as explored by e.g. Moore in *The Technology/Inquiry Typology* (Moore 2006), in which it is proposed that even institutions and socio-cultural establishments may be construed as technology, to the extent that they are developed for an ongoing purpose. This latter and very expansive understanding of technology is beyond the scope of this dissertation. I will be focusing on technologies on a smaller scale from the perspective that an integral part of gaining and developing insights into the indeterminate world consists of the development of instruments that augment our capabilities of practical and reflective inquiry. I propose the term *inquiring instruments* to denote technologies that are employed to scaffold the process of inquiry. In a pragmatist perspective, the development of such instruments is integral to inquiry: "The important thing in the history of modern knowing is the reinforcement of these active doings by means of instruments … devised for the purposes of disclosing relations not otherwise apparent" (Dewey 1925-53 vol 4 p 70) An example of the development of inquiring instruments in my work is the three types of maps, treated in greater detail in *Maps for Design Reflection [3]*, that were developed in order to gain a richer understanding of the design of interactive components for the Warsaw Museum of Modern Art.

Technology in inquiry is experiential: In the view of instrumentalism, technology is not limited to being a means to an end, something that we employ to facilitate our actions in the world once we have a pre-formulated plan for how to transform the situation that we are in. Technology is always already present, both in our repertoires and habits formed from past experience, and in numerous forms in our surroundings. This pervasive nature of technology means that it also frames, directs, and scaffolds our experience of the world: "… technological arts, in their sum total, do something more than provide a number of separate conveniences and facilities. They shape collective occupations and thus determine direction of interest and attention, and hence affect desire and purpose." (Dewey 1934 p 345) As a simple example, the use of a word processor can be seen as a functional means to an end: you use it to put into print the sentences that you have formed in your head. This may hold true the first time you use a word processor; however, extended use of a word processor will alter the way you think about and engage in the writing process through the changes it affects on seemingly functional levels. This has been explored by e.g. Johnson who writes of the experience from an author's perspective in *Interface Culture*: "The computer had not only made it easier for me to write; it had also changed the very substance of what I was writing, and in that sense, I suspect, it had an enormous effect on my thinking as well." (Johnson 1997 p 145). I use the example of a word processor to illustrate that even technologies that are widely construed to be functional tools in fact frame and shape the experience of inquiry in which they are employed. These shifts in experience may be more far-reaching when we examine technologies that serve as instruments beyond what is regarded as purely functional, e.g. engaging interactive environments in knowledge mediation settings. One example from my own work regarding experiential technology in inquiry concerns the installation *Balder's Funeral Pyre*, described in more detail in the paper *Designing for Inquisitive Use [4]*. In the development of this installation, we worked with the stakeholders from the children's literature center to develop a set of considerations with regards to the experiential qualities that were to be conveyed by the installations. Two of the considerations that guided the development of Balder's Funeral Pyre stated that (1) the installation should not retell the story of Balder word by word, rather it should inspire children to recall the story if they already knew it, or inspire them to read it after visiting the center, and (2) that the installation should establish a solemn atmosphere in order to convey significance of Balder's death. On the basis of these considerations, the final installation served to set the mood of the story and create chains of association and recall.

Technology in inquiry is transformative: The value of technologies as they are brought into play in an indeterminate situation is the extent to which they support the transformation of a situation into a state of provisional balance and unity - technologies are significant in the sense that they have transformative potential in a given situation. Transformation by means of technology can occur in a number of ways. If we look at very brief spans of time, this can happen e.g. as the subject employs a stable instrument to transform some other component in a situation, as the subject changes the instrument itself, as the instrument changes automatically, or as the instrument transforms the subject. Many processes of inquiry, however, expand

beyond single operations such as these, consisting instead of a unfolding series of intertwined and reciprocal operations. This is certainly the case in complex situations such as in design projects or in the use of interactive environments. The interesting insight from pragmatism is in fact that transformation should not be viewed as a distinct event within the situation, but rather that transformation is systemic, spanning the whole situation as perceived by the subject. In practice, this often means that some or all of the constitutive components of a situation undergo transformations, and that a number of technologies are brought into play in this process. A noteworthy implication of this position is that it brings attention to the fact that just as we as subjects carry with us repertoires and habits formed through past experiences, so are technologies around us in their current crystallizations results of past histories. Physical tools are developed and refined over the course of time. Likewise, semantic technologies such as rules and guidelines – e.g. heuristics for web design – are developed in specific situations and must change as practices change in order to remain of value. Language, the "tool of tools", evolves in practice. Architecture transforms over the course of time; this is thoroughly examined by Brand (1994) in *How Buildings Learn: What Happens After They're Built*. Brand lays out how buildings consist of different "shearing layers" - foundation, structure, dividing walls etc. - and argues that "because of the different rates of change of its components, a building is always tearing itself apart." (Brand 1994 p 13) The notion of the shearing layers of a building is a pre-eminent example of systemic transformation, since it highlights the reciprocal interplay between subjects, practices, and technologies. The experiential and transformative aspects of technology are intertwined: as laid out above, the experiential nature of technology frames our present inquiry; however, it also affects transformations in the self. Recalling Dewey's position that "The self is not something ready-made, but something in continuous formation through choice of action", it follows that our use of technology is a constitutive component in our self-understanding since the technologies we rely on – physical artefacts, computational devices, social constructs, buildings and places, language etc. – shape our habits and repertoires. As an example from a design situation, articulations of design sensitivities and considerations such as those presented in *Designing for Inquisitive Use [4]* are a type of semantic instruments, which may be applied to a specific design challenge, as well as be adopted into a designer's repertoire over the course of time. As an example of transformative technologies in a use situation, the case of Aarhus by Light serves to illustrate how the introduction of an interactive media façade transformed the perception of a well-known landmark as well as the social practices surrounding it.

5.2.2 DIALOGICAL AND DISTRIBUTED CREATIVITY IN INQUIRY

In the design and use of interactive environments, inquiry is creative, and creativity in inquiry is dialogical and distributed.

Inquiry is creative: Inquiry is inherently a creative endeavor, since it marks out as a departure from habitual thinking towards a re-alignment of one-self and the environment in which alternatives to the present state

are imagined and brought about. Creativity, in a pragmatist perspective, is not solely a cerebral activity. It is instigated by and - to varying degrees - directed towards environmental conditions, and it is embodied and externalized through the act of creating. In combination with my studies in the included papers, this perspective leads to an understanding of creativity in the design and use of interactive environments as an emergent and situated phenomenon that comprises both action and reflection, and which arises as an interplay between the subject and the environment. Creativity is a common trait; it is not the exclusive domain of especially gifted creative individuals. This does not mean that everyone exhibit and explore creativity in the same extent, for the capacity for creativity may be honed, and we may be placed in, or actively seek out, situations that place demands on creative practice; indeed, honing the capacity for creativity is often accomplished by being in such challenging situations. Design situations are prime representatives of such situations, since they are characterized by wicked problems that challenge our creative capabilities and inspire resourceful inquiry. This is exploited in design education (e.g. Schön 1987; Harrison, Back & Tatar 2006), in which design competencies are developed as educators frame challenging situations for students and provide resources that support creative inquiry in order to hone creative design competencies. In such situations, design theories can be central resources for inquiry, by which their "warranted assertability" is appraised in practice. Creativity can also play an essential role in interaction situations as users try to make sense of what an interactive installation may mean to them in the situation, how they can engage it, how and why it may be a resource in itself, how and why it may demand other resources be brought into play in the situation, and what changes it may bring about through use. E.g. in the installation *Silence and Whispers*, reported on in *Peepholes as Means of Engagement in Interaction Design [5]* and *Designing for Inquisitive Use [5]*, users were presented with fragmented narratives in audio snippets and were prompted to creative inquiry in order to either assemble the fragments into a coherent story, or to fill out the blanks by use of their own imagination.

Creativity in inquiry is dialogical: The dialogical traits of creativity are, on the one hand, present in the reciprocal imaginative reflection and the act of creation, i.e. in the relation between thinking and doing. On the other hand, the dialogical traits are also clear and present in the relations between the subject and the environment that is approached creatively. With regards to the first of these traits, the environment is not a passive recipient to the actions of the subject, it responds to the subject as he tries to transform the situation in creative action. In *The Sciences of the Artificial,* Simon (1969), presents this iterative process as it unfolds in painting, in which "[…] every new spot of pigment laid on the canvas creates some kind of pattern that provides a continuing source of new ideas to the painter. The painting process is a process of cyclical interaction between the painter and canvas in which current goals lead to new applications of paint, while the gradually changing pattern suggests new goals." (Simon 1969 p 163). Schön (1983) has explored the dialogue in design by the label of "situational back-talk", stressing that designers need to (1) accept that back-talk is an intrinsic component in design, and (2) to embrace it as a resource for moving towards design solutions that are well-aligned with the specific situation with all of its particular tensions and challenges. The

dialogue between subject and environment is not limited to the design situation or the artistic process, although these may be exemplary domains of observing and exploring it. In my own work, I have found this "reflective conversation" (Schön 1983) to be a recurrent theme in design, but I have also found it to be an inevitable premise in use situations. One of the salient properties of interactive installations is precisely that they can scaffold this dialogue, either if installations themselves offer means of expression, or if they are otherwise present in the situation in which the installations are encountered. Means of dialogue are not present in all interactive installations; many installations that are interactive - in the broad use of the term - can be described as impressive rather than expressive in the sense that they woo audiences without offering means of expression and exchange. I emphasize this to point out that interactive technologies hold special potentials for creating engagement through expression as well as impression, not to detract from primarily impressive installations. An impressive installation can be highly engaging if it stirs the imagination of the subject experiencing it and instigates appreciation and reflection. Imagination is a necessary component of creative inquiry that expands our capabilities and enables interim re-assembly of the components of the situation through formation of ideas and hypotheses for action. Imagination, in a pragmatist understanding, is thus instrumental, since ideas formed by imagination are directed at simulating and evaluating transformations of an indeterminate situation: "The proper function of imagination is vision of realities that cannot be exhibited under existing conditions of sense-perception."[23] (Dewey 1910 p 224). In imagination, the dialogue between tradition and transcendence unfolds as we imagine the potential transformations on the basis of our pre-existing habitual schemata and experiences.

The creative dialogue can take on a number of forms, and at any given time, the subject may be in dialogue with a number of components in the situation. The relations between inquirer and components can shift as some conversations become more significant and come to the fore, while others may fade into the background; and during inquiry, the parts of the situation that are engaged in dialogue may take on shifting meanings to the inquirer, shifting e.g. from being an indeterminate phenomenon of study towards being an instrument by which we manipulate other indeterminate phenomena (paraphrasing Heidegger's *Vorhandenheit* and *Zuhandenheit*), or by being both at the same time. The Aarhus by Light case discussed in *Staging Urban Interactions with Media Façades [6]* demonstrates salient traits of dialogical creativity, both in users' ongoing interpretation of the installation, and in shifting relations and roles between users and the interactive components of the installation.

Creativity in inquiry is distributed: In creative inquiry, we draw upon resources – semantic and physical, social and technological - to explore and transform the present state of affairs. Creativity – both in imagination and

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[23] Dewey makes a distinction between *imagination* as outlined in this quote and the *imaginary*, which in contrast refers to the workings of fantasy and the unreal, mental processes which are decoupled from practice. I shall not go further into a discussion of the imaginative and the imaginary, instead I will point interested readers towards Chambliss' treatment of the subject in *John Dewey's Idea of Imagination in Philosophy and Education* (Chambliss 1991).

in action - is not limited to the intrinsic capabilities of the inquiring subject. It is to a large extent dependent upon the use of resources, and as such creativity emerges as a phenomenon distributed across the inquirer, other people in the situation, and the resources brought into play in the course of inquiry. With regards to socially distributed creativity, many processes of inquiry are collaborative efforts involving several inquirers who work together towards transformations on a scale that it would be difficult or impossible for one inquirer to achieve single-handedly; e.g. a group of interaction designers collaborating with an architectural firm to design an innovative media façade, or a group of strangers exploring the interaction with said façade. Even in the case of a single inquirer striving for smaller-scale transformations, it is often the case that others are drawn into the creative process, for instance as short-term sparring partners giving rapid feedback on ideas, or even in the shape of imagined others, such as design personas (Cooper 2004).

Creativity, however, is not just distributed among people in a situation; it is also to a large degree distributed between inquirers and technological resources. On a semantic level, creative inquiry can for instance be distributed between inquirer and language, the tool of tools. Poets, for example, often introduce linguistic constraints such as particular poem structures to establish simultaneous tensions and affordances in the writing process. Even language itself is structured in ways that facilitate certain trains of thought and expression and hinder other ones. Kirkeby, a contemporary Danish philosopher, has explored this phenomenon, labelling it *translocutionarity*[24] (Kirkeby 1998) in reference to how meaning is sometimes not formed in advance, but emerges 'through-language' as we express ourselves; i.e. we start talking without knowing exactly what we will end up saying, but the resource of language and our command of it in combination lead us to form a correctly structured and (potentially) meaningful utterance nonetheless.[25]

Closer to the focus of this dissertation, however, is the role that manifest technologies play in creative inquiry. In creative inquiry, we very often rely upon physical materials that serve as medium for either exploring potential expressions, as the final medium of expression, or both. Instruments of creative inquiry that are physically manifest are often the easiest to observe and lend themselves well to scrutiny. A palpable example of this is how designers use sketches, models, mock-ups and prototypes when they explore the potential future forms of an artefact. These provisional forms are more than just ways of communicating ideas, they are a crucial part of the creative work: they serve as an extension or distribution of imagination and allow for the designer to bring the world into the process and enter into multiple reflective conversations to explore potential futures. The notion of distributed creativity in inquiry is akin to the theory of distributed cognition, developed by Hutchins (1995) in *Cognition in the Wild*, which holds that cognitive

[24] My translation from the Danish word *translokutionaritet*.

[25] It can be argued that social semantic constructs can also serve as simultaneous constraints and affordances for creative inquiry, e.g. when well-established social structures instigate artistic rebellion, e.g. the punk movement, but it is beyond the scope of this dissertation to address creativity at this level of abstraction.

processes occur beyond the individual and can be distributed across people and technologies. In the dissertation *How Designers Work*, Gedenryd (1998) builds upon both Dewey and Hutchins to develop the term *interactive cognition* to denote the distributed process of creative inquiry, and the term *situating strategies* to denote the particular method of employing resources in the situation to augment imagination: "Quite simply, these techniques re-create the various parts of this situation that do not yet exist. To make interactive cognition work well, the designer has to create her own working materials; before the world can become a part of cognition, the designer has to create it. Therefore, I will collectively refer to these design techniques as situating strategies. They serve to make the world a part of cognition." (Gedenryd 1998 p 157) The distributed traits of creativity are manifest in many forms of designerly inquiry, and the included paper *The emergence of ideas [2]* deals primarily with this notion, focusing on how the creative process of developing design concepts is distributed across designers and inspiration cards in a collaborative design workshop. Distributed creativity is not limited to the design situation, it is also discernible in use situations, e.g. in the installation *Silence and Whispers* in which users can assemble dispersed audio fragments of stories and add their own to an emergent narrative repository. Thus, some interactive artefacts, environments or assemblies of artefacts allow for or rely on distributed creative inquiry in their function, either because of designers' intent, or because of users' adaptation.

5.3 INQUIRY IN DESIGN SITUATIONS

In the following, I will discuss key points in the included papers from a pragmatist perspective. Whereas some of the papers contain inquiries, analyses and discussions framed by pragmatist concepts, other of the included papers are not explicitly based on this perspective. This is due to a combination of factors: (1) the pragmatist perspective has emerged through my ongoing involvement in and reflection upon the experimental design cases, thus pragmatist concepts are most clearly unfolded in the most recent papers; (2) the papers are intended for varying audiences and adhere to different requirements and standards, thus in some papers there is more space to unfold the pragmatist perspective than in others; (3) some of the papers bring several strands of theory into play in order to gain a richer understanding of the subject matter, and in these cases the pragmatist perspective has been employed in line with other perspectives, rather than being afforded a privileged position in relation to the other theories. These disparities notwithstanding, I will discuss in the following how the pragmatist perspective presented in this dissertation, and in particular the notions of creativity and technology in inquiry, is a relevant and fruitful perspective for addressing central issues in the design of engaging interactive environments. I will draw out key concerns from each paper and examine these in the light of the pragmatist notion of inquiry, with a particular focus on distributed and dialogical creativity, and the experiential and transformative nature of technology, as outlined above. For each paper I discuss, I will focus on two particular concerns. First, I treat the three papers dealing most directly with the interaction design process, namely *Inspiration Card Workshops [1]* (in which I focus on dialogical and distributed creativity in inquiry), *The emergence of ideas [2]* (in which I focus on distributed

creativity and transformative technologies in inquiry), and *Maps for Design Reflection [3]* (in which I focus on experiential and transformative technologies in inquiry).

5.3.1 INSPIRATION CARD WORKSHOPS

Inspiration Card Workshops outlines a specific technique for orchestrating collaborative design events in which special emphasis is placed on bringing diverse sources of inspiration to the table in order to generate design concepts that on the one hand address specific concerns in the design domain, and on the other hand bring into play interesting interactive technologies. As is evident from this combination of concerns, the method is intended for the type of collaborations that have dominated my PhD project, namely experimental design cases that explore the potentials of mixed reality installations in real-life settings. In discussing this paper, I will focus on the concepts of dialogical and distributed creativity in inquiry.

Creativity is at the heart of the inspiration card workshop technique in the dual sense of creation and innovation outlined in my pragmatist perspective: With regards to the act of creating, the technique is a mode of inquiry structured in a way that facilitates the development of externalized concepts in response to problematic situations in the domain; with regards to innovation, it is set up so as to bring about new and hitherto unexplored applications of interactive technologies as part of this response to the domain situation. The definition of problematic domain situations vary; in the paper, we outline three different domains, namely future exhibitions at a children's literature center and an electricity museum, and a product demonstration booth at a sales convention. In the first two cases, a large part of what constitutes the 'problem' in the situation is the very definition of what it should encompass; in the sales convention case, the problem is more well-defined. In order to respond to these varying levels of concreteness, the workshop technique is in itself quite open and flexible. We have primarily employed the technique at an early stage in design processes. At this point, the objective for employing the technique can be construed as a first attempt to bridge the tradition-transcendence gap: by capturing and representing salient aspects of the world that is by use of inspiration cards we represent the world that could be in the shape of design concept posters. The preparation for the workshop is as important, if not more so, as the workshop itself, for the selection of themes and sources of inspiration to be represented on the cards can give very specific directions for the workshop itself. One of the key insights from employing the technique across a variety of cases is to align the level of abstraction on the inspiration cards with the level of abstraction of the domain problem. E.g. in the case of the centre for children's literature, there was a loosely defined understanding of the problem as the establishment of a larger exhibition on Norse mythology. For this reason, the domain cards represented common themes and tropes from the mythology, e.g. blood, a recurring element, which lends itself to open-ended interpretation. In other cases with more specific problem settings, we have opted for more tangible topics to be represented, e.g. in the case of the sales convention booth, several domain cards were photos representing concrete parts of previous booths in need of improvement.

Figure 19: The 7th Heaven inspiration card workshop unfolds, resulting in a number of concept posters.

Creative inquiry during inspiration card workshops unfolds dialogically. In continuation of the above articulation of the tradition-transcendence dichotomy, a basic dialogical trait of inquiry in this workshop technique is that it frames imagination as a dialogue between existing and potential. It represents a structured approach to innovation by exploring the tensions and potentials that arise when the two move from being observed in juxtaposition on the cards to being combined in the shape of posters. On a more concrete level, the workshops are evidently dialogical as participants start to articulate ideas and interests and enter into dialogue with each other; however, analysing the workshop process in a pragmatist perspective, it appears that tangible props in shape of inspiration cards and design posters play the role of dialogue partners. They are invested with meaning from their initial creation and continuously evolve as these meanings are negotiated, articulated and expanded upon. The cards and posters thus act as mouthpieces for the situation talking back to the designers. In this iterative dialogue, cards and posters develop semantically throughout the workshop, and the shared meaning ascribed to a card by the end of the session may be very different from the initial understanding of it.

The important part played by cards and posters as dialogue partners leads naturally to consider the distributed nature of creativity in this workshop format. The resulting design concepts are seldom, if ever, created by individual participants working alone; they emerge through discussion and collaborative elaboration of design ideas. The cards and posters, as well as post-its, pens and paper, function as tools for creative inquiry in this respect, serving in combination to both inspire and respond to ongoing ideation, as well as capturing the resulting concepts. A reflective question regarding this notion of distributed creativity is whether the formulation of creative inquiry as distributed and dialogical is a circular argument, in the sense that the workshop forces distributed creative inquiry. The retort is two-fold: firstly, the pragmatist articulation of dialogical and distributed creative inquiry has been formulated after the development of the inspiration card workshop technique; secondly, that it may be necessary to force or direct creativity by

framing it in specific ways in response to problematic situations, and that distributing it appears to work, both in the case of the inspiration card workshop technique and in other methods for ideation and creativity, e.g. (Jungk & Müllert 1987; Madsen 1994; Djajadiningrat, Gaver & Frens 200). I will discuss the notion of distributed creative inquiry in inspiration card workshops further in the following section.

5.3.2 THE EMERGENCE OF IDEAS

The journal paper *The emergence of ideas [2]* presents an in-depth analysis of the ideation phase of inspiration card workshops. Whereas the previous paper introduced the workshop technique in more general terms, this paper relies on a micro-analytical approach in order to gain minute understandings of a specific instance of the technique, namely the collaboration with the Salling department store to develop concepts for engaging product promotion and information. In the following treatment of the paper, I will focus on the topics of distributed creativity and transformative technologies in inquiry.

The paper is based on transcribed video recordings of said workshop. As a special analytical feature, we have documented the gestures and use of artefacts, i.e. inspiration cards, posters, post-its, pens and paper, in order to get a detailed look at how these have influenced the development of design concepts. Analysing these transcriptions, we have mapped out how inspiration cards, external sources of inspiration, over-arching workshop themes, derived ideas, and concept posters came into play in the process, as exemplified in figure 20.

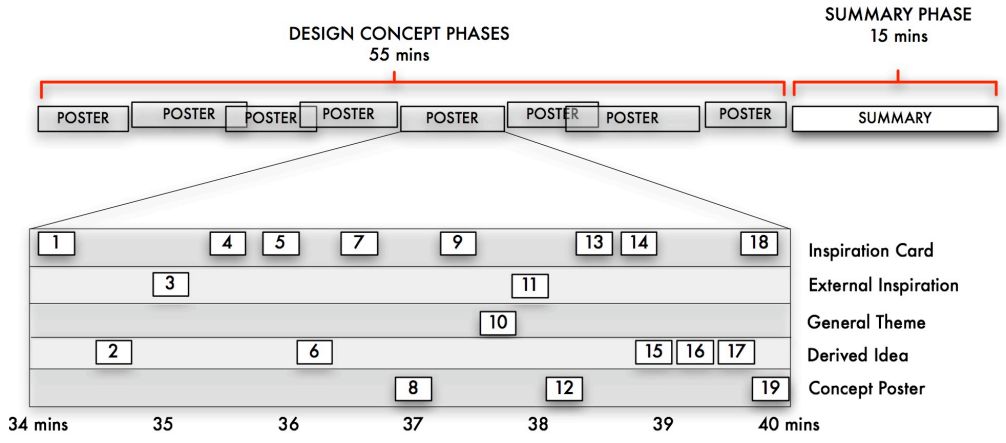

Figure 20: Key elements brought into play in the development of a design concept in the Salling department store workshop, reproduced from *The emergence of ideas [2]*. The numbers refer to incidents in the transcription and indicate the points at which participants make references to the five categories, either orally or by means of gestures.

As the timeline in figure # indicates, a large number of sources of inspiration are brought to the table in a very short time-span – the development of this particular concept took six minutes yet encompassed 19

references to sources of inspiration or design concepts. One of the reasons that this is possible is that the creative process is distributed among the participants and the design materials. Recalling Gedenryd's terminology, the process can be construed as a prominent example of *interactive cognition* (Gedenryd 1998), in which the participants of the workshop employ the available design artefacts to make the world (both the existing and the potential) part of cognition. The design artefacts thus work both as instruments in dialogue with co-participants, e.g. to draw attention to certain features or to gain conceptual backing for arguments, as well as to explore the existing and potential world by proxy. Creative inquiry, in this example, resides simultaneously in the situation and with the individual. Though we have sought the most detailed level of analysis in our transcription of this ideation process, it is not possible to locate the creative development of a design concept as a purely cerebral function. Individual participants bring to the table distinct repertoires of knowledge, habits, and predispositions, but in this design situation, their efforts are motivated by and directed towards (represented) problematic situations in the world, mediated by design artefacts, and negotiated, refined, and articulated in collaborative efforts.

The design artefacts employed in the workshop, in a pragmatist perspective, function as *transformative technologies* for addressing a relatively indeterminate design space and moving towards a more unified or coherent understanding through the creation of design concepts. The transformative processes occur on a concrete level with regards to the capture and formulation of design concepts in the shape of concept posters, on a semantic level, as e.g. the inspiration cards are imbued with new meaning through shared discussions, as well with regards to the repertoire of designers, as the process offers new understandings for the participants. As such, the design process is implicitly a learning process that can serve to expand the designers' horizons. This process of learning may relate to the specific challenges that are addressed in the workshop, i.e. developing knowledge about the domain, as well as to the workshop method itself, i.e. developing design competencies. The design artefacts employed in inspiration card workshops, i.e. cards and posters, are from the outset intentionally sparse in that they contain little concrete information. This affords a great degree of flexibility, both in regards to the aspects they can represent, e.g. interactive technologies, domain locations, situations, themes etc., and with regards to the meanings that can be ascribed to them during the workshop. In the course of the workshop, they are transformed semantically, and as such, the learning process is tied to the design artefacts. The design concepts developed in this type of workshop can be understood as emergent, both because they are continuously negotiated and refined upon during the creative processs, and in the sense that they are seldom fully developed by the end of the workshop. As a concrete example of distributed creativity and the emergent, transformative traits of technologies in this particular workshop, one of the concepts developed was entitled *Talking Heads*[26]. This concept, described in detail in the paper, was composed by putting together three inspiration cards: one representing a pair of

[26] Translated from the Danish title *Hovedet under armen*, literally meaning *head under the arm*.

animatronic puppets, another representing a floor plan of the department store, and a third representing an interactive installation entitled *Drumhead* (Konar 2009). This odd assembly of cards was put together through joint discussions and chains of association among different workshop participants that would have impossible to predict in advance. The resulting concept proposed that interactive heads with different personalities and tastes could be picked up and carried around by customers in need of guidance or assistance.

Inspired by initial successes with the inspiration card workshop technique, we have conducted a number of these workshops since the inception of the technique[27]. Reflecting upon our findings, the art of setting up a good workshop is based on framing challenges to spur, scaffold, and direct creative inquiry; as such, the workshop setup can be seen as a way of producing a problem, establishing a situation that is experienced as indeterminate, but relevant and worth engaging in, and which, in addition to presenting challenges and tension fields, offers recognizable entry points, e.g. crystallized in domain-related inspiration cards. In a systemic perspective, the selection of cards, the selection of participants, and the alignment of the two are crucial concerns when employing the technique. Revisiting the conclusions from the paper in the light of the pragmatist perspective presented in the present, the design situation facilitated by inspiration card workshops can be characterized as socially and technologically distributed and mediated (among designers and inquiring instruments), emergent (as ideas and concepts emerge both on the basis of pre-fabricated inspiration cards and as ad hoc improvisations), and adaptive (as the dialogue between participants and materials unfold and preconceptions, cards and posters are transformed in the process).

5.3.3 MAPS FOR DESIGN REFLECTION

The two papers discussed above have focused on the way design inquiries unfold through the use of the specific technique of inspiration card workshops, which is intended for use by designers. In the journal paper *Maps for design reflection [3]*, the techniques presented, namely three types of maps for design reflection, are first and foremost intended for use by interaction design researchers. This being said, the maps may also be employed in reflective design practice, and the findings that result from the use of the maps are based on involvement in and analysis of a concrete design project. This project was the collaboration between CAVI and BIG Architects to develop a competition proposal for the new Museum of Modern Art in Warsaw, as outlined in section 3.4.5. In my present discussion of this paper, I will focus primarily on the notion of experiential and transformative technology in inquiry as it appears through the employment of the maps for design reflection.

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[27] We have employed the inspiration card worksop technique in almost all of our experimental design cases since we wrote the first paper.

In the paper, we present and discuss three types of maps, namely *overview maps, strand maps*, and *focal maps*. They differ in scope as well as application: overview maps outline the entire design process and are intended for reflection upon the general trends and developments in the project, particularly with regards to the numerous concepts and materials brought into play; strand maps trace a specific design concept through its life-cycle in the design process and are intended primarily for reflection upon the transformations the concept undergoes and the various ways in which it is represented; finally, focal maps capture specific design moves and experiments and are intended for guided description of and reflection upon relevance, rationale and insights tied to these experiments.

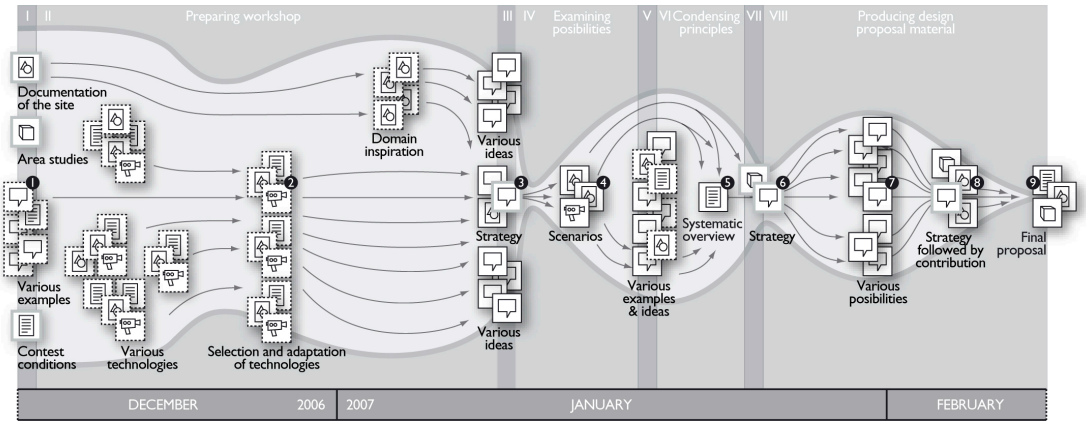


Figure 21. Overview map of the Warsaw Museum design process, focusing on sources of inspiration and ideas. Reproduced from *Maps for Design Reflection [3]*.

There is a traceable genealogy from the inspiration card workshops to the development of the maps for design reflection in the emphasis that the techniques place upon sources of inspiration and the importance of design materials. One of the main motivations for developing the maps is an increasing realisation of the importance of design materials; they are at the heart of design, and thus there is good reason to pay special attention to these in the design process.

Employing the pragmatist perspective laid forward in this dissertation, the technological nature of inquiry is evident both with regards to the maps, and with regards to the specific case explored in the paper through the use of maps. With regards to the maps, they have served for us as inquiring instruments in that they have been developed with the specific interest of guiding our reflective inquiry into the complexities of the Warsaw MoMA design case. As can be seen from the overview map in figure 21, a large number of ideas and concepts emerged in the course of the design process. One of these, the notion of using Thermo-Chromatic Concrete (TCC) as an integrated interactive display technology in the museum building itself, came to dominate the process. The strand map, which is represented in figure 22, shows the numerous transformations of this concept before its final form.

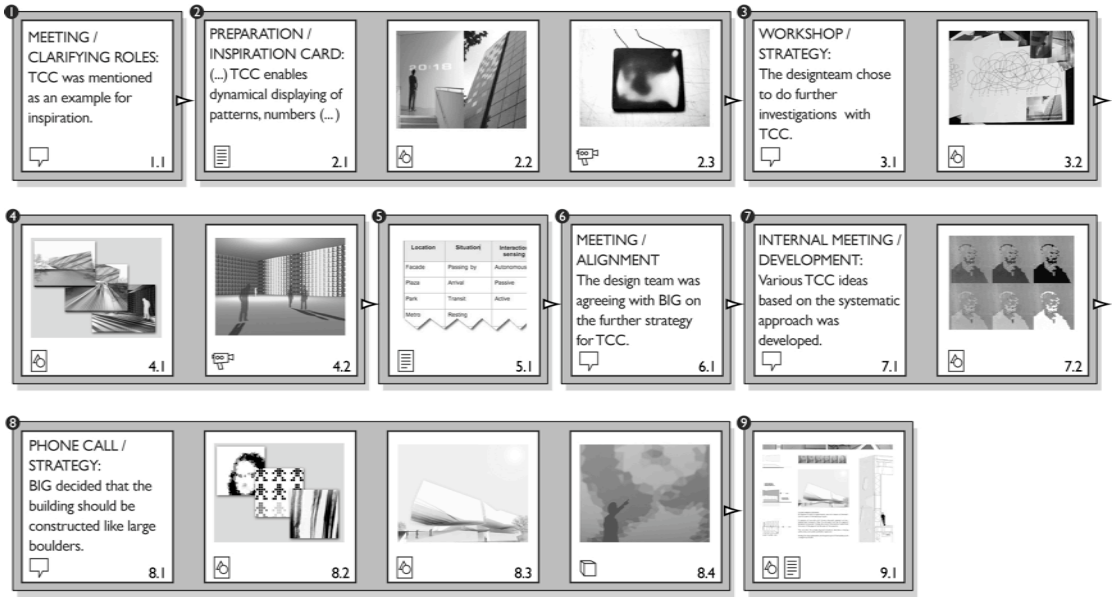


Figure 22. Strand map for the development of TCC for the Warsaw Museum. Reproduced from *Maps for Design Reflection*.

This strand map, as well as the overview map and the focal maps, can be construed as experiential technologies in the process of research inquiries, in that they have framed our inquiries into the specific design situation by focusing our gaze at specific tensions and topics. There are a number of relations that we do not capture explicitly in the three types of maps; most prominently given my background is the lack of stakeholder relations and exchanges between different participants in the process. However, to paraphrase the great Borges (1975), you cannot capture everything in a map, lest the map be as expansive as the territory it captures. The maps, however, did not unilaterally determine our research focus, they were themselves developed and transformed through the course of our research inquiries in interplay with the situation that we were mapping. Just as we have shaped and refined these inquiring instruments in order to suit the situation, we encourage others to do the same. For instance, it could be of value to both design practitioners and researchers to refine and develop the maps to better capture promising design concepts that did not suit the specific case, but could prove valuable in subsequent projects.

Turning the attention to the specific design case represented in the maps, the notion of experiential and transformative technology in inquiry is particularly suited for explicating the role of design materials in the development process. The design idea or concept is present in the design process in the way it presents itself, through its form. Some concepts and ideas exist briefly in transient forms such as oral discussions, but the ones that come to dominate the design process almost always find more tangible, though likely still tentative, forms. In the case of TCC, this concept arose first in oral form, but was then represented visually on an inspiration card and was subsequently developed and transformed in numerous iterations of sketches, video prototypes, 3D renderings and concept descriptions. This need for design concepts and ideas to take on form gives rise to reflection with regards to whether it is the design concept or the ways of giving form

that cause some ideas to flourish and others to wither: It may be the case that the good idea will always find a form in the hands of competent designers; it may also be the case that those ideas that are most easily given form are more likely to be explored and gain prominence in the design process - for a person with a hammer everything looks like a nail. There are of course numerous other aspects that influence the design process, but with regards to the notions of experiential and transformative technology in inquiry, this would nevertheless be an interesting topic to pursue further. E.g. within the field of architecture, the advent of CAD and 3D modelling software has resulted in structures that were previously unthinkable - and likely unbuildable as well; case in point are the organically inspired structures of Gehry (2009) and Hadid (2009). It is not untenable to assume that the development of inquiring instruments and design materials within the field of interaction design, e.g. tools for rapid prototyping, virtual video prototyping etc, share these traits.

5.4 INQUIRY IN USE SITUATIONS

Restating my own position laid forward in the introduction, I am primarily pre-occupied with the design process, but I find it crucial for designers to maintain a reflective stance not just regarding their own situation, but also with regards to the interaction situation as it unfolds once the interactive artefacts that result from the design process are taken into use. So, whereas the three papers discussed above focus squarely on the interaction design process, I will now turn to the four included papers that broaden the scope to also consider the process of use and interaction, namely *Designing for Inquisitive Use [4]* (in the discussion of which I focus on experiential and transformative technologies in inquiry), *Peepholes as Means of Engagement in Interaction Design [5]* (in which I focus on dialogical creativity and transformative technologies in inquiry), *Staging Urban Interactions with Media Façades [6]* (in which I focus on experiential and transformative technologies in inquiry), and *Performing Perception [7]* (in which I also focus on experiential and transformative technologies in inquiry). Though these papers address use situations, they are also written with the purpose of informing the design process. To varying degrees, they therefore present implications or considerations for design on the basis of findings from use studies.

5.4.1 DESIGNING FOR INQUISITIVE USE

While pragmatist notions have implicitly influenced the inquiries into design situations presented in the preceding three papers, they are unfolded in greater detail in *Designing for Inquisitive Use [4]*. The paper introduces the notion of inquisitive use on the basis of Deweyan pragmatism, and in many respects it can be understood as an early articulation of concepts more fully unfolded in this dissertation. In discussing this paper, I will primarily focus on the notions of experiential and transformative technology in inquiry.

The outset for the paper was an interest in exploring in more depth the notion of experience, since the use of the term in interaction design discourse at times seems somewhat eclectic and incoherent, and as

accounted for in the previous parts of this dissertation, pragmatism offered a coherent and substantiated avenue to pursue this interest. Rather than outlining an encompassing theory of experience, the paper concentrates on a particular mode of experience in the use situation, denoted inquisitive use. This notion emphasizes the reciprocal nature of experience in interactive systems and the role that users themselves play in the constitution of situated experience. It further outlines the potential resourcefulness of users confronted with problematic situations and the ways that they seek to resolve or overcome these tensions through inquiry. In this respect, the paper accentuates the potential for fostering engaging interaction by presenting users with indeterminate situations that require them to confront and overcome the challenges, potentially through creative and technologically mediated inquiry.

The concept of inquisitive use is based on the interplay of experience, inquiry, and conflict. One of the key propositions of the paper is that conflict is an underdeveloped concept in experience-oriented interaction design. If one accepts Dewey's stance that inquiry is instigated by conflict, and that inquiry signifies a heightened vitality and engagement with the world, it follows consequentially that it is meaningful to explore the potentials of elements of conflict in interaction design in greater depth. The paper develops a preliminary model of inquisitive use, represented in figure 23, and defines the concept in the following way: "Inquisitive use is instigated by problematic situations that challenge our conceptualizations. These situations may present themselves without the intent of the user, or she may actively seek them out. Through iterations of inquisitive action and situational back-talk, the user-situation transaction unfolds until resolution occurs, be it in an inchoate or consummatory way." (Dalsgaard 2008 p 25)

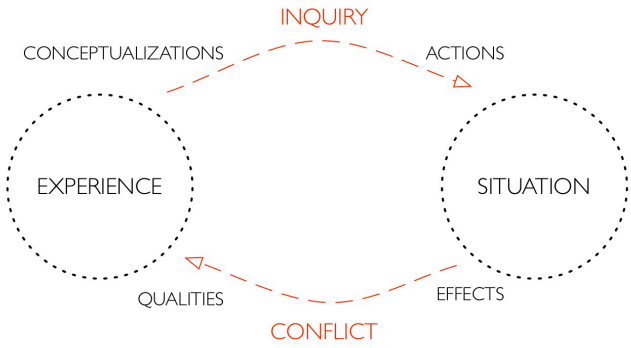


Figure 23: A model of inquisitive use, emphasizing the reciprocal relationship between inquiry and conflict adapted from *Designing for Inquisitive Use [4]*.

Further, nine so-called *design sensitivities* for designing for inquisitive use are presented, e.g. regarding challenge, risk, and resolution in the establishment of conflict. These are intended as key points for design reflection and inspiration, rather than design dictums, since inquisitive use may take on many forms dependent on the specific situation. The design sensitivities are explored in the paper through the two cases Balder's Funeral Pyre and Silence and Whispers, presented in sections 3.4.2 and 3.4.3.

With regards to the experiential and transformative nature of technology in inquiry, the notion of inquisitive use is presented as an articulation of how interactive environments can be designed to foster engagement by simultaneously presenting users with new and challenging ways of seeing the world and facilitating their inquiry in this new world by presenting them with resources to investigate, overcome, or resolve the challenges. However, conflict or discord is highly dependent on the given domain and the potential users – their background, repertoires, habits, expectations, and current situation – and for conflict to act as a catalyst for inquiry and potentially heightened experience, it must be aligned with these aspects. One way that we have sought to address this issue in design is to work explicitly with the experiential qualities that could emerge in the encounters between users and interactive environments. We have primarily done so in open-ended discussions in the design team, e.g. in the case of Balder's Funeral Pyre, we formulated explicit experiential qualities in partnership with our collaborators from 7th Heaven and used these to frame design events and guide design decisions. I consider this approach of employing articulated experiential value in design to hold much potential for further research; by this I am not suggesting the need for a fine-grained framework of experiential qualities to guide design decisions, but rather that a more structured and substantiated approach to integrating experiential inquiries in the design process would be worthwhile to exploring and formulate.

Presenting users with a perceived conflict, e.g. on the basis of explorations of experiential values, is one aspect of inquisitive use; the other concerns users' ongoing inquiry into the situation and the ways in which designers can scaffold this. Just as designers employ inquiring instruments, so do users. In the early parts of my PhD research, I worked mostly on relatively closed interactive environments, such as Balder's Funeral Pyre. In this installation, the interactive environment itself can be considered the inquiring instrument in combination with the users bodily movements, which alters the soundscape and the engulfing fire. Quite often, these closed installations rely on such built-in inquiring instruments, and since these are often framed in specific and somewhat restrictive or prescriptive ways, users tend to accept the use of the intended modes of interaction. In the latter stage of my work, I have started working on more open-ended interactive environments, e.g. in urban spaces. These situations display a much greater variety and it is considerably harder to stage the use of intended inquiring instruments; the inventiveness of users in exploring interactive installations in these settings is often quite fascinating to observe (although it may run counter to what designers intended). However, in both closed and open-ended interaction situations, the findings from exploring inquisitive use point to coupling of what may be called *impressive* and *expressive technologies* – i.e. those that stage or frame users' experience and facilitate their response, respectively - as a central challenge in designing engaging interactive environments. In the following paper, I explore in more detail the notion of peepholes as a concept that can be employed to foster engagement through inquiry.

5.4.2 PEEPHOLES AS MEANS OF ENGAGEMENT IN INTERACTION DESIGN

Peepholes as Means of Engagement in Interaction Design [5] can be read as a continuation of the concepts laid forward in *Designing for Inquisitive Use [4].* The paper discusses the concept of engagement from a pragmatist perspective and presents the notion of *means of engagement* as a conceptualization of the resources that scaffold engagement. It furthermore presents *peepholes* as an example of a general type of means of engagement in interaction design. In the paper, we describe peepholes as "[…] interactive artifacts and environments that utilize the tension between what is hidden and what is revealed to foster engagement through curiosity and inquiry" (Dalsgaard & Dindler 2009 p 1). In the light of the discussion of the previous paper, peepholes can be considered a specific design strategy for creating tension and providing inquiring instruments to facilitate resolution of this tension. In addition to four external examples of peephole installations, the paper presents two experimental design cases that build upon peephole strategies, namely the Hydroscopes developed for a Danish Marine centre, and the aforementioned Silence and Whispers installation. In discussing the paper, I will focus primarily on the dialogical traits of creativity and the role of experiential technologies in inquiry.

The characterization of engagement presented in the paper draws upon the work of Berleant (1991), Borgman (1995), and Dewey and defines engagement as an emergent and relational quality of the subject-environment interplay. Engagement is a temporal phenomenon in that it arises in the subject's continuous adaptation to the situation. It is often dependent on the subject's experience of a certain depth or unfoldedness, either in the sense that something hitherto unseen presents itself to the subject, or in that seemingly well-known phenomena contains layers of meaning that are not immediately accessible to the subject. Engagement demands an investment on the part of the subject who has to devote time and interest to the process in order to explore the depth or unfoldedness of the situation. In this respect, engagement is analogous to inquiry. Furthermore, means of engagement can be construed as a type of inquiring instruments, in that they are the resources that facilitate the reciprocal interaction between subject and situation. Peepholes are a specific means of enagagement that build upon the tension and curiosity evoked by giving a glimpse of that which is otherwise hidden while simultaneously offering ways of further exploring these concealed phenomena.

Peephole strategies can be employed by designers by way of non-digital technologies, however interactive technologies in general, and mixed reality specifically, appear to hold special potentials for developing peephole installations, a proposition we explore in the paper. The Hydroscopes employ a peephole strategy in a quite literal way by offering a visual peephole into a virtual ocean. They scaffold dialogical creative inquiry by initially offering a glimpse of the world underneath the waves, spur the imagination of visitors to envision the creatures living there, and offer exploration of this world by moving the physical hydroscope which is aligned with the virtual sea that moves accordingly. The installation thus offers a type of back-talk and invites the user to enter into dialogue with it. Silence and Whispers relies on auditive rather than visual

engagement, presenting visitors with fragments of stories that can only be assembled by moving about caves, or possibly by imaginative inquiry in which the visitor weaves together his own past experiences with the narrative strands offered by the installation.

Figures 24 and 25: Hydroscopes and Silence and Whispers both employ peephole strategies, but in dissimilar ways.

Both installations rely upon the user's imagination and the deep-seated tendency to form hypotheses about that which is hinted at, yet not fully revealed. In a pragmatist understanding, imagination is intentional in the sense that it is directed towards ordering and making sense of phenomena in the world, and it is this quality that peephole installations exploit. Revisiting the open versus closed installation discussion from the previous section, both Hydroscopes and Silence and Whispers are dependent upon specific settings which frame the interaction experience and allow designers to base their work on warranted assumptions about the expectations with which people engage the installations: in the Marine centre, the hydroscopes are surrounded by real aquaria and furthermore interconnected with an interactive installation with which visitors can create fish to be released into the virtual sea; in Silence and Whispers, the narratives are tied to the Suomenlinna islands in which the installation is placed, and the stories are mostly sombre and gloomy, befitting the dark corridors and caves. It is the specific reality of these settings that sets the stage for the mix with alternate, digitally represented realities to instigate imagination.

As introduced, interactive technologies hold specific potentials for creating dialogical means of engagement. This is not solely due to the capability to "mix realities", for alternate realities can be presented in other ways, e.g. through oral storytelling and cave paintings. The temporal character of interactive technologies is key to understanding this potential, enabling dynamic response and giving users a feeling of getting something in return for the time and resources invested in engagement. In addition to giving immediate feedback to users – e.g. by having the virtual sea in the Hydroscopes move in accordance with the physical movement of the instrument – this also facilitates evolution over the course of time – e.g. as users of the hydroscopes create their own fish and release them into the virtual sea.

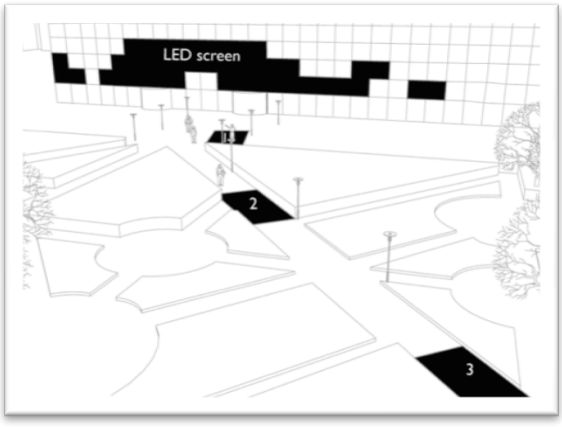
Looking back at the previous discussion of the paper *The emergence of ideas [2]*, it comes into view that there are a number of affinities and common traits with regards to setting up a creative ideation workshop

in the design process and establishing an interactive environment that spurs inquiry. Both challenges concern the staging of a situation that is perceived as problematic and indeterminate, though still significant and worth engaging in, and which offers familiar entry points for addressing the challenges and tensions, as well as inquiring instruments to scaffold the explorative process of inquiry.

5.4.3 STAGING URBAN INTERACTIONS WITH MEDIA FAÇADES

Staging Urban Interactions with Media Façades [6] presents and discusses *Aarhus by Light*, a large-scale media façade developed for Concert Hall Aarhus, a prominent cultural institution situated in the centre of Aarhus, Denmark. Whereas the installations discussed in the previous two papers have been described as relatively closed interactive environments, Aarhus by Light is of a more open variety. The paper outlines the research through design process that led to the development of the installation and presents the general findings from observing the installation in use 24/7 for nearly two months. In the present discussion of the paper, I will focus primarily on the role of experiential and transformative technologies in inquiry as it unfolds in the use situation.

From a research perspective, Aarhus by Light was intended as an exploration of the potential for facilitating social interactions by means of media façades; however, our collaborators from Concert Hall Aarhus entered the project with the motivation of transforming the image and perception of the institution in the eyes of the public; roughly stated, the general perception of the concert hall was that it was a somewhat conservative establishment. Working from this starting point, we sought to develop a playful, eye-catching, and collaborative interactive environment. The result proved to be highly successful, both in terms of yielding research results and in transforming the practices and experiences in the Concert Hall park, as described in more detail in the paper



Figures 26 and 27: Aarhus by Light installed in the Concert Hall park, and a schematic view of the semi-translucent display and the three interaction zones in the park.

The open nature of the setting for the installation and its integration into the existing architectural structures constituted pivotal challenges in the design process; however, as the findings presented in the paper indicate, these factors were addressed very satisfactorily in the development of Aarhus by Light. Considering the experiential qualities of technology in inquiry, the development of the media façade and the adjacent interaction zones in the park served to frame the experience of the place in novel ways: In one respect, it served to connect two entities in the city centre – the concert hall and the park – which were beforehand disjointed; in another respect, it altered the perception of the façade of the building as more than an elegant building skin; and in yet a third respect, it also caused a shift in the general understanding of the character and image of the concert hall and its role as a cultural institution. As touched upon in the paper, I propose that one of the reasons for the success of the project was that it struck a balance between framing and open-endedness, in the sense that it evoked a number of different interpretations and interactions; although the installation was of course developed to a certain range of potential inputs, it did not prescribe a specific behaviour among users. In continuation of the arguments from the preceding paper, the installation contained a certain unfoldedness or depth on different levels: Some people responded to the basic functionality out of seemingly technical curiosity, some sought to make sense of the behaviour of the luminous creatures in the façade, some explored the potential for social encounters and interactions, and yet others seemed most fascinated by bodily the play and interaction that the installation made possible; most people would ultimately cycle through multiple of these levels. As such, engagement with the installation cannot be neatly defined and boxed in: it took on a number of shapes in the course of people's encounters with Aarhus by Light. Arguably, the social mediation that it scaffolded was the most important feature of the project, but this is inextricably interwoven with the technological setup. The exploration of the potential of digital technologies to foster engaging interactive environments in settings such as this one poses substantial challenges to interaction design – and looking beyond my own field, to architecture as well. The ongoing development of augmented spaces will likely bring these two disciplines closer together, as we are already witnessing in the projects I partake in, and inspire cross-pollination of conceptualizations and methods. In the specific case of Aarhus by Light, several crucial design challenges fell into the borderland between the two, e.g. in exploring ways to integrate the large-scale, semi-translucent display into the existing architectural expression of the Concert Hall, and in developing modes of interaction that would function from various distances and at different viewing angles. I look forward to the ongoing evolution of genres, media, and practices in this cross-section of disciplines.

As is evident, the experiential traits of the technological inquiry made possible by Aarhus by Light are closely tied to its transformative technological traits. On a very concrete level, users could interact with what at first hand appeared to be a very alien intrusion into the park and move towards a unified sense of this new situation through bodily interaction coupled with sense-making of the interactive components on the façade. Given the fact that the installation was in place for almost two months, the most interesting transformation was of a more systemic nature, however, as the atmosphere of the park changed from being primarily a

place of transit to a livelier and arguably more joyful setting. This, as it appears from interviews conducted with park visitors, also sparked reflections and discussions about the role of interactive technologies in this setting, as well as in urban spaces in general. As such, Aarhus by Light and the subsequent experimental design interventions framed by the Digital Urban Living research project, may influence more expansive transformations, not merely in the sense of augmenting specific buildings and spaces, but in the sense of causing citizens to engage with and reflect upon the role of share interactive technologies in the city. Recalling the aforementioned quote from *Art and Experience*, "… technological arts, in their sum total, do something more than provide a number of separate conveniences and facilities. They shape collective occupations and thus determine direction of interest and attention, and hence affect desire and purpose." (Dewey 1934 p 345).

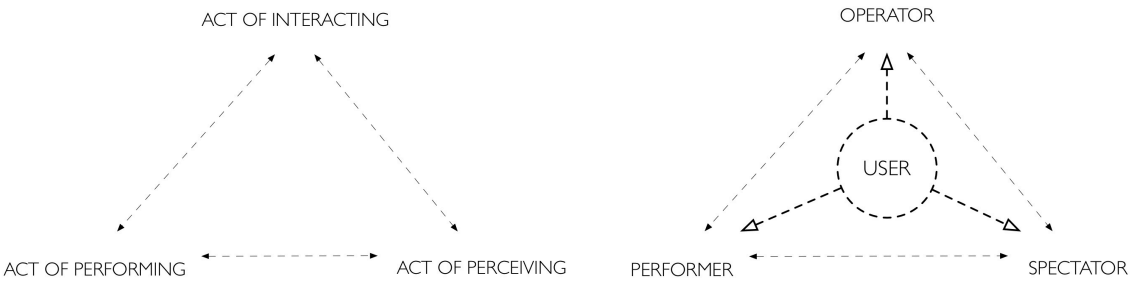
5.4.4 PERFORMING PERCEPTION

Performing Perception [7] addresses situational aspects of the experience of interaction by exploring the ways in which factors outside of the user-artefact relation affect the user's experience of interaction. Specifically, the paper presents the notion of *performing perception* as an articulation of the different roles the user takes on in interaction, and how a user's awareness of being a potential performer for others to observe during interaction innately affects the use experience. Based on analyses of a variety of use situations ranging from interactive arts to everyday use of technology, the paper highlights the need for interaction designers to take into account the ways in which the use of interactive artefacts and environments play out as performances in socio-cultural settings. As a consequence, considerations regarding the staging of interaction are necessary components in reflective design practice. In discussing the paper from a pragmatic perspective, I will primarily draw upon the notions of experiential and transformative technologies in inquiry.

As explicated above in the discussion of Aarhus by Light, engagement with interactive environments take on a number of forms and are affected by a multitude of factors. In *Performing Perception* [7], we establish a vocabulary for addressing the subset of factors that concern the user's awareness of the surrounding situation and the ways in which this affects interaction. As we explore in a range of cases, the intentionality of the user, i.e. the directedness of thoughts and actions, is seldom, if ever, focused solely at the interactive artefact or system itself; rather, intentionality spans the range of components in the situation. Depending on the situation, different aspects of the situation come into focus and fade out of view in interaction. This phenomenon has been treated quite extensively with regards to the discussion of transparency of interfaces, but only cursorily with respect to factors outside of the immediate user-interface relation. With regards to the experiential and transformative nature of technology in inquiry, it is clear that there are experiential aspects at play beyond the fact that an interactive installation can reveal e.g. the secret lives of luminous creatures in the Concert Hall façade: the use of technologies also affects the experience of the surrounding

situation, and it may shape and influence transformations of self-awareness and self-representation through interaction.

In the paper, we explicate these changes by articulating the different actions that are part of interaction, and the different roles the user plays in doing so. When interacting with an interactive system, the user carries out several simultaneous and interrelated actions, not all of which deal with the uninterrupted manipulation of the system: Firstly, the *act of interacting*, which denotes the understanding of the system and the operation of it; secondly, *the act of perceiving*, which denotes the ways in which the user takes in the relation between himself and the system and himself and the surrounding situation; and thirdly, *the act of performing*, which denotes the ways in which the user implicitly or explicitly carries out performative acts as part of this situated interaction. These three types of actions correspond to the three different roles that the user takes on during interaction: firstly, the role of *operator* of a system; secondly, the role of *performer* for others present in the situation (be they imaginary or actual); and thirdly, the role of *spectator* of this performance. It is the reciprocity of this triad of roles that is at play in performing perception. The three types of actions and their corresponding user roles are represented in figures 28 and 29:



Figures 28 and 29: The three acts of interacting, performing, and perceiving, and the corresponding user roles of operator, performer, and spectator. Adapted from *Performing Perception [7]*.

The phenomenon of performing perception occurs not only in intentionally staged interactive performances, but in a wide range of interactions with technology, as explored in the paper. Some uses of technology naturally call upon themselves special attention and expose users in very noticeable ways, e.g. Aarhus by Light employs an intentionally eye-catching technology and mirrors people who step onto brightly coloured interaction zones on the façade of the Concert Hall for all by-passers to see. Evidently, users here may be particularly aware that their interaction is also inherently a performance and adjust their behaviour accordingly. However, also more mundane interactions with technology, e.g. the use of a cell-phone, show traits of performing perception, as explored in the paper. When we are aware that others may perceive our interaction, we alter our mode of interaction; in recurring use situations, this may happen so often that the performative aspects of interaction become habitual and we seldom consider them. Performing perception, in a pragmatist perspective, can thus be construed as an articulation of the reciprocal relation of reflection and action in the situated use of interactive artefacts and environments.

An awareness of these phenomena holds implications for interaction designers. In the paper, we have refrained from turning the theoretical analysis into design heuristics, and I shall maintain this stance in the present. Instead, I will propose that the understandings from performing perception can serve as a worthwhile reflective background for design practitioners, especially those dealing with the design of interactive environments, since these often present extraordinary potential for the acts of performing and perceiving to influence the act of interacting. These considerations can then take on more concrete shapes in the course of a reflective design process as they are integrated with other key concerns in designerly inquiry.

5.5 SUMMARY: INQUIRY IN DESIGN AND USE SITUATIONS

In this chapter, I have presented the pragmatist perspective on interaction design that I have assembled and developed during my PhD research project. Based on the explication of the field of interaction design and the pragmatist philosophy of John Dewey laid out in the previous chapters, I have argued that the key concerns of pragmatism are well-aligned with those in interaction design, and that it may serve as a constructive foundation for inquiries in the field. I base this proposition on the grounds that situated practice and the reciprocity of action and reflection in experimental inquiry, which are integral components of pragmatism, are also of key concern to interaction designers. In addition, Deweyan pragmatism presents coherent understandings of a number of phenomena, which are of particular interest to my research into the design of engaging interactive environments, among these technology, knowledge, experience, and aesthetics.

Given my research agenda, I have focused on the particular concept of inquiry and developed it in an exploration of how it may scaffold an understanding of creative and purposive transformation supported by technological resources in design and use situations. Guided by this objective, I have articulated the notions of experiential and transformative technologies and dialogical and distributed creativity in inquiry and employed them in a discussion of the included publications. Creativity and technology are intertwined in inquiry, and though I have strived for a clear presentation of these notions, there are of course many overlaps between them, since they are both integral to inquiry. One of the particular salient points that arises from a pragmatist perspective is the understanding of the potential resourcefulness and creativity of users, which I consider an important and intriguing subject for further inquiry in design research and practice. The key points from the discussions of these notions are summarized in figures 30 and 31:

TECHNOLOGY IN INQUIRY	DESIGN SITUATIONS	USE SITUATIONS
EXPERIENTIAL	Instruments and technologies frame initial problem understanding and direction for design. Design materials and instruments shape the approach to, actions towards and ongoing reflection about the design problem.	Interactive technologies scaffold new ways of experiencing the world. They may themselves contain 'new worlds' to be experienced. Instrumental aspects of technologies are also intrinsically experiential because of our innate use of technologies when acting in the world.
TRANSFORMATIVE	The resolution of a design problem consists in the transformation of the design situation as a whole. Various resources can serve as instruments and may themselves be transformed in the process. Tools and instruments may be developed and refined in the design process - it becomes a process of developing tools as well as solving problems. Design is a transformation of the designer's repertoire and habits – a learning process.	Introduction of interactive technologies can affect systemic changes in the use environment. People draw upon all experienced resources, as well as own repertoires, in understanding and addressing situations. Transformations may occur on the level of a functional tool, in situated practices, in people's experiences and habits, or in the physico-spatial structures.

Figure 30: Summary of experiential and transformative technology in design and use situations.

CREATIVITY IN INQUIRY	DESIGN SITUATIONS	USE SITUATIONS
DIALOGICAL	Situational back-talk as designers enter into dialogue with the components of the design situation. Iterative articulation and re-formulation of concepts as they are explored in different forms. Dialogical exchanges between imaginative reflection and the act of creating.	Imaginative dialogue between past experience, present situation, and potential futures. Making sense of current situation, imagining potential futures, and putting the imagined to the test in practice. Instruments, e.g. interactive environments, can be designed to scaffold dialogue.
DISTRIBUTED	Creative inquiries instigated and framed by features of the design situation. Collaborative creation of ideas and concepts as well as iterative improvements of them in design teams. Semantic tools facilitate certain trains of thought. Design materials and inquiring instruments employed and developed as situating strategies to make the use domain part of the design process.	Collaborative and social sense-making and exploration of potentials. Creativity spurred by and directed towards other components in the situation (e.g. artefacts and spaces). Challenging situations foster creativity – staging this is part of the designer's responsibility. Users employ instruments, either provided or improvised, as part of creative interaction.

Figure 31: Summary of distributed and dialogical creativity in design and use situations.

I have outlined a number of aspects of inquiry that apply to the design situation as well as the use situation: firstly, the framing of a problematic situation which challenges the current perception of things and instigates inquiry; secondly, the opportunity for entering into a dialogue with the situation and alter it towards a more unified experience, which can occur through shifts with both the subject and one or more components of the situation through restructuring, reformulation, or manifest transformation; thirdly, the interplay between reflection upon past experiences and the use of inquiring instruments by which we project, assess and carry out these transformations in the world. I have discussed these concerns as they relate to the included papers; although some of the papers are not explicitly based on a pragmatist foundation, these concerns are nevertheless central to them. With regards to notion of designing *engaging* interactive environments, I have shown how a pragmatist conceptualization of inquiry yields insights into characteristics of resourceful and engaging use of interactive systems; in particular, I have explored the potentials of challenging users whilst providing them with means that scaffold their inquiry into - and potential resolution of - demanding situations.

In addition to serving as a basis for exploring and articulating the notions of inquiry, technology, and creativity, I find it of value that Deweyan pragmatism offers an established conceptual foundation upon which interaction design researchers and practitioners can build. Such foundational frameworks are somewhat absent in interaction design, although there are notable contributions building upon e.g. cultural-historical activity theory (e.g. Bødker 1990; Kaptelinin & Nardi 1997; Kuutti 1996) and phenomenology (Dourish 2004). One of the merits of pragmatism is that it is quite amenable with regards to entering into dialogue with other perspectives and strands of theory. While I have not discussed this point in the dissertation, I consider pragmatism to have a number of affinities and overlaps with other perspectives, such as activity theoretical and phenomenological approaches, and I suspect that there are interesting insights to be gained by establishing such theoretical encounters.

My exploration and development of inquiry is itself highly intentional, since it is motivated by and directed towards addressing a specific research agenda. For this reason, there are a wide array of topics and themes within Deweyan pragmatism that I do not touch upon, and some that I have only afforded limited space for discussion. I suggest that the pragmatist perspective could be further explored and developed to address a wider set of topics of interest to interaction design practitioners and researchers. Among these are the interrelations between temporal aspects of interaction and experience, the ways in which new technologies and forms of expression and use unfold over the course of time, including the shifting roles and responsibilities of users, designers, and researchers, the ways in which inquiring instruments may shape self-image and self-representation, further inquiries into the social use of technology, ways of exploring experiential values and their incorporation into design, the links between habitual structures, expectations and challenges, and further explorations into the role of imagination in inquiry, especially with regards to how it is developed through interaction. As is implied by this list, I am not claiming to present an exhaustive conceptual framework for interaction design. However, on the basis of my own work, and inspired by that

of others, e.g. the work of Schön, McCarthy and Wright, and numerous other contributors, I find it tenable to advocate pragmatism as a foundation for further theoretical development within interaction design.

6 CONCLUSION

Three years of research into the design and use of engaging interactive environments form the backbone for this summarizing dissertation. In addition to studies of literature and existing interactive environments, my involvement in experimental research projects has provided the basis for my inquiries. My participation in three large-scale collaborative projects has provided me with rich insights into tensions and challenges, as well as bursts of creativity and achievement in interaction design processes as they have unfolded. In order to pursue my research agenda, I have chosen an approach that I label *research in and through design*; this approach has been laid out and discussed in this dissertation. On the basis of my approach and the findings resulting from it, I have developed a pragmatist perspective on interaction design centered on the concept of inquiry. My debt to notable pragmatists, especially John Dewey, is great, for I consider my perspective on the design of interactive environments to be an examination and articulation of the application of pragmatist principles to this particular domain.

The contributions from my PhD research fall into three categories: on the highest level of abstraction, I consider my development and explication of a **pragmatist perspective on interaction design** to be the most cohesive contribution of this dissertation. In addition to exploring how this perspective can scaffold understandings of distributed and dialogical creativity as well as experiential and transformative technology in inquiry, my research approach is also based on pragmatist principles. I have argued that this position offers a coherent conceptual foundation for interaction design research. This does not rule out other positions as fruitful foundations for conducting inquiries into the field; on the contrary, it would be interesting to explore how pragmatism can enter into dialogue with alternative positions. On a more concrete level, the included papers present various **means for design and design reflection**. These range from specific workshop techniques to employ in the design process through ways of capturing aspects of the process for reflection to design considerations and sensibilities stemming from analysis of use situations. A common denominator among these means is that they are not prefabricated solutions for specific design problems, but rather instruments that can be part of the repertoire underpinning reflective design practice and research. On the most concrete level of contributions, I count the **prototypes and installations** developed as part of my research in partnership with collaborators from my research community and external institutions. These artefacts embody specific themes, questions, and hypotheses, and in a pragmatist perspective, they can be construed as manifestations of conceptualizations that are put to the test in practice.

By employing the pragmatist perspective in a discussion of these publications, I have shown how the concept of inquiry can provide useful insights into both the design and use of interactive environments. Three of the included papers focus on the design situation. The first of these papers presents **inspiration card workshops**, a collaborative workshop technique in which cards representing sources of inspiration serve as inquiring instruments in the development of design concepts. The second paper provides an in-

depth analysis of **the emergence of ideas** during an inspiration card workshop, highlighting the ways in which creativity is distributed across the participants and the inspiration cards, which scaffold the exploration and transformation of emerging design ideas. The third paper introduces three types of **maps for design reflection** that capture salient aspects of the design process and scaffolds reflection upon these, in particular with regards to the ways in which design concepts are represented and transformed throughout the process. Four of the papers primarily address the use situation, though all with the aim of informing the design of interactive environments. The first of these papers presents the notion of **designing for inquisitive use** on the basis of pragmatism, proposing a view on engaging interactions based on users' resourceful inquiry into challenging situations. The second paper explores **peepholes as means for engagement in interaction design**, further pursuing the concept of inquiry in interactive environments that reveal glimpses of hidden phenomena to evoke users' interest and offer means for further exploration. The third paper presents insights into **staging urban interaction with media façades** on the basis of the development and study of a large-scale interactive installation that transformed the practices and experiences related to a cultural institution and its surroundings. The fourth paper presents the notion of **performing perception**, which denotes the simultaneous acts of interacting, perceiving, and performing that a user carries out when operating interactive systems and the consequences that these interrelated acts have for the experience of interaction.

The contributions have all been motivated by the framing research question: *How can we conceptualize the design and use of engaging interactive environments?* My contributions do not provide exhaustive answers to this question, neither are they intended to, for the question is posed in order to generate hypotheses and to drive and inspire inquiry, rather than to achieve closure. For this reason, my research process has presented a number of openings for future inquiry.

6.1 FUTURE WORK

Being afforded the space and opportunity to reflect upon the different strands of three years of research allows one to weave a number of them together. However, it also becomes clear that not all strands can be addressed adequately within the frame of a PhD dissertation, either because they diverge from the main line of inquiry because there has not been enough time to explore them in depth, or because they open up entirely new and expansive fields. From my current position there are a number of intriguing research prospects to explore in the future, including but not limited to the following:

Experiential qualities in design: In spite of growing interest in this topic, witnessed in some of the included publications, there is still ample leeway to explore ways of articulating and integrating qualities and values in the design process. Those areas include: exploring ways on how to examine existing qualities in use domains; incorporating and tracing experiential qualities through the design process; exploring how given

design concepts are aligned with experiential qualities; and evaluating experiential aspects of prototypes and installations in use situations.

Structured design documentation and reflection: Inspired by the development of maps for design reflection, it appears that there are unexplored potentials in documenting what occurs in the design process, possibly supported by custom-built systems. This is not only relevant for subsequent analyses, but also for making possible a proactive and ongoing structured reflection in the design process. In addition to scaffolding design research, this could also result in generating adaptable inquiring instruments for design practitioners.

Hybrid interactive environments: Conducting research into interactive environments is akin to aiming at a moving target due to the unceasing development of new technologies and use applications. From my point of view, the particularly interesting issues for future research into this field concern how the rapid proliferation of interconnected devices influence experiences in shared spaces, e.g. urban settings and public institutions and how this in turn affects the perspectives for designing interactive environments, vis-à-vis the discussions of open-ended versus closed design touched upon in section 5.4.3.

Further articulations and developments of pragmatist concepts: There are a multitude of pragmatist concepts that warrant further examination in relation to interaction design, among these are the temporal aspects of experience and sense-making and the notion of the work of art as it applies to designers and users of interactive technologies. On a final note, it would also be of great interest to establish dialogues between pragmatism and other positions within the field of interaction design in order to examine affinities, departures, and potentials for further development.

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DESIGNING ENGAGING INTERACTIVE ENVIRONMENTS: A PRAGMATIST PERSPECTIVE

PART 2: PUBLICATIONS

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PhD Dissertation

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LIST OF INCLUDED PUBLICATIONS

Publication [1]: Inspiration Card Workshops

Halskov, K., Dalsgård, P. 2006, "Inspiration Card Workshops", DIS '06: Proceedings of the 6th ACM conference on Designing interactive systems, ACM, New York, pp. 2-11.

Publication [2]: The emergence of ideas

Halskov, K., Dalsgård, P. 2007, "The emergence of ideas: the interplay between sources of inspiration and emerging design concepts ", CoDesign - International Journal of CoCreation in Design and the Arts, vol. 3 no. 4, pp. 185 – 211.

Publication [3]: Maps for design reflection

Dalsgaard, P., Halskov, K., Nielsen, R. 2009, "Maps for design reflection", accepted for publication in Artifact, Routledge.

Publication [4]: Designing for Inquisitive Use

Dalsgaard , P. 2008, "Designing for Inquisitive Use", DIS '08: Proceedings of the 7th ACM conference on Designing interactive systems, ACM, New York, pp 21– 30.

Publication [5]: Peepholes as Means of Engagement in Interaction Design

Dalsgaard, P., Dindler, C. 2009: "Peepholes as Means of Engagement in Interaction Design", Accepted for Nordes 2009: the third Nordic Design Research Conference.

Publication [6]: Staging Urban Interactions with Media Façades

Brynskov, M., Dalsgaard, P., Ebsen, T., Fritsch, J., Halskov, K., Nielsen, R. 2009, "Staging Urban Interactions with Media Façades", Accepted for Interact 2009.

Publication [7]: Performing Perception

Dalsgaard, P., Hansen, L.K. 2008, "Performing Perception - Staging Aesthetics of Interaction", ACM Transactions on Computer Human Interaction, vol. 15 no 3, pp 13:1-33.

Inspiration Card Workshops

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ABSTRACT
In this paper we start from the position that sources of inspiration play an important role in the design process albeit in a frequently intangible way. We present the *Inspiration Card Workshop* as a collaborative method for combining findings from domain studies, represented in *Domain Cards*, with sources of inspiration from applications of technology, represented in *Technology Cards*, to create new concepts for design. We report our findings from three projects in which we have used the method and argue that the use of Inspiration Cards can successfully frame and guide workshops with disparate participants and bring various sources of inspiration into the design process. We furthermore compare the method to four related methods in the design process, namely Future Workshops, Metaphorical Design, Interaction Relabelling and Lateral Thinking.

Keywords
Design, workshop, inspiration, innovation.

ACM Classification Keywords
H5.2. Information interfaces and presentation (e.g., HCI): User-centered design.

INTRODUCTION
Ehn [12] identified the balance between tradition and transcendence as one of the most important dilemmas in design. On the one hand, when we design, we have to take current qualifications, work organization, and work activities as points of departure ; on the other hand we also want to design something which is innovative, and which can support new activities, or support current activities in new and better ways.

A variety of design techniques and approaches which address the *tradition-aspect* are at our disposal, including ethnographic field studies [3], interview [23], use of video [5], etc. Moreover, a vast collection of techniques address the transcendence-aspect, but are (as the term transcendence suggests) rooted in the existing tradition or work practices, including the use of scenarios [8], mock-ups [13] and prototyping [7]. Additionally, there are a number of design techniques that specifically support innovation, for example Future Workshops [18], use of metaphors [22], and interaction relabelling [10].

In this article we zero in on what we consider to be two of the important elements in innovative processes: 1) design materials, in our case, index cards; 2) sources of inspiration.

The paper is organized as follows. First, we briefly review related work, and use this as a platform for introducing the specific format that we are proposing: *The Inspiration Card Workshop*. In the following sections we introduce and analyze our use of the Inspiration Card Workshop in three design cases we recently conducted. In the next section we compare our approach to four other approaches to innovation in design.

BACKGROUND
According to Schön [27,28], design is a reflective interaction (or in his terminology "conversation") with materials, wherein the designer works with different media or materials, experimenting with various aspects of the design. In the case of information systems, a diverse set of design materials is being used, including video, paper documents, mock-ups, prototypes and posters. Moreover, small paper documents are commonly used as an integrated part of various design techniques. One category of small paper documents is the Post-it®, for instance used when making affinity diagrams [2].

A different kind of small paper documents are cards with pictures or text representing other kinds of design materials. In one instance of this category, Buur and Søndergaard [6] have been using what they call 'video cards', with still images of video segments, and space for annotations, to be used as part of collaborative video analysis. In their approach, Buur and Søndergaard found inspiration in the work of Tuder, Muller & Dayton [29], who have used cards to turn ideas into tangible objects. The video card game is a precursor for the use of cards in a similar way, as part of a design workshop where virtual video prototypes have been used [1].

DIS 2006, June 26–28, 2006, University Park, Pennsylvania, USA.

Brandt and Messerter [4] have been using various kinds of cards in four different types of workshops. In addition to using cards to make video clips tangible, they have made cards with single words (so called 'sign-cards'), which constitute a conceptual framework for the activities of the design process. In a technology game they have used LEGO-Duplo bricks with generic functions - such as 'transfer documents' - written on them, taking advantage of their tangibility, and the ease with which the bricks connect to one another. From the use of such tangible objects as components of design games, Brandt and Messerter [4] have made the observation that game pieces, including the various kinds of cards, 'support different stakeholders in making design moves on a conceptual level' [ibid p. 129], and that such design artifacts have become an intrinsic part of the dialogue, argumentation, and means of expressing design moves. Additionally, it seems evident that the objects at hand help focus the design activities .

Additionally, according to Schön [27], rather than looking for standard solutions, the designer sees the situation as something already present in his/her repertoire of paradigm cases or prototypes , despite which he/she manages to make something new by making experimental moves, which may result in something which goes beyond his/her initial expectations. One of the renowned examples from Schön's [26] work is the story of how a group of product developers invented a new kind of paint brush, by thinking of the paint brush as a pump. In the area of information systems design, Madsen [22] has explored how metaphors may shed new light on the way in which information technology might be used by seeing a domain of applications as something different, e.g. seeing a library as a meeting place. In a later study based on three cases in which digital artists and designers worked together, Lervig and Madsen [21] addressed the way in which design materials serve both as examples pinpointing specific attributes, and as sources of inspiration that serve as jumping-off points for work in a design project. Sanders [25] has argued that inspiration plays a prominent role in experience design and points out what she sees as a clash between an information oriented approach and an inspiration oriented approach.

One particular source of inspiration (in a meta sense) for the ideas presented in this article is the Tech Box, as reported by T. Kelley [19] in his book about innovation and creative processes at IDEO. The Tech Box [ibid. p. 144f] is a centrally located file cabinet filled with gadgets and materials, such as tiny switches, Aerogel, Kevlar, rubber balls that don't bounce, super heat conducting copper heat pipes, and the like. People look into the Tech Box for inspiration, then use it for launching new projects, and for selecting items to bring to design meetings to spark innovation, etc. Conversely, people contribute their objects, which become part of the Tech Box [ibid 144ff]. An essential concept relevant to successful innovation processes is the concept of cross-pollination which is, in essence, the idea of bringing together hitherto unrelated elements.

Consciously looking for inspiration is part of the innovation strategy discussed by Kelly [19 p 280]: "Take a trip to Akihabara, the blinking electronic hub of Tokyo" or "Looking for the future of athletics apparel? Head to the beach. Venice Beach, that is." J. Foster [15] is even more radical, suggesting, in his book on generating ideas, that you do things to which you are unaccustomed, for instance: "Study Latin", "Read a magazine that you've never heard of"[ibid. p 72], "Take up water-colour painting" [ibid. 72], etc. The point is not to do all these, but to do something different [ibid p. 73].

An essential point made by Foster [15 p69] is that if generating new ideas primarily consists of combining old elements, a thorough familiarity with old elements is essential.

CONCEPT: INSPIRATION CARDS

An Inspiration Card is a 2" by 3" cardboard card on which an image, a title, a description, and a reference is printed. The card also has an empty box for comments.

We work with two broad categories of inspiraration cards, *Technology Cards* and *Domain Cards*.

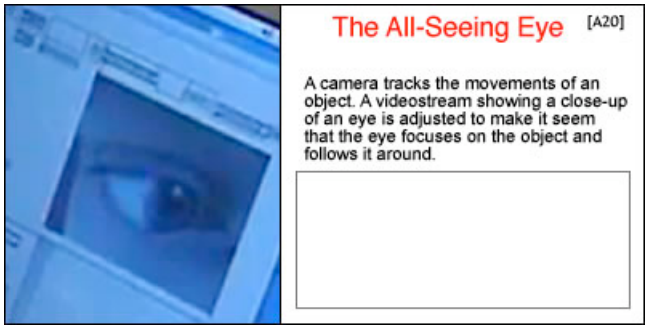

Figure 1: A Technology Card

A Technology Card represents either a specific technology (i.e. Motion Capture) or an application of one or more technologies (i.e. The I/O Brush [24]). For Inspiration Cards to be comprehensible, the content needs to succinctly exemplify one clear concept. As an example, the card in Figure 1 is a Technology Card representing a specific application of a technology (in this case, one of our experiments with camera tracking combined with a video stream). It has a title for easy reference ("The All-Seeing Eye") followed by a short description. It also contains a reference to further information on the technology described. Technology Cards are typically created by designers. They may be related to a specific design project, but they can often be reused in various other projects.

We use Technology Cards as a standard format for storing information on interesting technologies that we have encountered, whether they are of our own design, or that of other designers. We have thus created a repository of Technology Cards for ongoing use in our design projects. Technology Cards can often be reused in other projects and the ones we produced are created from a pool of resources available at http://www.digitalexperience.dk.

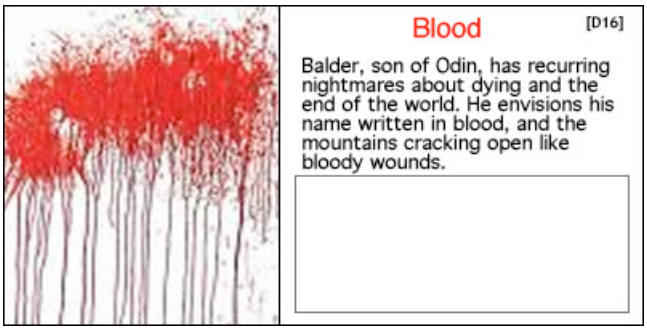

Figure 2: A Domain Card

Domain Cards represent information on the domains for which we design. This information may pertain to situations, people, settings, themes etc. from the domain. As is the case with Technology Cards, these work best if the concept represented is unequivocal. Figure 2 is an example of a Domain Card from a project on designing interactive exhibits related to Norse mythology. The card represents "Blood", a recurring trope in this domain.

The Domain Cards can be created both by designers, usually as a condensation of field studies and research, and by domain experts who participate in the design process. Domain Cards are typically only meaningful within the specific project for which they were created, and reuse is limited.

We work with just two categories of cards due to considerations of simplicity, since the Technology and Domain Cards represent the two main areas that converge in the design process. Designers seeking to appropriate this method may wish create further categories and subsets, eg. the domain cards could be divided into People Cards, Situation Cards etc.

The Inspiration Cards can be used in a number of ways: as a standard for collecting and consistently representing sources of inspiration, as a way to gain an overview of various concepts, as means of communication between designers and domain experts, etc. In the following section, we expand on a particular application of the cards, namely *the Inspiration Card Workshop*.

METHOD: INSPIRATION CARD WORKSHOPS

In an Inspiration Card Workshop, participants create design concepts by combining Technology and domain Cards. This design method is primarily used in the early stages of a design process, during which designers and their collaborators narrow down potential future designs. The method is loosely structured, informal, and has a simple set of rules.

Participants

The method is participatory, and usually involves designers as well as participants with knowledge of the design domain. The participants may be users or stakeholders from the domain, or have certain areas of expertise otherwise related to the domain. The method has proved most fruitful with 4-6 participants. In cases involving more participants, the preparation and presentation stages of the workshop can be conducted in common, with the participants splitting into groups for the combination and co-creation stages.

Preparation

The preparation for the workshop primarily lies in selecting and generating the Inspiration Cards. Technology Cards, primarily generated by the designers, represent technologies that may directly or indirectly be part of the design concepts. The Domain Cards may be generated by the designers based on studies of the domain, however it often makes for more involving workshops and rewarding outcomes if the participants take part in creating them. There should be multiple copies of each card, as well as a number of blank cards to be filled out at the discretion of participants. At a later point, we expand on a number of issues to consider when selecting Technology and Domain Cards.

Presentation of Inspiration Cards

The workshop commences with a presentation of the Technology and Domain Cards selected. Each card is presented in turn, often with the help of images or video clips, to ensure a shared understanding. In general, this takes 1-3 minutes per card. Designers usually present the Technology Cards and the domain participants the Domain Cards.

Combination and co-creation

The main phase of the workshop consists of the participants collaboratively combining the cards on posters, in order to capture design concepts. This phase is often initiated by a discussion in which the participants establish a shared understanding of the cards. There are no set rules for turn-taking, and cards may be combined in the way the participants deem productive. Participants can start by selecting themes or situations from the domain that they wish to support, or transform and then select Technology Cards as a means to this end. Although a rarer occurence, they may also take intriguing technologies as their starting points, then look for situations to which they may be applied.

Any number of cards may be combined to create a design concept. The cards are affixed to poster-sized pieces of cardboard. Participants are encouraged to write descriptions and brief scenarios on the posters, for further detail.

Figure 3: Combination and co-creation

The main point of the Inspiration Cards is to inspire this creative process, and as such, the cards may be used both directly (i.e. "This specific technology may alleviate that specific problem in the domain") and indirectly (i.e. "This application of technology embodies a style that we wish to reproduce in the domain"). To better support creativity, criticisms of design concepts are better left for later stages . Interruptions and complementary ideas are welcome in this phase, and the resulting concepts are seldom the work of a single creator, but rather a collective effort.

Presentation of posters and design concepts

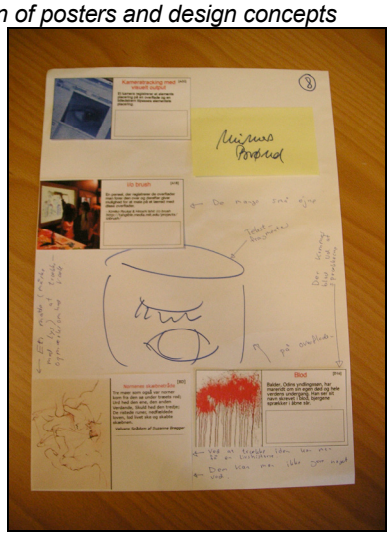

Figure 4: A poster with cards combined to generate and capture a design concept.

After the combination and co-creation phase, the participants take a short break to step back and reflect on the resulting design concepts. In the case of a single group of participants, each poster is discussed *in plenum*. In the case of several groups concurrently combining and creating posters, each group presents its design concepts. The object of this phase is to ensure a common understanding of the concepts, rather than to evaluate them in terms of whether they are appropriate or realistic.

Inspiration Cards in the design process

The main benefit of conducting Inspiration Card Workshops is the generation of new design concepts based on domain and technology studies. The workshop sessions described in this paper were carried out in the early stages of the design process after initial field studies, but prior to mock-up sessions, prototyping and development of final products. The over-all process for the three cases is illustrated in Figure 5:

The findings from the domain and related technology studies form the input for the Inspiration Cards in a condensed form. In turn, the outcome from the Inspiration Card Workshops provides concepts that are further explored in mock-ups sessions, virtual video prototypes [1] and prototypes, before some are eventually realized as final products.

In the cases we set out in this paper, two of the projects are currently in their final stages, and in both cases, design concepts that were the resultof the Inspiration Card Workshops are being developed as final products. Figure 5 contains images of the highlighted steps in the design process of the Gumlink case, from the initial domain and technology studies to the final product.

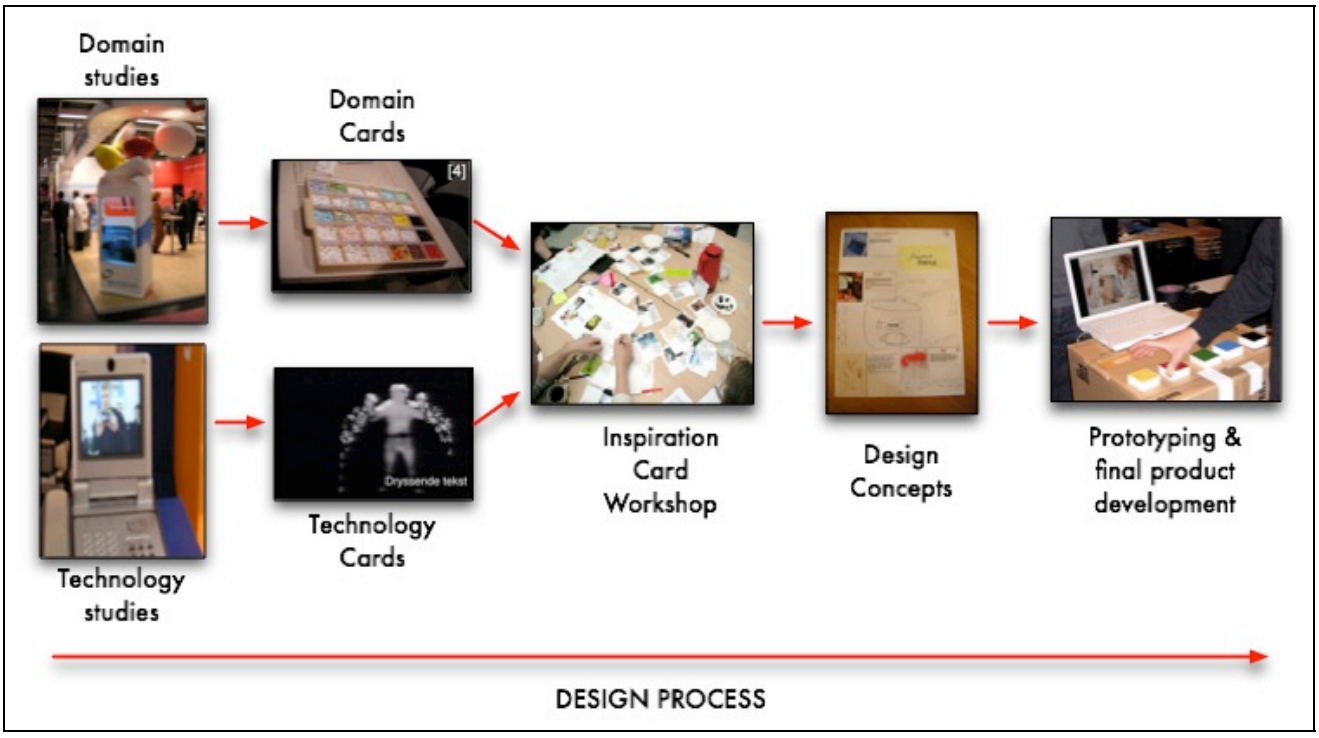

Figure 5: The Inspiration Card Workshop in the Design Process

USING THE INSPIRATION CARD WORKSHOP IN THREE DESIGN PROJECTS

We currently use Inspiration Cards in the ongoing research project, "Experience-Oriented Applications of Digital Technology in Knowledge Dissemination and Marketing". The project explores the use of digital technologies in settings ranging from museums to the retail sector. The Inspiration Cards are used in various ways in the project; in this paper we focus on Inspiration Card Workshops conducted with three of the collaborating partners in the project: 7th Heaven, The Danish Electricity Museum, and Gumlink. These partners and their objectives in the project are highly diverse, allowing for comparative analyses of the Inspiration Card Workshop in different design situations.

7th Heaven – a centre for children's literature

7th Heaven is a very small organization (two full-time employees and a number of free-lancers and subcontractors) that organizes exhibitions related to children's literature. They are currently building a centre for Scandinavian children's literature, and our function in this process is the development of interactive installations in which visitors experience settings and moods from this domain. 7th Heaven is a very democratic organization, in that the staff communicates on a daily basis and makes major decisions based on shared agreement. The staff is very accustomed to explorative and creative processes, and has a good understanding of the domain of experience centres, based on past work and research.

The Danish Electricity Museum

The Danish Electricity Museum is a well-established science and cultural heritage museum. It has many permanent exhibits centered about a fully functional water-power plant, and also organizes special exhibitions. Our work with the museum aims at engaging visitors by augmenting existing exhibits and developing prototypes for new interactive, collaborative installations for learning about energy production and consumption. The museum is a fairly small organization (10 staff members develop exhibitions and conduct tours and talks). The staff is heterogeneous in their various fields of expertise, however there is a high degree of communication and shared understanding. All of the staff members have a solid understanding of the museum domain, and are somewhat accustomed to creative processes with regard to exhibitions and installations

Gumlink – chewing gum research and production

Gumlink is a market leader in research and production of new types of chewing gum, and has 450 employees. We work with Gumlink to create interactive elements for their booth at the world's largest sweets convention. The organization is divided into a number of branches with specific areas of expertise, and the staff is thus very heterogeneous. The Gumlink staff has some understanding of the convention domain, as they participate in a few such events annually. The staff is generally not accustomed to design processes – it is a conventional organization with functionally distinct departments.

Conducting the workshops with the three partners

The three workshops were set up in a similar manner, as described in *Method: Inspiration Card Workshop*. The following is a short account of how the workshop sessions played out:

The 7th Heaven Workshop

The 7th Heaven workshop session had five participants, two from 7th heaven and three from the research group. 7th Heaven took part in the creation of the Domain Cards prior to the workshop by selecting the themes of most of the cards, and supplying many of the descriptions. The 7th Heaven staff made almost non-stop use of the Inspiration Cards. The cards were used primarily in the sense intended by us as designers, namely to combine sources of inspiration and generate new concepts. Much of the time, we could lean back, as the 7th Heaven participants picked out, commented on, altered, and combined the cards. The participants were quick to assemble the cards on posters to capture and freeze ideas. Posters were very rapidly completed and put aside to be finished later, in order to move on with alternate ideas. The 7th Heaven Workshop resulted in 7 concepts. The level of detail varied across these concepts; some were fully formed ideas, including comments on implementing them, others were sketches for further thought and exploration.

The Danish Electricity Museum workshop session

For this workshop, the participants split into two groups, each consisting of two participants from the museum and two participants from the research group. The first of the groups went through a process very similar to that of 7th Heaven. The participants in the second group, however, used the Inspiration Cards for two purposes. First, they lined up and categorized the cards. The categorization served as a starting point for a discussion of the ways in which they, as domain experts, perceived the museum, in contrast with the perceptions we had formed, as visitors and designers. As designers, we had created the Domain Cards based on a number of field studies at the museum, and the participants from the museum wanted to ensure that no important aspects were left out. The participants of the second groupd were thus eager to handle and reorganize the cards, and to create new ones from the blank cards, although in a different manner than intended. This discussion took up almost half of the time allotted to the combination and co-creation phase. The remaining time was spent combining the cards and creating new concepts, although due to time constraints, the second group produced fewer concepts than the first group. The workshop resulted in a number of new concepts, the majority of these originating from the first group. The concepts produced the second, analytically oriented group were generally at an earlier phase of completion than those of the first group. However, the process of the analytically oriented group yielded insight into the self-perception of the museum staff, and prompted discussion of the domain with

us as designers. This outcome, though not fruitful in terms of design concepts, established a valuable common ground for furthering the design process.

The Gumlink workshop session

As was the case with the Danish Electricity Museum workshop, the participants in the Gumlink workshop session carried out the combination and co-creation phases in two groups, consisting, in this case, of three Gumlink participants and two participants from the research group. The processes of the two groups were fairly similar. The participants from Gumlink made less use of the Inspiration Cards than the participants in the 7th Heaven and Danish Electricity Museum workshops. The research group, based on field studies and interviews with Gumlink staff, created the Domain Cards. Some Gumlink participants were very hesitant to use the cards, especially the Technology Cards, handling them only a few times during the workshop. The creation of posters with concepts was largely left to the research group. The participants came from different departments, and primarily used the cards to present and discuss differing views on the convention setting among themselves, or to communicate these views to us. They were less inclined to combine the cards in new ways, and instead evaluated the Technology Cards in terms of how the technologies could be applied in concrete ways. In relation to the 7th Heaven and Danish Electricity Museum workshops, the results of the Gumlink combination and co-creation phases were thus limited in terms of new design concepts. Prior to the workshop, the research group had presented three conceptual design proposals to Gumlink. These proposals were meant as input to discussion of new concepts. However, the design concepts that were produced in the combination and co-creation phases either were very similar to these previously presented proposals, or to the concepts presented on the Technology Cards.

FINDINGS FROM CONDUCTING THE WORKSHOPS

Disparate participants, disparate outcomes

Although the setups for the three workshops were almost identical, there were a number of differences in how they progressed, and how fruitful the outcome was with regard to the intended purpose of the workshop, i.e. the development of new design concepts. With the identical workshop setup in mind, the disparate processes and outcomes of the three sessions point towards the following factors for participants' influence on the success of Inspiration Card Workshops, in terms of producing rich and relevant design concepts:

Familiarity with fellow participants

The workshop establishes a forum for creative interchange between participants. When creating new concepts, participants put themselves on the line, and risk failure by presenting ideas that other participants may reject or deride. If participants are well acquainted and have collaborated in previous projects, they have established an understanding amongst themselves, and recognize that their behaviour in experimental, creative settings is not necessarily representative of how they would act in other fora. However, if they are only slightly acquainted, as was the case with the Gumlink staff, they may be less likely to venture into unknown terrain. The nature of the organization from which participants come exerts an influence on this, as participants from hierarchical or formal organizations may feel more constrained than participants from those that are less formal.

Familiarity with creative methods and processes

It was evident that the workshops were fruitful when participants had previously worked with creative methods and processes. This was the case with the participants in the 7th Heaven workshop, and to some extent with the participants in the Danish Electricity Museum workshop. These participants quickly grasped the workshop format, and were eager to use the cards as intended. The Gumlink participants were clearly used to working in a different way. They were more reluctant to accept the workshop format, and used the cards in a limited way.

Insight into use domain

Combining Domain and Technology Cards is a process of appropriating aspects of existing technological applications that in some way transforms the domain. This is best achieved if the participants have a firm understanding of the domain. This was very much the case for the participants from the Danish Electricity Museum. They used the Technology Cards by evaluating the ways in which they might influence practices at the museum, and in which the museum could better communicate central concepts to visitors. The concepts from the 7th Heaven workshop were more speculative, in that the actual domain - the literature centre - was not yet built. The participants thus drew on experiences from similar contexts, and were limited in the level of detail they could reach in the design concepts. The Gumlink participants had a more limited insight into the use domain, namely the convention setting, as they only participate in sweets convention a few times a year, and had no formal fora in which to discuss it in their everyday work. Thus, they used the Domain Cards to start such discussions, and had very few comments on ways in which to appropriate the Technology Cards.

Different kinds of inspiration

For the preparation of the workshops we paid attention to the differences between the various sources of inspiration, which became even more evident during the workshops.

Some of the cards represented applications from the same domain as the one for which we were designing, as was the case with the Danish Electricity Museum's where the '*The Theremin*', the predecessor to the sound synthesizer, was on one of the inspiration cards. In other cases there was a larger conceptual distance between the source of inspiration and the design domain. Both technology card close to the design domain and ones with a larger conceptual distance seem to play important roles, the former making it immediately easy to acknowledge the usefulness of inspiration sources, and the latter having a greater innovative power.

Some of the Technology Cards represented a collection of technologies, such as *Slow Technologies* (Hallnäs & Redström 2001), or a combination of complex technologies, like *Khronos* (Cassinelli et al. 2005), which we found did not fit so well into a process wherein large collections of inspiration cards were presented in a short time frame. Participants simply did not grasp the idea, or could not remember the information presented.

We have however observed that it is valuable to have Domain Cards that represent single elements from the domain, such as *Gold,* as well as complex information such as *The Twilight of the Gods*.

In addition to sources of inspiration represented by the Technology Cards, a number of cases and examples were spontaneously brought into play by workshop participants. At the 7th Heaven workshop, reference was made to a specific science museum, which was used to explain a type of place the domain experts did not like. Reference was in fact made to a diverse set of previous cases and examples, including 'Vin og Ølgod', a well known Danish pub, which was used to suggest the atmosphere of Valhalla. The art of Bill Viola was also brought into the discussion of speed, atmosphere and the style of 7th Heaven. At the Gumlink workshop, Virgin airlines was mentioned as an argument for the potential of doing ordinary things in a special way, and was used in a discussion of the way in which technologies from the cards could be used to enhance the potential customer awareness and recollection of Gumlink.

The relations between sources of inspiration and ideas

Some of the ideas generated during the workshops had a very direct relation to the source of inspiration, and the creative move merely consisted of replacing a single element from the source of inspiration with an element from the design domain. At the 7th Heaven workshop it was suggested that the letters in *The Falling Letters* be replaced with short pieces of text from Norse mythology, and our Gumlink partners suggested that the letters be replaced with chewing gum.

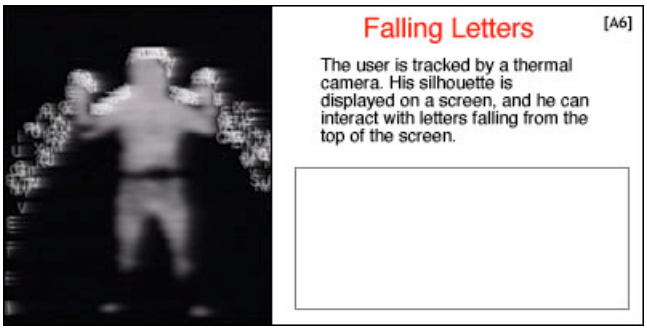

Figure 6: The *Falling Letters* Technology Card.

Clearly, combining previously unrelated elements is a crucial aspect of innovation. At the 7th Heaven workshop we explored the idea of combing *Wodan's Throne* with the *Information Table,* which stimulated a discussion about making a very contemporary implementation of Wodan's Throne.

Some situations consisted of combining just two cards, as in the examples above, but in other cases several cards were simultaneously involved. For example, at the 7th Heaven workshop, there was an extensive exchange involving several cards, including Technology Cards, Inspiration Cards and custom-made cards created by participants during the workshop.

The role of cards

In addition to their direct role in idea generation, the technology cards supported focus shifts in the process, and made it easier to bring new perspectives, and, by extension, new ideas, into the design process. Using cards in this way was particularly prominent in the last past of the 7th Heaven workshop, wherein the domain experts picked up new cards and used them to introduce new subjects for discussion, when the process was not proceeding as rapidly as in the previous very intense phase. In a similar way, participants in the Gumlink workshop used the cards to try to start the process, and made it easier for people to raise their voices.

As discussed above, the cards played a vital role in generating specific design ideas, but we have also observed that the design ideas that emerge are not always further elaborated, or at least documented. Moreover, some inspiration cards were not used at all, although we could not identify a clear reason. However, part of the rationale behind *The Inspiration Workshop* is to bring a large selection of material into the workshop, which implies that not all material will be used.

COMPARISON OF THE INSPIRATION CARD WORKSHOP AND RELATED METHODS

In this section we briefly introduce four related approaches to innovation in design, and use them as a platform for comparing them with The Inspiration Card Workshops. The selection of related approaches is by no means intended to be exhaustive, but rather to serve as a starting point for putting The Inspiration Card Workshops into perspective.

Metaphorical design

A metaphor may be defined as a concept from one linguistic category, used to describe a phenomenon normally referred to by concepts from a different linguistic category [22]. The essence of metaphorical design is to understand the product being designed by using metaphors to see it as something different, and in this way generate new perceptions, explanations, and inventions [22] and [26]. As an example, Madsen [22] describes how a library may been seen in new ways, by seeing it metaphorically as a storage for books or as a meeting place, thereby generating different ideas about which kind of information system may support activities at the library.

Future workshops

'Future workshop' is a highly structured process originally suggested by Jungk and Müllert [18]; F. Kensing [20] has

proposed its use in systems development. As briefly summarized by Kensing and Madsen [20], the Future workshop technique is meant to shed light on the common, problematic situation of generating visions for the future, and to discuss how these visions can be realized. Key elements of the technique include a set of specific rules such as restricting speaking time to 30 seconds during certain periods of the workshop, and not allowing critique during the fantasy phase. Moreover, the use of materials like Post-it®'s and posters is an important aspect.

Interaction Relabelling and Extreme Characters

'Interaction Relabelling' and 'Extreme Characters', which have been suggested by Djajadiningrat, Gaver, and Frens [10], are two methods for exploring aesthetic interaction. There has been an interest in developing new kinds of interaction, which are guided not only by ease of use and efficiency, but also by richness, attractiveness and other aesthetic qualities.

'Interaction Relabelling' has at its core a consideration of the product one is designing in terms of an existing product. In Djajadiningrat, Gaver, and Frens [10 p67] the technique is illustrated by the example of relabelling a toy revolver as an appointment manager, generating interaction design ideas like thinking of rotating the cylinder to scroll through appointments.

The idea of 'Extreme Characters', as the term suggests, takes the approach of design for characters with extreme emotional attitudes. Djajadiningrat, Gaver, and Frens [10 p68] explain the approach by showing how extreme characters, such as a drug dealer and the pope, may inform the design of an appointment manager.

Lateral thinking

Lateral thinking**,** introduced by de Bono [11] includes a large collection of creativity techniques, of which we restrict our discussion to *random input* [ibid 177], which has at its core the selection of a randomly chosen word (e.g. the word number three on page 89 of a dictionary), which acts as the starting point for idea generation.

Comparison

With the exception of Future Workshops, all approaches have in common multiple domains as sources from which they draw inspiration as a driving force to innovation. Lateral Thinking, as well as Interaction Relabelling and Extreme Characters argue for a large distance between the domain for which one designs, and the domain that serves as inspiration, as a large distance stimulates seeing the design task in a new way. By a similar argument, Metaphorical Design argues for a conceptual distance between the two domains, but also recommends that there be at least one bridging concept between the two domains. According to our experiences, it seems productive to include inspiration from both close and remote sources of inspiration. Future Workshops do not include sources of inspirations as such.

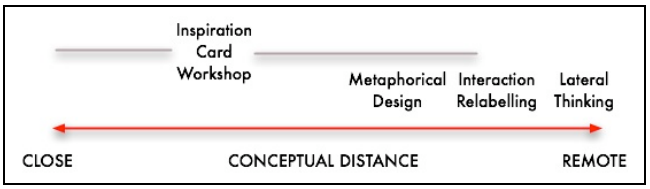

Figure 7: Comparison of conceptual distance between domains of inspiration and use.

The various approaches also differ with respect to the number of sources of inspiration they suggest bringing into the process. Lateral Thinking, together with Interaction Relabelling and Extreme Characters, propose few sources of inspiration at a time, in contrast to the Inspiration Card Workshop, which simultaneously brings into play numerous elements. We have identified Metaphorical Design as belonging somewhere between these two extremes.

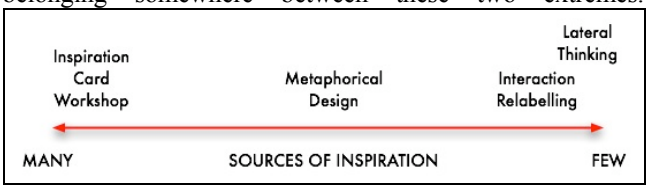

Figure 8: Comparison of the number of sources of inspiration.

Metaphorical Design and Lateral Thinking primarily use language as a tool in the innovation process, whereas physical materials are essential means of supporting the design process in Inspiration Card Workshops. Extreme characters works at the conceptual level, whereas Interaction Relabelling suggests bringing mechanical devices into the process, in order to stimulate new ways of thinking about interaction.

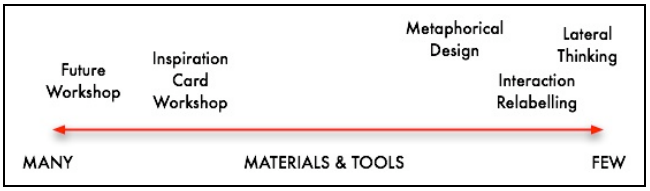

Figure 9: Comparison of the number of materials and tools.

The Future Workshop technique is a highly structured process with clearly defined phases (critique, fantasy and implementation) and with a number of specific rules, such as restricting speaking time to 30 second during certain periods of the first phases, and not allowing critique during the fantasy phase. On the other hand, Lateral Thinking is very much a 'light weight' process with minimal structure. In between, we find the other approaches with few rules and some kind of overall structure, e.g. 1) generating metaphors, 2) evaluating metaphors and 3) selecting and applying the metaphors in the case of metaphorical design; or in the case of The Inspiration Card workshop, presenting sources of inspiration and domain cards, developing design concepts, and presenting design concepts.

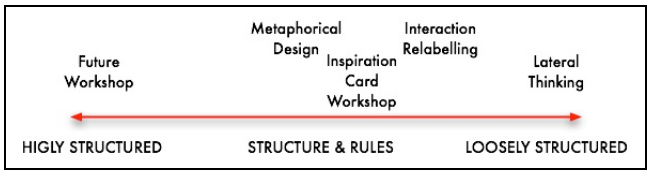

Figure 10: Comparison of structure and rules.

CONCLUSIONS AND FUTURE WORK

In this paper we have presented Inspiration Cards as a means for the designer to present condensed findings from domain and technology studies. We have further elaborated on the Inspiration Card Workshop as a method for combining sources of inspiration to develop new design concepts, and reported on three design cases in which we have employed the method.

Our over-all evaluation of the Inspiration Card Workshop method and the response from participants in the workshop sessions is positive. The Inspiration Cards have clearly stimulated an innovative and productive process, and we have observed that the design concepts developed generally find a suitable balance between being innovative, and realistic in terms of implementation. The method is designed to be informal, loosely structured, and simple (eg. we only present two categories of cards). These factors have facilitated the involvement and engagement of participants and have been crucial with respect to the productiveness of the workshop.

The findings from the design cases highlight a number of important aspects with regard to the sources of inspiration introduced in the workshop sessions, and the role of the Inspiration Cards. We recommend including sources of inspiration that vary in their conceptual distance from the use domain, in order to foster design concepts that may both fit into, and expand the domain. In our experience, the combination and co-creation phases of the workshop work well without setting up rules for roles and turn-taking. This allows participants to use the Inspiration Cards in a number of ways, such as pointing out specific ideas, framing over-all discussions, shifting focus from one aspect of the design concept to another, moving from concrete to abstract discussions etc. The experience of participants in Inspiration Card Workshops plays at least as important a role as the setup of the workshop, with regard to the generation of viable design concepts. Prior collaboration experience, insight into the use domain, and familiarity with creative methods and processes have proved to be valuable prerequisites for participants in the workshops from which we have reported.

The Inspiration Card Workshop method addresses the way in which designers draw upon repertoires of prior knowledge and expertise, while respecting the discreteness of the situations they encounter, referred to by Schön [27] as a process as of reflective conversation. Fallman [14] suggests that accounts of development of new prototypes in HCI literature focus primarily on the attributes of the prototypes themselves, rather than on the vital design process by which the prototypes come about. On the one hand, The Inspiration Card Workshop method can be construed as an approach for designers to actively consider their repertoire in relation the distinct situation they face, and, on the other hand, to engage in reflective conversations between the repertoire and the situation.

We continue to experiment with the workshop format in order to incorporate our findings and iteratively improve this design technique. Among other things, we are looking into ways of supporting the method technologically, both with regard to the Inspiration Card Workshop, and the creation, storing, and sharing of the inspiration cards throughout the design process. One possible avenue to pursue in this regard would be to combine a database for inspiration card storage and sharing with input devices and displays for use during the workshop, like the Video Wall presented in Jensen, Buur & Djajadiningrat [17]. However, the current "low-tech" solution has proved successful in yielding ideas and concepts. The implementation of digital support for the method might hamper the creative, explorative and collaborative processes that the current workshop format supports, by presenting entry barriers in terms of having to learn to use new technological tools.

The Inspiration Cards have a range of applications in the design process, which goes beyond the workshop method presented in this paper. One such application is the use of the cards as a standard means of representing and communicating sources of technological inspiration, as well as key findings from field studies. We plan on typologically classifying the Technology and Domain Cards into subsets as our repertoire expands. With regard to Technology Cards, this will help generate an overview of state-of-the-art applications of IT, whereas a typology of Domain Cards will support comparative analyses of recurring patterns across domains.

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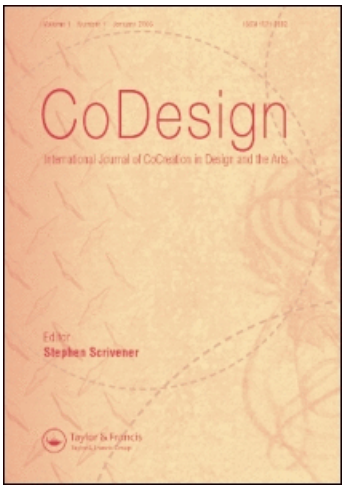

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The emergence of ideas: the interplay between sources of inspiration and emerging design concepts

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The emergence of ideas: the interplay between sources of inspiration and emerging design concepts

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The development of new ideas is an essential concern for many design projects. There are, however, few in-depth studies of how such ideas emerge within these contexts. In this article we o er an analysis of the emergence of ideas from specific sources of inspiration, as they arise through negotiation and transformation, and are mediated by design artefacts during an Inspiration Card Workshop, a collaborative event in which findings from domain studies are combined with technological sources of inspiration, in order to generate design concepts. We present a micro-analytic study of the interwoven social and artefact-mediated interactions in the workshop, and identify essential phenomena that structure and create momentum in the development of new design concepts, namely (1) the manifest properties of Inspiration Cards and Concept Posters as physical props for encouraging and supporting design moves, (2) the semantic dimensions of the cards and posters as catalysts for discussion, derivation and ideation, and (3) ad hoc external sources of inspiration as means of supplementing and developing design concepts. The analysed design situation is characterised as being socially distributed, artefactually mediated, adaptive and emergent.

Keywords: Design; Workshop; Innovation

1. Introduction and background[1]

According to Schön (1983, 1988), design is a reflective interaction (or in his terminology, 'conversation') with materials, wherein the designer works with di erent media or

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[1]The first part of the introduction and the description of the Inspiration Card Workshop technique in this article are based on Halskov and Dalsgård (2006).

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materials, experimenting with various aspects of the design. In design processes involving multiple participants, such as many Participatory Design events, a diverse set of design materials is often employed, including video, paper documents, mock-ups, prototypes and posters. Moreover, small paper documents are commonly used as an integrated part of various design methods.

One category of small paper document is the Post-it [1], used, for instance, when making a nity diagrams (Beyer and Holtzblatt 1998). Another kind of small paper document is cards with pictures or text representing other types of design materials. In one instance of this category, Buur and Søndergaard (2000) have been using what they call 'video cards', with still images of video segments, and space for annotations, to be used as part of collaborative video analysis. In their approach, Buur and Søndergaard found inspiration in the work of Tuder et al. (1993), who have used cards to turn ideas into tangible objects. The video card game is a precursor for a similar use of cards, as part of a design workshop in which virtual video prototypes have been used (Bardram et al. 2002). Brandt and Messerter (2004) have been using various kinds of cards in four di erent types of workshops.

Additionally, according to Schön (1983), rather than seeking standard solutions, the designer sees the situation as something already present in his/her repertoire of paradigm cases or prototypes, despite which he/she manages to create new constructs by making experimental moves, the results of which may exceed his/her initial expectations.

In the area of information systems design, Madsen (1994) has explored how metaphors may shed new light on the way in which information technology might be used by seeing a domain of applications in a di erent light. In a later study based on three cases in which digital artists and designers worked together, Lervig and Madsen (2003) addressed the way in which design materials serve both as examples that pinpoint specific attributes, and as sources of inspiration that function as jumping-o points for work in a design project. Consciously looking for inspiration is part of the innovation strategy discussed by Kelly (2001, p. 280). Foster (1996) takes an even more radical stance, recommending, in his book on generating ideas, the deliberate pursuit of unaccustomed experiences.

In this article we o er an analysis of the emergence of ideas from sources of inspiration mediated by design artefacts during an Inspiration Card Workshop (Halskov and Dalsgård 2006), a collaborative event in which findings from domain studies are combined with technological sources of inspiration to generate design concepts.

Sanders and William (2001), and Stappers and Sanders (2003) have identified the distinction between three ways of harnessing the creativity of end-users in the development process: (1) 'what people say' concerns what people say, for instance in focus groups; (2) 'what people do' concerns direct or indirect observation; (3) 'what people make' enables expression of creative ideas. Our approach relates to the third of these categories.

Moreover, our work is also related to other studies of the social dimension of the design processes, including the use of design artefacts. Perry and Sanderson (1998) have, in two ethnographically informed studies from the domains of mechanical and construction engineering, focused on the diversity of design artefacts, including their role in communication and the organisation of co-located group design processes. More related to our specific approach is the work of Mondada (2006), who, in the domain of architectural design, employs a praxeological perspective on the analysis of interaction 'which locates cognition not in the head of the lone subject but in the orderly production

and recognisability of actions as they are designed, dealt with, and, if necessary, repaired by participants' (Mondada 2006, p. 2). The paper provides a detailed interaction analysis which includes findings concerning the role of gaps in the conversation, gestures, and the spatial organisation of objects.

In contrast to Sanders and William (2001), Stappers and Sanders (2003), Perry and Sanderson (1998), and Mondada (2006), the research agenda driving the work reported here is based in the study and analysis of the specific role played by sources of inspiration—both those with a physical form and those in the form of ad hoc improvisations—in creative design sessions. Specifically, we study sources of inspiration, manifest and improvised, in an Inspiration Card Workshop conducted with our collaborating partner, a major Danish department store. The pragmatic agenda of the workshop in relation to the department store was to develop innovative ways of using digital technology in marketing.

The research contributions we present as a result of this work are twofold: first, the concrete findings of this paper o er an understanding of the artefact-mediated emergence of design ideas. Second, we believe that our micro-analytic method will encourage design researchers to carry out similar studies of design practices.

2. Inspiration Card Workshops

An Inspiration Card Workshop is a collaborative design event involving professional designers and participants with knowledge of the design domain in which domain and technology insight is combined to create design concepts. The event is similar to the Playful Collaborative Exploration approach (Johansson and Linde 2005).

Inspiration Card Workshops are primarily used in the early stages of a design process, during which professional designers and their collaborators narrow down potential future designs. The goal of the workshop is to develop design concepts starting from Technology Cards and Domain Cards.

A Technology Card represents either a specific technology (e.g. Motion Capture) or an application of one or more technologies (e.g. The I/O Brush; Ryokai et al. 2004). As an example, the card in figure 1 is a Technology Card representing a specific application of a thermal camera tracking technology.

Figure 1. A Technology Card. The text label translates as 'Dripping text'.

Domain Cards represent information about the domains for which we design. This information may pertain to situations, people, settings, themes, etc., from the domain. Figure 2 is an example of a Domain Card from the setting for which we designed in the specific case addressed in the subsequent part of this article.

The preparation for the workshop primarily involves selecting and generating the cards. Technology Cards, primarily generated by the designers, represent technologies that may directly or indirectly be part of the design concepts. Technology Cards can often be reused in various other projects, and the ones we produce are predominantly created from a pool of resources available at www.digitalexperience.dk. The Domain Cards may be generated by the designers based on studies of the domain, or by the participants from the design domain.

The workshop itself commences with a presentation of the Technology and Domain Cards selected. Each card is presented in turn, often with the help of images or video clips, to ensure a shared understanding.

The main phase of the workshop consists of the participants collaboratively combining the cards on posters, in order to capture design concepts (see figure 3). This phase is often initiated by a discussion in which the participants establish a shared understanding of the cards. There are no set rules for turn-taking, and cards may be combined in the way the participants deem most productive. Participants can start by selecting themes or situations from the domain that they wish to support, or transform and then select Technology Cards as a means to this end. Although a rarer occurrence, they may also select intriguing technologies as their starting points, then look for situations to which they may be applied.

Any number of cards may be combined to create a design concept. The cards are a xed to poster-sized pieces of cardboard. Participants are encouraged to write descriptions and brief scenarios on the posters, for further detail (figure 4).

After the combination and co-creation phase, the participants take a short break to step back and reflect on the resulting design concepts. In the case of a single group of participants, each poster is discussed in plenum. In the case of several groups concurrently combining and creating posters, each group presents its design concepts. The object of this phase is to ensure a common understanding of the concepts, rather than to evaluate

Figure 2. A Domain Card. The sign translates as ‘Today’s special o er’.

Figure 3. Combination and co-creation of design concepts using Inspiration Cards.

Figure 4. A poster with cards combined to generate and capture a design concept. The scribbled notes on the poster translate as (clockwise from the top): 'Waiting/Queue/ Transit/Waste', 'Checkout line', 'Info about level content/elevator', 'Art þ play', 'Better mood while waiting', 'Mirror activities outside of toilet inside the toilet' and 'Checkout þ waiting time'.

them in terms of whether they are appropriate or realistic. Figure 5 gives an overview of the workshop phases.

3. Introduction to the department store workshop case

We currently use Inspiration Cards in the ongoing research project, 'Experience-Oriented Applications of Digital Technology in Knowledge Dissemination and Marketing' (www.cavi.dk/projects/experienceapplications.php).

The project explores the use of digital technologies in settings ranging from museums to the retail sector. As an integral part of the concept development phase, we have carried out one or more Inspiration Card Workshops with each of the collaborating partners (The Danish Electricity Museum, the 7th Heaven Centre for Children's Literature, the chewing gum manufacturer, Gumlink[1], and the department store, Salling). We have extensive experience with carrying out this type of workshop, both in this project and in others, as reported in Halskov and Dalsgård (2006), and Dalsgård and Halskov (2006).

In this paper, we focus on one specific workshop, in order to analyse in detail the ways in which ideas emerge from sources of inspiration mediated by design materials, the way in which they are negotiated throughout the workshop, and combined into design concepts. The degree of detail in the selected analytical method does not leave room for direct comparative analyses of multiple workshops; however, we compare the general findings from the specific workshop reported in this paper, to our findings from other workshops carried out within the project. This extends the generalisability of the findings from this specific case, and indicates broader themes that relate to the emergence of ideas in this type of design event.

The Inspiration Card Workshop we present and analyse in detail was conducted with one of our collaborating partners, Salling, a major Danish Department Store. Salling is one of the oldest and most renowned stores in Denmark, and has just celebrated its 100th anniversary. The store has undergone a recent expansion, and as a part of the rethinking of the store layout, the authors collaborated with Salling in developing interactive ways of inviting potential customers to explore the store and its merchandise.

Prior to the Inspiration Card Workshop, we held a number of initial meetings to establish the scope of the project, discuss the intentions and values that were to guide the design process, and reach a general understanding of our respective competences and working methods. These meetings were supplemented by a number of field studies at Salling, in which we gathered empirical data about situations, interactions, people, and places in the department store. Simultaneously with the field studies, we researched innovative and experience-oriented uses of interactive systems. This research is partially available in a condensed form at http://www.digitalexperience.dk.

Based on the field studies and the technological research, 18 Domain Cards and 14 Technology Cards were selected (see Appendix). The Domain Cards represented locations in Salling that were either key places in the store, e.g. the store entrance

Figure 5. Overview of the workshop process.

(figure 6), or that left room for transformation and improvement, e.g. so-called 'dead zones' in the store (figure 7).

The Technology Cards were selected on the basis of two diverging criteria: (1) because they were conceptually related to the domain in a fairly direct way (so the workshop participants would easily relate them to Domain Cards), e.g. 'Touch Light', a touch display for use on window facades (figure 8), or (2) because they were conceptually quite di erent from the domain of product display (which could stimulate discussions and provide alternative views on the domain), e.g. Drumhead, a musical installation combining video projection on amorphous surfaces, touch sensors, and audio feedback for drummers (figure 9).

The workshop participants were four designers (including the authors) and two interior decorators from Salling. No shoppers participated in the process. The Technology Cards were selected by the designers, and the Domain Cards were selected collaboratively by the designers and the Salling interior decorators.

Figure 6. The Salling Main Entrance Domain Card.

Figure 7. The Dead Zones Domain Card.

Figure 8. The Touchlight Technology Card.

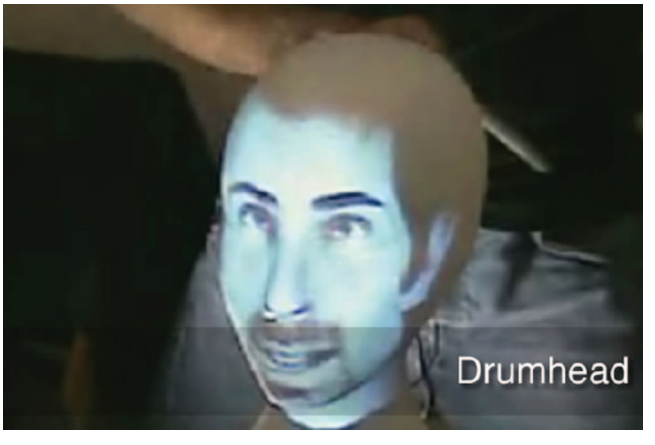

Figure 9. The Drumhead Technology Card.

4. The structure and progression of the design concept phases

The initial stage of the workshop consisted of explaining the purpose and structure of the event to the workshop participants. After that, the participants from Salling, and the designers presented the Domain Cards and the Technology Cards, respectively, explaining the content of each card, and the reasons for including it in the workshop.

Then followed the main part of the workshop, the combination and co-creation phase, in which design concepts were developed and discussed. This phase lasted approximately 70 minutes. During this period of time, eight posters with design concepts were created. In the following, we shall refer to these phases as design concept phases. The design concept phases were followed by a summary of the process and the posters created. The design concept phase took 55 minutes, the summary phase 15 minutes.

The posters varied greatly in level of detail and concreteness: Some posters described distinct interfaces and applications, whereas others suggested possible areas of interest for design, indicating specific domains and technologies on which the design process might focus. The number of Inspiration Cards used on each poster varied from two to six, and were not indicative of the level of concreteness, i.e. the most concrete design concept was a combination of three cards, whereas posters with two and five cards loosely pointed to areas of interest.

Figure 10 provides an overview of the structure and progression of the combination and co-creation phase of the workshop.

An analysis of the transcription and video of the workshop reveals a number of distinct boundary markers (Gumperz 1982), statements and/or actions that initiate or terminate discrete phases within the combination and co-creation phase. Two examples of boundary markers are the statements and actions that initiate and conclude the poster creation phase.

> P1 (Picks up the Interactive Table Technology Card) 'I have to say, this thing is fantastic. I mean, for the 100 year anniversary, if we want to tell a story'.

The initiation boundary marker consists of an oral statement combined with a physical gesture, the act of picking up a specific card. These actions also serve as the initiation boundary marker for the first discrete poster phase, and frame this phase as relating to a certain technology and theme from the domain (the anniversary).

The termination boundary marker also consists of an oral statement and a physical gesture, that of putting aside the last poster:

> P3 (Has put aside poster no. 8) 'Well, do you think that we have missed anything?'

These actions also serve as the initiation boundary marker for the summary phase. This double character of initiation and termination boundary markers was evident in a number statements and actions throughout the process, in that a participant's statement of starting a new phase often implied that the previous process has run its course.

As is illustrated in figure 10, the phases overlapped in a number of cases. This happened when one design concept was being discussed, and a new and interesting idea not directly related to the concept was brought into the discussion. In some cases, these ideas would be integrated into the current design concept poster. In other cases, the idea

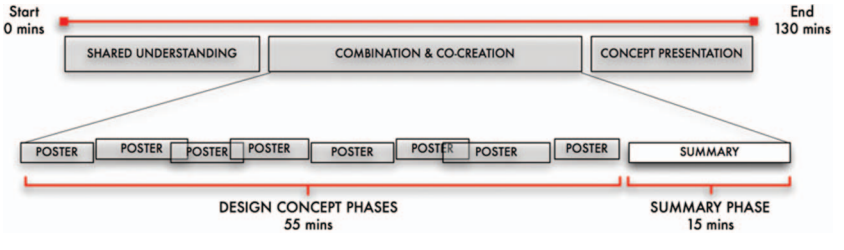

Figure 10. The structure and process of the combination and co-creation phases of the Inspiration Workshop.

did not fit into the current discussion, and two discussions would play out simultaneously. In these cases, the physical work of creating new posters was often initiated before work on the old posters had ended.

In a similar vein, participants would increasingly point to previously discussed concepts as the workshop progressed. Since the participants had not worked together before the workshop, these concepts formed a common ground, and were arguably the most stable points of reference in the discussion. The act of referring to previously formed design concepts also served to connect the concepts and establish coherence between them.

5. Analysis of the Talking Heads concept phase

In this section, we move to a micro-analytical level and focus on the creation of one of the design concepts created. The centre of attention in this analysis is the identification of how the participants in the Inspiration Card Workshop move from having a general goal and a number of sources of inspiration, towards forming a design concept; in other words, identifying which elements in the process created and maintained structure and momentum.

We were initially interested in the roles of physical design artefacts, i.e. Inspiration Cards and Design Concept Posters, in the process. However, initial analyses of the eight design concept phases revealed three additional key elements that structured and drove the process in conjunction with the physical design artefacts, namely External Sources of Inspiration, General Workshop Themes and Values and Derived Ideas.

In the following, we give an account of a single design concept phase, entitled Talking Heads, and in the subsequent section we discuss the general roles of the key elements in the workshop, which included two participants (P1 and P2) from the department store and three designers/researchers (P3, P4, and P5).

The Talking Heads concept was the fifth concept developed in the Inspiration Card workshop, and the chronological order of the key elements is illustrated in figure 11. For the sake of temporal overview, the numbers in the figure refer to specific incidents in the process, referred to in this section with numbers in square brackets, e.g. [1]. We present each of these incidents in this section. The categories of the incidents are identified in the horizontal rows, which signify Inspiration Cards, External Sources of Inspiration, General Themes, Derived Ideas, and Concept Posters.

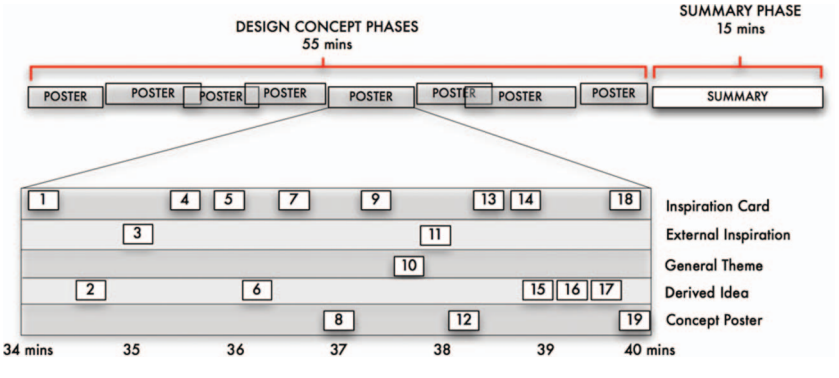

Figure 11. The structure of key elements in the development of the Talking Heads concept.

During the transition from the previous concept, people chatted and drank co ee. While referring to the Drumhead Technology Card [11] P1 starts out:

> P1 'Speaking of heads, I can actually imagine that. I would actually like heads that you could swap and replace.'

Here, the Drumhead Technology Card (figure 9) acts as a boundary marker which indicates that a new subject is introduced, and which is followed by a brief exchange between P1 and P3, leading P2 to suggest an idea [2]:

> P2 'I would prefer something like having someone telling the story.' [about the department store]

Next P1, P2, and P5 elaborate the idea with a focus on who that person could be.

By making a reference to museums as an external source of inspiration [3], and indicating Drumhead [4], P2 formulates a supportive statement:

> P2 'Yes, I have seen it numerous times at museums, so where they use it [unclear], it works incredibly well. Because you walk right up to that person and it functions like someone talking to you.'

which makes P1, while seizing the Drumhead card [5], come up with an idea [6]:

> P1 'But, but couldn't it be used so that .... Couldn't it be used in connection with the overview boards, to ask the way? You know then that it is simply someone talking to you?!'
> P1 'So you do not grab a ball, but a head?'
> P1 'Yes, you can find your way with the head under your arm.'

Accompanied by a few brief exchanges, P5 seizes the Drumhead card [7] and pastes it to a blank piece of poster paper [8], a rming that a shared understanding has been reached. Here the generation of the idea reaches temporary closure.

The idea generated has its roots in the Drumhead Technology Card, and it is remarkable that certain attributes of Drumhead were active, for instance the physicality of the head, the idea of a specific person, and the use of audio, while the unconventional form of interaction and the use of projection on a curved surface did not seem to play a significant role. The mention of the museum as an external source of inspiration served as a supporting argument rather than actually contributing to the idea.

Next P3 takes up the Floor Plan Domain Card [12] (figure 12), opening a dialogue about the use of signs at the department store, but this is quickly turned into a humorous conversation elaborating the idea of using a Talking Head as a personal guide for customers.

P2 suggests that one of the heads could resemble the owner of the department store. This is a reference to a recurring, general theme [10] in the workshop, the tradition and the public image of the store:

> P2 'We should have a head that addresses you as 'Sir' or 'Madam'. It could be Mr. Salling' [the founder of the department store].

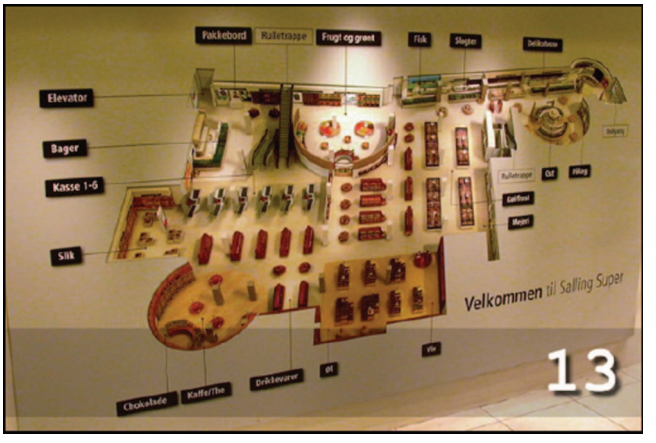

Figure 12. The Floor Plan Domain Card.

By making a reference to an external source of inspiration, Krak (the dominant Danish providers of online maps) [11], P3 raises a concern about digital guides and tour planning:

P3 'The problem with getting directions, perhaps you know it from using Krak. You know, you sit at home and plan the route, and then if you go wrong just once . . .'
P1 'Then it is just . . .'

During this part of the process, the Floor Plan Domain Card [12] is pasted to the poster, thereby connecting the idea emerging from the Drumhead Technology Card [13] to an issue of relevance for the domain, as represented by the Floor Plan Domain Card [14]. The Floor Plan Domain Card plays the role of connecting the idea to the department store, rather than contributing to the elaboration of the idea.

In the subsequent part of the process, another idea [15] emerges, apparently from the Drumhead discussion:

P3 'One could also imagine having a much simpler variety, where you walk up to the board and say: ''I would like to know where I can find jeans'', for instance, and then someone tells you.'

But the discussion returns to the elaboration of the idea of the head, and how to carry it around, including the need for an extra arm [16], which leads to the idea of having two heads [17]:

P3 'Then there should be two, one sitting on one shoulder and telling you to save your money, and one that . . .'
P2 'Yes, like a real devil . . .'
P5 'Yes, or one that says that ''we are going down to the candy section, come, we are going to the candy section'''
P1 'And the other one says ''No, no, go to the sports department'''.

To support the idea, the Animatronics Technology Card [18] (see figure 13) is pasted to the poster [19], and P1 paints wings and a halo on one animatronic doll, and horns, a tail and a trident on the other. In this way the card becomes more like a medium for illustrating an already developed idea, for instance the idea of having multiple heads, rather than playing a role in the creative process.

Finally, the poster is put aside and the concept is closed (see figure 14).

Having thus analysed the creation of one specific design concept, we now move to a higher level of abstraction, in order to analyse the role of key elements in the workshop.

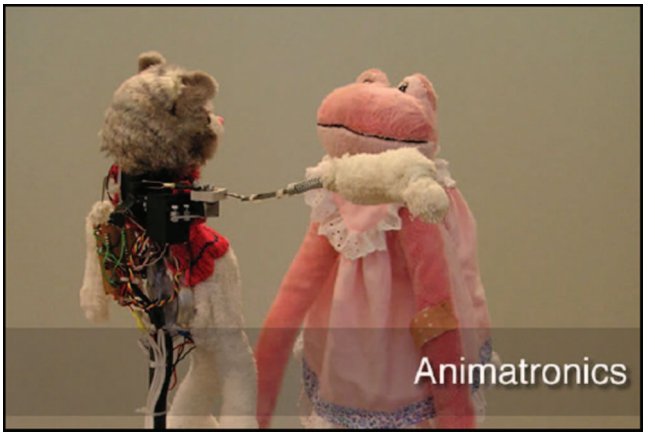

Figure 13. The Animatronics Technology Card. The animatronic dolls are from the Watschendiskurs art installation (Frank Fietzek and Uli Winters).

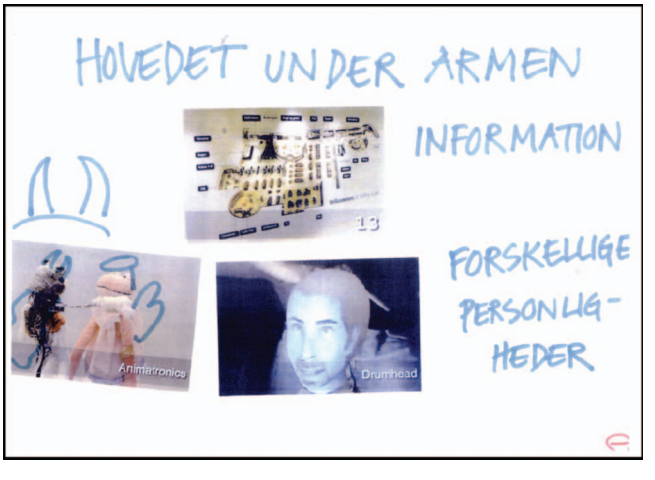

Figure 14. The finished Talking Heads concept poster. The text translates as: 'Head under the arm—Information—Various personalities'.

6. The role of key elements in the workshop

In this section, we describe and analyse the key elements in the eight design concept phases, and their interplay in the process of generating new design concepts.

6.1 Inspiration Cards

Inspiration Cards are physical instantiations of sources of inspiration, and as such they have a number of attributes that set them apart from oral arguments and gestures, in the discussion and creation of design concepts. First and foremost, they are concrete and fixed, in the sense that their appearance remains the same throughout the process, unless participants physically alter them by writing or painting on them, or cutting them to pieces. Due to this stability, they are fixed points or hubs for discussions. This can be observed in that they often serve as boundary markers in conjunction with oral arguments. An example of this is the initiation of the Talking Heads concept phase:

> P1 (Picks up the Drumhead Technology Card) 'I like the one you talked about, the one with the head. I'd like heads that you could swap and replace.'

The participant uses the card as a nexus for the following discussion, first by holding it in her hand, then by placing it in the centre of the table for all participants to see.

Participants imbue the cards with meaning throughout the workshop: they are presented and explained in the introductory phase, and in the concept development phase participants almost always use oral arguments to explain their choice and use of cards. When one or more participants attribute characteristics in this way, the cards become influential in structuring and driving discussions. The cards can thus serve as repositories for statements and arguments, and the meaning of a card may be disputed, and change in the course of a discussion.

This being said, analyses of the workshop did show a primacy of the material, in that the cards can be construed as lasting statements, whereas oral statements are temporary and may be overheard. This can be observed in the way that Inspiration Cards were often used by participants to concentrate the discussion, either by creating, maintaining or shifting the focus, much in the same way as the cards were used to form boundary markers.

In the analysis of the workshop we found that it was quite di cult to capture and analyse the oral statements as key elements in the discussions, even though the workshop was meticulously transcribed. It was much easier to observe how cards and posters structured the event, or in other words, the tangible elements of the workshop lend themselves well to video analysis. This can be a pitfall when analysing workshop data, and observers should beware of the tendency to focus overly on the visible and concrete elements. However, through careful examination of the data, it is clear that the emphasis on physical components is not merely ascribed in the post-workshop analysis, it was in fact clear throughout the workshop that the tangible design materials served as strong structuring elements.

6.2 External sources of inspiration

Whereas the Inspiration Cards are selected prior to the concept development phase, participants brought a number of external sources of inspiration into the discussion in

the course of the process. These sources of inspiration could be both closely related to the discussion, or point to entirely new directions for concept development. As an example of a closely related external source of inspiration, consider the aforementioned reference in the Talking Heads concept phase:

> P3 'The problem with getting directions, perhaps you know it from using Krak. You know, you sit at home and plan the route, and then if you go wrong just once . . .'

While discussing how to find one's way around the department store, the participant describes how this problem is solved in a related domain. At the opposite end of the spectrum, external sources may be conceptually remote from the current discussion, as this example from another concept phase illustrates:

> P4 (Following a discussion of how to interact with items on display in shop windows) 'We were at a public swimming bath this summer, where you could control a water cannon with your mobile phone, you could shoot water at the other guests by using the keys on the phone.'

Here, the participant draws upon personal experience to present possible modes of interaction that may be easily transferred to the current focal point of the discussion.

The introduction of external sources of inspiration was a recurring event in the workshop. We identified an average of three to four such instances in each distinct concept development phase. The e ect of these sources of inspiration varied greatly. Some where overheard and dismissed or simply not responded to, whereas others resonated within the group of participants and came to influence the design concepts. Due to the setup and goals of the workshop, the external sources of inspiration that proved to be influential over the course of time were the ones that were set down on paper, either on new cards or as comments on Concept Posters. This was usually done when the participants agreed that a source of inspiration was valuable to furthering the process. The act of setting down in writing these sources of inspiration thus came to be an act of confirming common ground. On the other hand, sources of inspiration that were not written down did not endure.

6.3 General themes

During the workshop analysis, we identified a number of recurring, over-arching themes. These themes reflected shared values or conceptions of the use domain and the nature of the design process between the participants and the designers. When they were introduced or reiterated in the workshop, they served to guide the idea generation towards common goals. One example of these general themes was the designers' acknowledgement of the department store's particular tradition and image in the mind of the public, which they wanted to retain and enforce. Likewise, the participants from the department store knew and respected the designers' interest in exploring innovative interfaces. As an example, the general theme of the long-standing history and status of the department store was often referred to by proxy of the founder of the store, a well-known character in the region:

> P2 (Following a discussion of having talking heads with various identities) 'We should have a head that addresses you as ''Sir'' or ''Madam''. It could be Mr. Salling' [the founder of the department store].

The act of bringing this general theme into the discussion had a stabilising e ect, and served to ground the creative phase: by hinting at the theme, the participants from the department store could take part in the creative process, and at the same time keep the designers from pressing ideas that would conflict with the store's image.

6.4 Derived ideas

A vital element in the concept development phase was, of course, the set of ideas that were derived from the discussions of Inspiration Cards and external sources of inspiration. These ideas sprang from, and in some way transcended, elements already present in the discussion. As with the external sources of inspiration, the derived ideas might live on in the design process, depending on whether or not they were set down on paper. Although the concept development phase was set up to be open, and encourage participants to bring forth as many ideas as possible, there was an implicit element of critique and evaluation of the derived ideas, in that the response from the group determined whether or not an idea was made manifest and written down.

The following is an example of a derived idea that came to influence the final Talking Heads design concept:

P3 (Takes the Animatronics Technology Card, following a discussion of having talking heads with various character traits, to guide customers in the department store) 'Then there should be two, one sitting on one shoulder and telling you to save your money and one that . . .'
P2 'Yes, like a real devil . . .'
P5 'Yes, or one that says that ''we are going down to the candy section, come, we are going too the candy section'''.
P1 'And the other one says: ''No, no, go to the sports department'''.
P5 (Paints wings and a halo on one animatronic doll, and horns, a tail and a trident on the other)

In this sequence, a participant brought up the idea of having multiple guides. A second participant responded to this immediately, twisting the idea in the direction of devils (and, implicitly, angels), quickly followed by a third and fourth participant voicing their understanding and consent. This in turn led the second participant to manipulate the Inspiration Card to fit the idea so as to make it permanent. This interchange of ideas and manipulation of cards took less than 30 seconds.

6.5 Concept Posters

Concept Posters display many of the characteristics found in Inspiration Cards. They are physical artefacts, and large ones commanding the attention of participants when they are brought into play. On a semantic level, the over-arching goal of the Inspiration Workshop is to come up with design concepts, and articulate these concepts on the posters, which further emphasises the posters' dominant position in the process.

Whereas oral statements or the handling of Inspiration Cards may initiate distinct concept development phases, the posters often terminate them: When concepts are described on a poster, the work is done, and the participants move on to a new concept. This can be observed when a poster is physically moved to the edge of the table, and thus into the periphery of the participants' attention, when it is completed.

As with Inspiration Cards, posters are imbued with meaning through participants' statements. These statements may be oral, but may also consist of the act of a xing cards to the poster, or writing and drawing on it. Since participants regard the poster as a very important entity in the workshop, summing up an entire design concept, they usually hesitate to do this until concepts have been discussed and some sort of agreement has been reached; i.e. participants feel that there should be a consensus as to what is put on the posters, since it sums up the discussion.

The posters establish which concepts and ideas live on in the design phase, and which ones are discarded. For this reason, the summary phase of the combination and co-creation process was spent reviewing the posters, to ensure that the participants understood and agreed on the concepts.

6.6 Combination of key elements in Concept Posters

Since the design Concept Posters are instrumental in storing and transferring concepts to the continued design process, there is a great deal of relevance in an analysis of which elements of Inspiration Cards, external sources of inspiration, general themes and derived ideas are contained in the posters. The main components of Concept Posters are the Inspiration Cards a xed to them. These cards are supplemented by text and/or illustrations, often to indicate external sources of inspiration, general themes and derived ideas, and to underline relationships between these elements. To illustrate these points, figure 14 shows the poster that resulted from the Talking Heads design concept phase.

To this poster are a xed three Inspiration Cards: Animatronics, Drumhead and Floor Plan. Snippets of text are written, namely 'A head under the arm', 'Information', and 'Di erent personalities'. Furthermore, small drawings have been made on and above Animatronics, to symbolise angelic and demonic characters. To recap, the concept presented by the poster is that of supplying customers in the department store with talking heads that can guide them, and present relevant information about products. However, it is virtually impossible to decipher this concept if the context and process of the workshop are unknown; the poster has clearly been embedded in layers within layers of meaning and understanding in the process of making it. Thus, the Inspiration Cards are not used to directly represent the phenomena from which they originate, but instead each is used to illustrate minor points: Drumhead, originally an interactive and experimental musical instrument, is used to illustrate the idea of carrying around heads. Floor Plan is used to illustrate the fact that the heads are used to guide customers. Animatronics, which originally refers to a pair of mechanical dolls that are part of an art installation, is used to illustrate the idea of having heads with divergent personalities that may guide customers in specific directions. The ways in which the cards are employed are as much a question of participants' prior knowledge and emerging communication, as of what is actually represented on the card. Understanding the final poster is ultimately a matter of understanding the process that led to its fabrication.

Condensing these findings, we identify the key elements that structure and create momentum in the design situation as follows:

- the manifest properties of Inspiration Cards and Concept Posters, which enable them to function as props that encourage and support design moves in a manner visible to all participants and are open to ongoing reconfiguration, and furthermore support the construction of assemblages of ideas into concepts in physical form;

- the semantic dimensions of the cards and posters, as catalysts for deriving, communicating, discussing, and evolving design ideas and concepts; and
- the ad hoc improvised external sources of inspiration brought into the discussion by participants as means of supplementing and developing design concepts.

6.7 Further concepts developed in the workshop

Including Talking Heads, eight concepts were developed in the Inspiration Card Workshop. They fell into four categories.

Direction and guidance for customers in the department store—these were concepts that presented customers with forms of guidance and direction for finding specific products and special o ers. The Talking Heads concept falls into this category.

Experience Zones—these concepts suggested ways of creating special interest zones, specifically one zone for entertaining children while their parents shop, and another zone for conveying the history of the Salling department store in relation to its 100th anniversary.

Recommendation—a set of concepts that suggested ways of implementing recommendations systems, known from web-based stores such as Amazon[1], but in this case integrated into the physical layout of the department store.

Interactive Façades—this group of concepts addressed the use of the façade. One of these concepts, Dynamically Transparent Windows, has been further developed, and is now in the final stages of product development. We expect to test the product at the department store in the autumn of 2007.

7. Results and findings from related Inspiration Card Workshops

As mentioned previously, we have conducted a number of workshops with the other partners in the course of the research project Experience-oriented applications of digital technology in knowledge dissemination and marketing—Gumlink[1], 7th Heaven, and The Danish Electricity Museum. Each of these workshops resulted in approximately ten concepts see (Halskov and Dalsgård 2006).

The workshop with Gumlink[1] was executed in order to create interactive elements for their booth at the world's largest annual sweets convention. Two of the concepts developed at the workshop have been implemented: a walk-up-and-use interactive console using tangible interaction; and a large motion-sensing interactive display at the front of the booth, intended to draw in passers-by (Dalsgaard and Halskov 2006, p. 4).

The concrete results of the Inspiration Card workshop with 7th Heaven are two installations at a children's literature centre focusing on Norse mythology: The first installation, Balder's Funeral Pyre, is an interactive corridor in which one of the sides features an immersive rear projection of fire (Dalsgaard and Halskov 2006, p. 5). The second Installation is Mimer's Well, a 3D stereo cinema that presents elements of Norse mythology.

The workshop held in collaboration with The Danish Electricity Museum resulted in a catalogue of concepts for further development. Due to limited resources for the project, these concepts have not yet been further developed. However, two of the most promising concepts, The Energy Floor and The Energy Table (Dalsgård and Halskov 2006, p. 6), have been developed as virtual video-prototypes (Halskov and Nielsen 2006).

With regard to the key elements identified in the Salling Inspiration Card Workshop, our findings from conducting related workshops with other partners in the research project can be summed up as follows.

7.1 Inspiration Cards

Our findings regarding the structuring role of Inspiration Cards are supported by the findings from the three other cases (see Halskov and Dalsgård 2006). In all the workshops, the Inspiration Cards served as physical markers around which many discussions and arguments were anchored, and they clearly guided the processes of ideation and negotiation. Typically, some Inspiration Cards presented in the initial stages of a workshop are never used. We have not been able to identify a clear pattern as to which types of cards are left unused; this may pertain to the limited amount of time in the idea generation phase, or it may have to do with the content or presentation of the cards themselves.

7.2 External sources of inspiration

In all cases, external sources of inspirations have played a prominent role. For example, the art of Bill Viola was brought into the discussion of atmosphere and style of the 7th Heaven literature centre, as documented in Halskov and Dalsgård (2006). As another example, Virgin Atlantic Airlines[1] was introduced and discussed at the Gumlink[1] workshop as an argument for the potential for doing ordinary things in an extraordinary way. In order to capture strong external sources of inspiration, we suggest that a number of Inspiration Cards be initially left blank, so that these sources of inspiration can be put onto them, and be preserved throughout the ideation phase.

7.3 General themes

In every workshop we have conducted, certain general themes have dominated the idea generation phase. In the case of the department store, these pertained to the store's renowned history. In other cases, we have worked directly at identifying and formulating such themes. Dalsgård and Halskov (2006) elaborate on this work, specifically with regard to incorporating over-all intentions and values into the design process in general, and Inspiration Card Workshops in particular. For instance, creating room for reflection and a solemn mood were recurring themes at the 7th Heaven workshop, in contrast to the Gumlink[1] workshops, in which promotion of Gumlink's[1] standing as hi-tech company driven by innovation and research was the focal point.

7.4 Derived ideas and combinations of key elements in the Concept Posters

In our experience from conducting a series of Inspiration Card Workshops, the ideas derived from combining cards and external sources of inspiration cover a broad spectrum, ranging from obvious concepts to surprising and unexpected proposals. In the case of the department store, concepts of interactive façades were created, which was to be expected, given the inclusion of both Domain and Technology cards that specifically addressed this aspect of retailing. However, as evidenced by the Talking

Heads segment analysed in detail in this paper, completely unexpected combinations and ideas can also spring from the process. In general, we have observed that this is often related to the experience that workshop participants have in working with creative processes and methods, e.g. the Salling participants were accustomed to working creatively with exhibitions and displays. With regard to preserving the ideas generated at Inspiration Card Workshops, it is worth noting that Concept Posters on their own are not adequate for documenting the design concepts. The posters are often hard to understand for those who have not participated in the workshops, and they need to be documented and elaborated if they are to be further used in the design process. Indeed, even workshop participants can have trouble identifying the concepts set down on posters a week or two after the workshop event. For this reason, it is highly advisable to capture the workshops on video, and generate textual descriptions of the developed concepts as soon as possible after the workshops.

8. Further discussion and conclusions

8.1 Issues of participation—design moves and process structuring

From a participatory perspective, the Inspiration Card workshop approach has proved to be a very productive way of involving domain experts in the early parts of the design process. As Brandt and Messerter (2004) observe, design props such as the Inspiration Cards 'support di erent stakeholders in making design moves on a conceptual level' (Brandt and Messerter 2004, p. 129). The cards are thus an integral part of the ongoing design dialogue, and a means of expressing or emphasising design moves. The politics of cards and posters has been particularly evident, for instance in the way that cards make it easy for participants to voice their ideas, and in the key role that posters play in bringing discussions to a close. At the same time, the choice of Technology Cards, which is made by the designers, has had a strong impact on directing the development of design concepts. What might appear at first glance to be a process with strong participation from stakeholders from the design domain was actually heavily influenced by the choice of Technology Cards. Traditionally, Participatory Design has made a high priority of taking the current (work) practice as the starting point for the design process, and in this respect has favoured tradition at the expense of innovation. In the workshop reported here, the balance shifts instead towards innovation, in the conflict between tradition and transcendence, identified by Ehn (1988) as one of the most important dilemmas in design. Thus, the design dialogue that unfolds in the concept development phase is highly participatory, while the framing of this process (in terms of the workshop setup and the sources of inspiration on the cards) is clearly directed by the designers, for better or worse.

8.2 Micro-analytical studies of design processes

Within the field of interaction design and human–computer interaction (HCI), there are precious few in-depth studies of the processes from which design ideas and concepts emerge. This seems paradoxical, given the ongoing interest in new and evolving technologies, systems, and artefacts. Following the lines of Mondada (2006), among others, we have employed a micro-analytical approach to one specific situation

from which a design concept emerged. The circumstances surrounding the situation allowed us to both participate in, and later reflect on this process. We chose this setup in order to gain an understanding of the many potential semantic layers of the design situation, e.g. the meaning ascribed to us by our collaborators and vice versa, the understandings of the use domain and workshop purpose, and, not least of all, the ongoing interpretations and reconfigurations of the Inspiration Cards and Concept Posters. Depending on the circumstances, roles other than those of participant-observer may be more appropriate in dissimilar design situations. In reviewing our method and findings, we feel encouraged to carry out similar micro-analytical studies in our future work. The approach has yielded insights into the intricate ways in which design props such as the Inspiration Cards structure the ideation process, make room for converging concepts, and function as boundary objects in discussing, resolving or transcending conflicts and misunderstandings. In future work, we will most likely develop our techniques of notation further, to more clearly visualise key elements and progression.

8.3 Innovation through an artefactually mediated, socially distributed, and adaptive design process

Since the Design Concept Posters from the Inspiration Workshop establish a potential future course of the design process, it is pertinent to explore the level of detail and completion of the posters. The aforementioned Talking Heads concept is clearly far from being a functional requirement or specification. It can instead be construed as emergent, in that it serves as a guide for the ongoing design process, but is still flexible and negotiable. Whether it will be realised, how, and in what form, is thus a question of continuous negotiation among the participants in the design process. The Talking Heads design concept is representative of the main parts of the design concepts that result from Inspiration Card Workshops: The elements that are combined to form the concepts are seldom directly transferred or copied (i.e. fixed and non-negotiable), but instead form negotiable, emergent designs. In this respect, the design concepts bear a close resemblance to boundary objects, as described by Star and Griesemer (1989): they are constructs that serve as common points of reference for people from di erent domains. They are flexible enough for people to interpret them in di erent ways and thus relate them to their practices, yet concrete enough to serve as means of translation and coordination across domains. In the Inspiration Card Workshop we can thus describe the collaborative e orts of practitioners from various domains to bring forth design concepts, as boundary objects in the making.

The specific Inspiration Card Workshop analysed in this paper can be characterised as a design situation that is socially distributed (in that multiple practitioners from various domains collaborate in bringing about ideas and concepts), artefactually mediated (in that the Inspiration Cards and Concept Posters help structure the process and mediate understandings) and adaptive and emergent in that ideas emerge, both those based on derivation from already presented concepts, and through ad hoc improvisation in continuous adaptation to the unfolding of the design situation.

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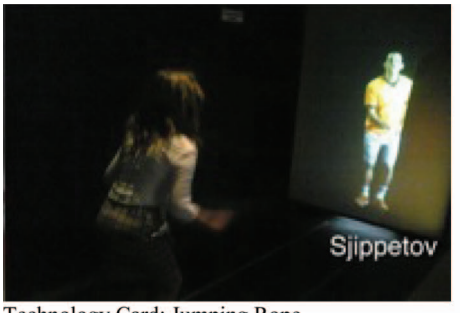
Appendix

The 14 Technology Cards



Technology Card: Jumping Rope

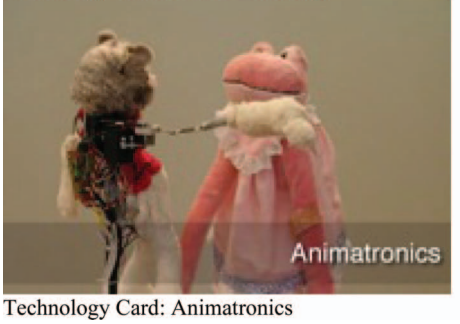
Technology Card: She

Technology Card: Blinkenlights

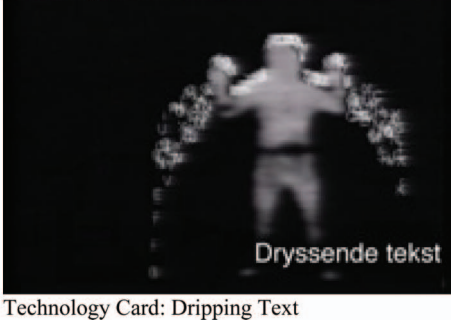
Technology Card: Eye follows movements

Technology Card: Slow Technology

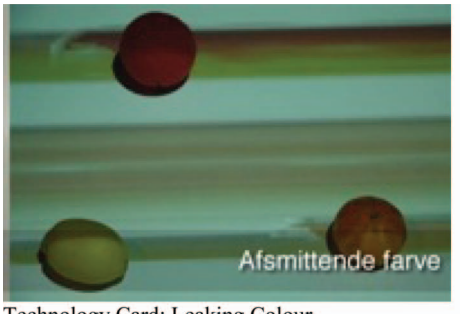
Technology Card: Drumhead



Technology Card: Animatronics

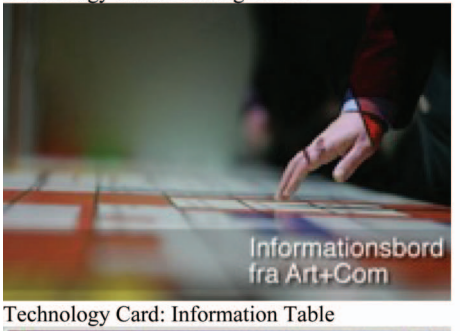


Technology Card: Dripping Text



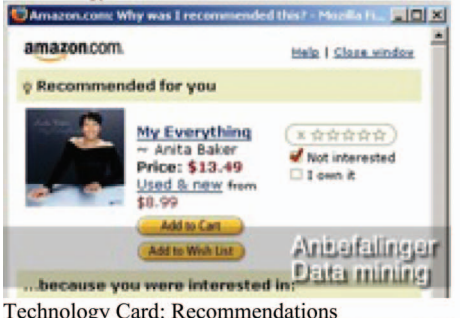
Technology Card: Leaking Colour

Technology Card: Interactive Dressing Room



Technology Card: Information Table

Technology Card: Interactive Shopping Window

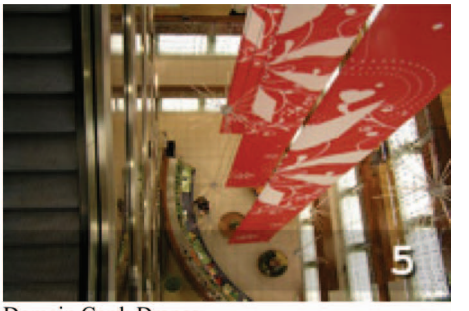


Technology Card: Recommendations

Technology Card: Touch Light

The 18 Domain Cards

Domain Card: Food Court



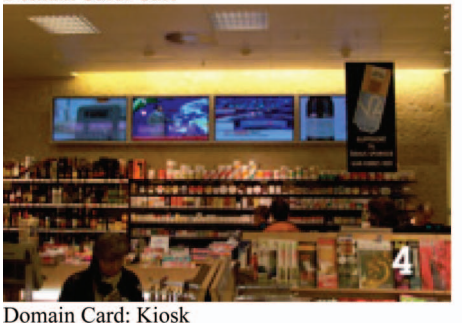
Domain Card: Drapes

Domain Card: Bistro

Domain Card: Children's Entertainment

Domain Card: Cafe

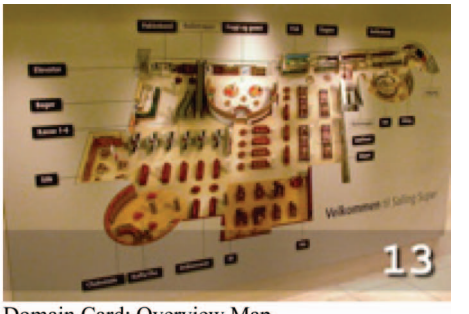
Domain Card: Large LCD TVs



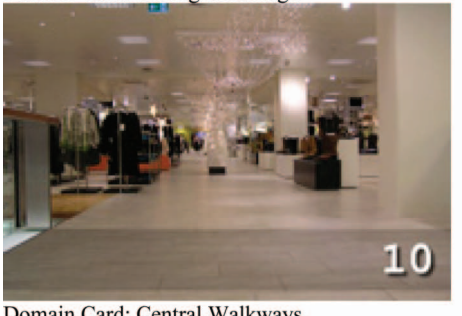
Domain Card: Kiosk

Domain Card: Dead Zones

Domain Card: Salling's Heritage



Domain Card: Overview Map

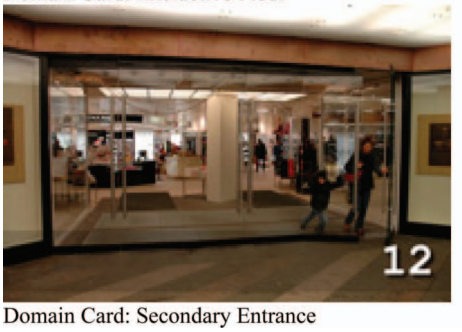


Domain Card: Central Walkways

Domain Card: Dressing Room

Domain Card: Interactive Floor

Domain Card: Poster Columns



Domain Card: Secondary Entrance

Domain Card: Today's Special Offer

Domain Card: Transitional Zones

Domain Card: Facade at Night

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MAPS FOR DESIGN REFLECTION

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MAPS FOR DESIGN REFLECTION

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In this paper the authors introduce, apply, and discuss a set of design artefacts called *maps*, intended to support design researchers in capturing, analysing, and reflecting upon design processes. The maps focus on reflection with regard to the role of sources of inspiration and design materials in the emergence and transformation of design ideas. The paper revolves around a specific case, the design of media façades i.e. displays that are an integrated part of a building's façade as part of the development of material for a bid in an architectural competition for a new modern art museum in Warsaw, Poland. They discuss their findings from using the maps for design reflection in this case, with a particular focus on the importance of employing artefacts to support design reflection.

Keywords: design process, reflection, sources of inspiration, design materials, design idea, media façades

For interaction design researchers, the emergence of design ideas from sources of inspiration through a series of experiments that transform design ideas is central to research inquiries. However, there is a lack of tools that support researchers in documenting and reflecting on these elements and their interrelations. In this paper, we present and discuss three types of maps intended to support reflection and research into design processes. The contributions of this paper are, first and foremost, the presentation of the maps as concrete design artefacts for researchers interested in exploring how design processes unfold, and, second, a presentation, analysis, and discussion of a specific case in which we delve into the ways maps can offer insights into the transformations that design ideas undergo, as they are transformed from initial sources of inspiration to well-rounded design concepts, through design experiments using a repertoire of design materials.

Our development of the maps for design reflection is inspired by Lanzara and Mathiassen's (1984) work on mapping design processes. Whereas Lanzara and Mathiassen primarily address issues related to management of design processes, this paper is aimed at design researchers, and focuses on reflection on design practice, particularly with respect to the role of sources of inspiration and design materials in the emergence of design ideas.

The research area of interactive systems design includes studies of interactive systems, new design tools and techniques, and case studies of design practice. Our contribution may be regarded as a response to the call for research into the practice of design, put forward by Wakkary (2004), who states that "it is by far more common to record interactions and real-time observations of 'users' but not practitioners" (Wakkary, 2004, p. 443). Our approach can be construed as one way of conducting research through design (see Zimmerman et al., 2007): As design researchers, we have taken advantage of our engagement in specific design practice, to explore and develop approaches to reflection on critical aspects of the design process. With reference to the design theory and HCI research taxonomies proposed by Atwood et al. (2002), and Wanie et al. (2006), our work is rooted in the participatory design tradition, and theoretically based on Schön's (1983, 1988, 1991, 1992; Schön & Bennett 1996) pragmatic design theory.

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The specific case that provides the fuel for researching design practice concerns our involvement with BIG (Bjarke Ingels Group, a Danish architectural group), in the development of material for a bid in an architectural competition for a new modern art museum in Warsaw, Poland. As design researchers at CAVI (the Centre for Advanced Visualization and Interaction, at the University of Aarhus), we (the authors) became engaged in the process due to CAVI and BIG's mutual interest in the development of innovative ways of integrating interactive media façades as part of the proposal for the new museum. Media façades is the general term for incorporating displays that are an integrated part of a building façade (ag4, 2006), and constitute a fast-growing business, primarily due to the increase in quality and a drop in the cost of light emitting diode (LED) technology. The content may range from pure artistic expression, to informative art and entertainment, and company and brand communication. In the present instance, we were particularly interested in going beyond LED displays, to explore the potential of using unconventional materials for the implementation of media façades, and ended up using thermo-chromatic concrete (TCC), a material that enables a concrete façade to become a display in its own right.

TCC was originally invented by Glaister, Mehin, and Rosén (http://www.chromastone.com), and utilizes a current applied to a heating element placed inside the concrete to make the temperature rise, causing it to then change colour due to the presence of a heat-sensitive ink mixed into ordinary concrete. Available colour changes are black to white, red to white, and grey to white, but more colour options are being developed. The nature of the material makes it best suited to low-resolution displays (see Figure 1). As we shall elaborate later, TCC turned out to play a key role in our collaboration with BIG, from this point onwards.

As design researchers, we have used the specific case introduced above as a platform for exploring new ways of making sense of design situations. In the collaborative process with BIG, we have thus been acting both as researchers, in having the aforementioned agenda of exploring design reflection, and as designers, in actively partaking in the development of the museum proposal. Specifically, our contribution to the collaboration was the design of interactive digital elements in the museum building, whereas BIG was responsible for the general architectural concept and structure of the museum. Our work within the interaction design group was largely autonomous, though coordinated with BIG through meetings and ongoing discussions. This intimate knowledge of the design process supported the development of detailed maps for design reflection in our simultaneous and subsequent work as design researchers, in which we have explored the unfolding of the design process.

This paper is structured so that in section 1 we first outline the background for developing the three kinds of maps Overview, Strand, and Focal Maps and the influences of related academic work on the topics of sources of inspiration, design materials, experimental design, and tools for process mapping. This is followed, in section 2, by a detailed presentation of the maps. To give a comprehensive account of their support of design reflection, we present the specific case of developing the design proposal for the Warsaw MoMA, in sections 3, 4, and 5. In these sections, we present in-depth uses of each of the types of maps, coupled with our findings and analysis of their use. We then present our conclusions, and discuss further perspectives on using Overview, Strand, and Focal Maps in combination, in section 6.

Background

According to Schön (1983, p. 135), design is a reflective conversation with materials, wherein the designer works with different media or materials, and experiments with various aspects of the design. There is a continuous dialogue between the designer and the materials, causing him/her to apprehend unanticipated problems and potentials in terms of a system of implications for further moves (Schön, 1983, p. 101). Rather than looking for standard solutions, the designer sees the situation as something already present in his/her repertoire of paradigm cases or prototypes, despite which he/she manages to make something new by making experimental moves, which may result in something that goes beyond his/her initial expectations. Schön's design theory distinguishes between reflection-in-action and reflection-on-action. Reflection-in-action is the kind of thinking that takes place as an integrated part of the action, and which may affect the completion of the action itself. Reflection-on-action is the sort of thinking that occurs after the completion of an

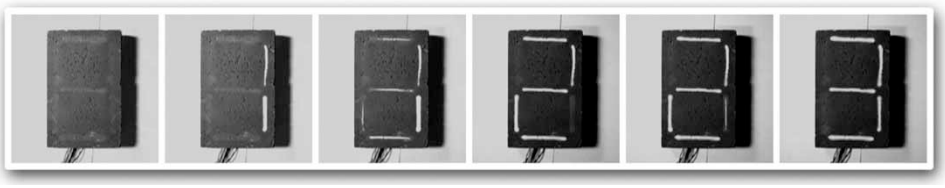

Figure 1. Thermo-chromatic concrete.

action, and by definition is excluded from affecting the action.

Whereas Schön is primarily concerned with the kind of reflection-on-action conducted by design practitioners, we are interested in supporting design researchers' reflection on design activities. Our research focus is strongly connected to Schön's design theory, with a particular focus on the emergence of ideas from sources of inspirations arising through a series of experiments with various kinds of design materials.

In addition to Schön (1983), several researchers, including Sanders (2005), have addressed how sources of inspiration play an important role in the emergence of design ideas. In the area of information systems design, Madsen (1994) has explored how metaphors may shed new light on the ways in which information technology might be used, by seeing a domain of applications as something else. Lervig and Madsen (2003) addressed the ways in which sources of inspiration serve as jumping-off points for work in a design project, when digital artists and designers worked together. Sanders (2005) has argued that inspiration plays a prominent role in experience design. Consciously looking for inspiration is part of the innovation strategy discussed by Kelly (2001, p. 280), and Foster (1996) suggests doing things to which you are unaccustomed, as potential sources of inspiration. An essential point made by Foster (1996, p. 114) is that if generating new ideas primarily consists of combining old elements, a thorough familiarity with the old elements is essential.

Following Schön's pragmatist understanding of the design situation as a dialogue between designer and materials (see Schön, 1983, p. 135 and Schön & Bennett, 1996), the notion of design materials is of central concern in our inquiries. In reflective practice, design experiments often imply the use of materials through which potential design moves are shaped, evaluated, and put into the world. Such representations by use of design materials can highly influence both our performance and understanding, as is extensively demonstrated by Klemmer et al. (2006). To the extent that design materials extend our cognitive practice, we may think of them as inquiring materials, as proposed by Gedenryd (1998, p. 149): "An inquiring material then, like an inquiring action, does not function as an end product of design, but as a means for inquiry that design is." Design materials can be physical materials such as pen and paper for sketches, and foam core board for mock-ups, but they can also be digital materials, such as 3D models and virtual video prototypes (see, for instance, Halskov & Nielsen, 2006).

To support researchers' reflection on design, we propose a set of three kinds of artefacts, called maps, which are material tools for recording unfolding design processes. In our mapping of design processes, we have a strong focus on sources of inspiration and the various forms and instantiations of design ideas, and how they use a repertoire of design materials, manifested as written memos, as sketches on paper, as 3D renderings, as physical models, etc.

As mentioned in the introduction, our maps for design researchers' reflection on design activities are inspired by the maps proposed by Lanzara and Mathiassen (1984), who have proposed four different maps, which may help design practitioners make sense of the situations in which they are involved (see also Andersen et al. 1990). Lanzara and Mathiassen focus on management issues, and distinguish between four kinds of maps: diagnostic maps, ecological maps, virtual maps, and historical maps. A diagnostic map relates perceived problems in a project situation to their sources, as well as the general conditions of the project. An ecological map relates the situation to the conditions that shape the circumstances in which people are acting. Virtual maps address possible future situations. Finally, historical maps organize past experiences in a time sequence, by focusing on the dynamic interplay between actions, conditions, events, and issues.

Based on Schön's (1983 p. 54) notion of reflection-in-action, Jepsen et al. (1989) have suggested the use of diaries as tools for reflection on the progress of a design process, with a particular focus on diaries as media for project management, addressing problems and conflicts related to deviations from plans, but also with an awareness of methods applied, and working habits. Another related use of diaries as media for design reflection has been reported by Pedgley (2007) in the context of physical design, using the design of a polymer acoustic guitar as the main case. In addition to a number of general diary instructions, and a list of good practices in diary writing, Pedgley (2007, p. 473f) provides three types of pro forma stationery or templates for end-of-the-day diary writing. For the subsequent analysis of the entries in the diary, Pedgley uses an emergent coding scheme covering a broad range of aspects, including "2D modelling", "Knowledge and values", and "Level of detail reached". In a similar vein, McDonnell et al. (2004) have described how designers can employ video story-making relating to their design work to support critical reflection on design experience beyond reflection-on-action.

The maps for design reflection are related to and inspired by the above-mentioned works; however, the maps contribute to the field of interaction design research by extending the repertoire of design researchers in a number of ways: first, although differing in scope and focus, the related publications generally address tools for design practitioners. The maps we present in this paper are, however, intended as tools for design researchers. Second, analyses and discussion of design processes in research contributions are most often based on theories as design artefacts; for instance, Schön's understanding of design as reflective conversation can serve as theoretical scaffolding for design analyses. The maps presented here can be

construed as design artefacts in the shape of a set of concrete, tangible tools that scaffold reflective analyses. In this respect, our approach is inspired by the perspective of distributed cognition (Hutchins, 1995), in that our main approach to mapping and reflecting upon the design process is based on charting the representations present in the design process (e.g. words, text, images, movies, and models) and their transformation and flow. The distributed cognition perspective proposes that cognition and knowledge are situated not solely in the mind of an individual, but rather they are distributed amongst a number of actors, artefacts, and surroundings. Studies of distributed cognition are thus founded in the study of the various representations present in a situation, and the changes they undergo. Our use of maps leads us to propose that the central ideas in a design process are those that are explored through various modes of representation. Subsequently, mapping these representations constitutes a meaningful foundation for design reflection. The maps thus provide researchers with a structured method of identifying and capturing aspects of the design process that may otherwise be overlooked. The use of maps for design research reflection points to the importance of having artefacts to support cognitive processes. This is the case at two levels: With regard to the events that unfold in a design process, the design representations that emerge (e.g. conceptual sketches, mock-ups, and prototypes) are manifestations and crystallizations of design reflections and moves in action. With regard to design reflection, maps themselves are crystallizations of the design researchers' reflections. As such, the maps can serve as useful boundary objects between researchers and designers, including on those occasions that researchers examine from the outside design processes in which they themselves were not involved.

In the following section, we present three kinds of maps that focus on reflection on design practice, with regard to the role of sources of inspiration and design material in the emergence of design ideas.

Maps for design reflection

The three types of maps for design reflection we propose are: Overview, Strand, and Focal Maps. Each of these maps highlights different aspects of the design process, and supports analyses of distinct design considerations and moves, as well as overall trends in design processes. The Overview Map provides a comprehensive outline of sources of inspiration and the emergence of the multiplicity of ideas throughout the process, whereas the Strand Map focuses on the transformation and materialization of the main idea. The Focal Map looks in greater detail into the refinement of ideas through specific design experiments.

Overview Maps

Overview Maps encapsulate the main elements and trends of an entire design process in a single representation. The map consists of a timeline, along which the emergence and interrelation of conditions, sources of inspiration, and design ideas are mapped (see Figure 2).

For overview purposes, these elements are represented by icons (see Figure 3) representing words (i.e. oral statements), text, images, movies, and models. Specific phases in the process (e.g. field studies and prototype development) may be indicated on the map for a structured overview. Furthermore, an important part of the Overview Map is the pair of lines representing the design horizon, that is, the scope of potential design solutions that are considered in the design process. The design horizon often fluctuates throughout a project, as designers move through phases of divergence (Löwgren & Stolterman, 2004), when multiple design solutions and moves are explored, and convergence, when specific design solutions are

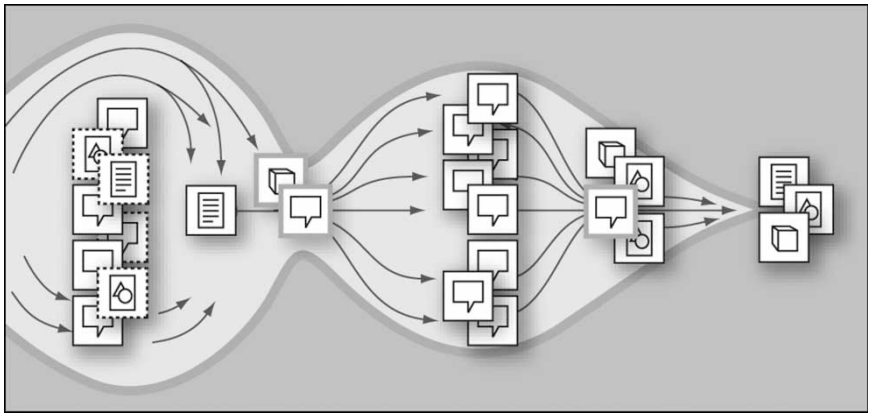

Figure 2. Overview Maps provide an overview of the entire design process.

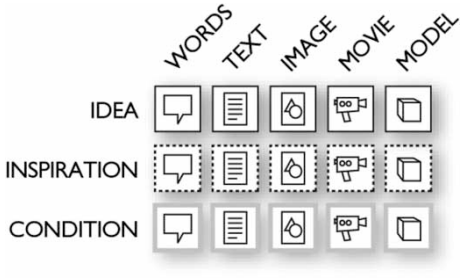

Figure 3. Icons used in the Overview Map.

decided upon or determined by external factors.

Overview Maps first and foremost facilitate a structured overview of the design process as a whole. Used as an analytical tool for finished projects, it affords opportunities for reflection on the flows and trends that have shaped the project, and makes clear the key phases or incidents, for example points in time at which the design horizon changed dramatically. For an example of a complete Overview Map and the reflections it facilitates, see section 3.

Strand Maps

Strand Maps represent the emergence, transformation, and concretization of specific strands or threads though a design process (see Figure 4). This allows designers to home in on the emergence and flow of a particular design idea, and analyse the ways in which it has materialized throughout the process. The Strand Map uses the same iconography as an Overview Map, but is more specific about the design materials used in each of the iconographic categories: words (referring to oral statements such as presentations, telephone calls, etc.), text (e.g. design documents and memos), images (e.g. field study photos and idea visualizations), movies (e.g. video prototypes and test videos), and models (e.g. mock-ups and prototypes). The icon is supplemented with a larger representation, such as representative text snippets from conversations or documents, a photograph, a screen capture from a movie, or a photograph of a model. The elements are listed in the sequence in which they materialize in the design process.

Strand Maps facilitate reflection on the development of specific concepts or ideas throughout a design process. For example, they may capture the way in which a concept initially emerged as a loose idea in a conversation, was then sketched out on paper, visualized in 3D, mocked-up, prototyped, and finally manufactured as a finished product. This facilitates reflection with regard to the specific transformations and crystallizations of a design idea. For an example of a complete Strand Map and the reflections it facilitates, see section 4.

Focal Maps

Focal Maps spotlight specific design experiments within a strand (or at their intersections) in a design process. A Focal Map lists descriptive elements of a situation, namely the subject of a design experiment, the approach to the subject, and the outcome of the inquiry. The descriptive elements each have reflective counterparts, namely their relevance to addressing a specific subject, the rationale behind the approach chosen, and the insights gained from carrying out the inquiry (see Figure 5).

The combination of descriptive and reflective elements prompts reflection on the reasoning underlying specific design moves and experiments, the ways they transform a design idea, and the general insights gained from carrying them out. This may take place immediately after an experiment, when outcomes and insights are considered, or it may take place after a project is completed, in order to delve into situations that, in retrospect, turned out to be crucial to the project. For examples of complete Focal Maps and the reflections they facilitate, see section 5.

As presented above, the three kinds of maps focus on different aspects of the design process (see Figure 6), but share a common concern for the emergence of ideas in the design process. The maps are not to be construed as exhaustive and fully objective representations of a design process; instead, the process of mapping an overview, a strand, or a specific situation is an interpretive act in which reflection on design practice occurs.

Overview Map focusing on sources of inspiration and ideas

In this and the following sections, we offer a reflection on the development of the interactive concepts for BIG's MoMA competition bid, using the Overview, Strand, and Focal Maps. The maps were developed after the design process, in order to facilitate reflection on relations between sources of inspiration, ideas, materialization, and experiments. The process was documented through the ongoing use of field notes, video recordings of meetings

Figure 4. Strand Maps represent a specific design strand.

DESCRIPTIVE ELEMENTS	REFLECTIVE ELEMENTS
Subject: What is explored?	Relevance: Why is it explored?
Approach: How is it explored?	Rationale: Why this approach?
Outcome: What is the result?	Insights: What knowledge is gained?

Figure 5. Focal Maps spotlight a specific design situation.

(including transcriptions of selected passages), and the archiving of all design materials in use.

The overview map (Figure 7) is organized according to the eight main activities of the overall process (columns I VIII in Figure 7), and the numbers 1 9 refer to the Strand map to be addressed in section 4.

From inspiration to idea

At the initial meeting (column I in Figure 7), our partners from BIG presented the competition conditions, which addressed not only the museum itself, but also the development of both a square and a park adjacent to the museum. BIG presented volume studies they had conducted, along with sources of inspiration from architectural reference projects, and these constituted the starting points for the design process, see Figure 8. Various sources of inspiration emerged spontaneously, including TCC. Not all sources of inspiration were systematically documented, but photos and notes document a wide range of sources such as architectural references, various materials such as expanded metal, interactive installations, and, as mentioned, the TCC. By the end of the meeting, the basic idea to be pursued was still vague, but revolved around using digital technologies in transitional areas, rather than in the exhibition space.

After the initial meeting, we decided to continue by using the inspiration card workshop format (see Halskov & Dalsgård, 2006), an approach primarily used in the early stages of a design process, and involving sources of inspiration for narrowing down potential design ideas. The inspiration card workshop (column III in Figure 7) sparked a number of ideas, such as integrating a navigation system into the architecture, principles for visually connecting the museum with the nearby subway station, and a series of principles for the use of TCC. A few of these were documented as concept posters though often only in a sketchy way. The use of TCC evoked the interest of the principal architect, in particular, and came to play a key role during our collaboration with BIG, from this point onwards. We take this incident as the point of origin for the Strand Map in section 4. Even though only TCC was chosen to be used in the subsequent process, the Overview Map documents how aspects of other sources of inspiration influenced the use of TCC.

MAP	FOCUS
Overview	Source of inspiration and ideas
Strand	Materialization of ideas
Focal	From experiments to ideas?

Figure 6. The three kinds of maps.

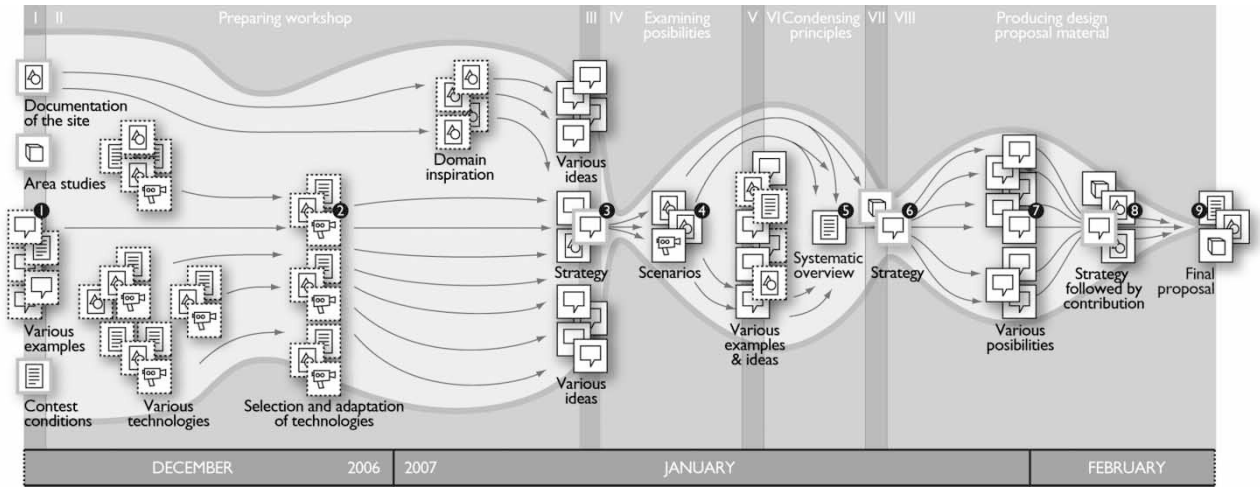

Figure 7. Overview Map of the Warsaw Museum design process, focusing on sources of inspiration and ideas.

After the inspiration card workshop, the decision to use TCC initiated a series of experiments examining the possibilities of this particular material (column IV in Figure 7), and, in order to further explore the potential of the TCC, CAVI organized a workshop with a digital artist (column V in Figure 7). The digital artist brought a number of sources of inspiration from the area of interior design into play, which provided important input to the process, but it was also evident that the huge amount of visual material available was overwhelming. In the subsequent period (column VI in Figure 7) the properties and potentials of the TCC were organized into a matrix that attempted to structure an overview of the possibilities.

At the last workshop with BIG (column VII in Figure 7) CAVI presented the previously developed visualizations and scenarios, together with the matrix. The meeting was followed by the last phase of the process (column VIII in Figure 7), which started from the conclusions and guidelines agreed upon with BIG, with regard to the possibilities of the matrix. The matrix itself inspired numerous ways of integrating TCC into the building proposal, and also led to discussions about perception, by means of distances and angles in relation to visuals created using TCC, which in turn led to experiments expounded in the analysis in the Focal Map in section 5.

At the end of the design process, CAVI's final contribution consisted of a brief description of TCC: this included the basic premise of using TCC interactively. Presentation principles: these consisted of practical considerations regarding TCC content, seen at various distances and from various angles. Technical references: these included links to related examples and prototypes. Proposals for use of TCC in the Warsaw MoMA: these comprised the primary part of CAVI's contribution, and consisted of three specific ideas for the use of TCC in the MOMA, namely to (1) integrate visualizations

Figure 8. Left: The wide range of sources of inspiration and materials. Right: The principal architect refers to an inspiring book to help illustrate various digital projection possibilities.

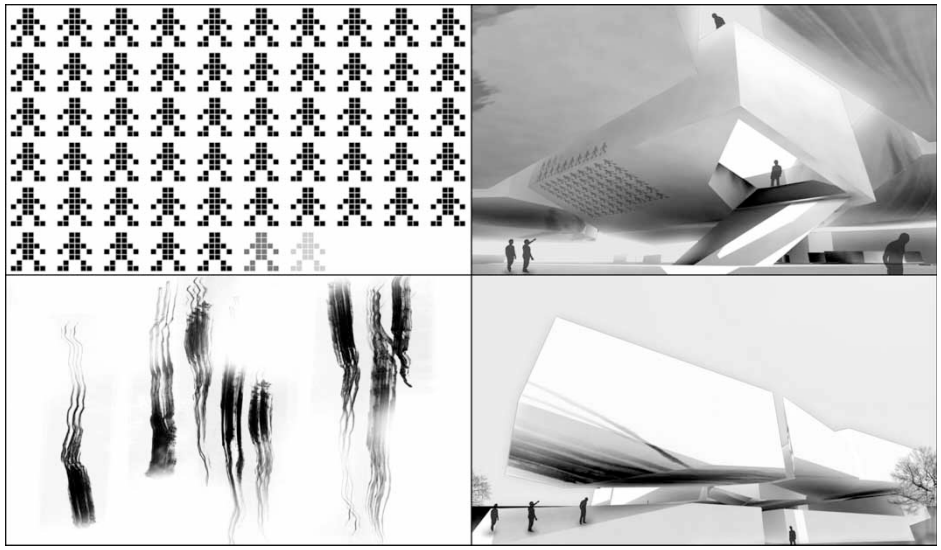

Figure 9. Upper left: Symbolic representation of number of visitors. Upper right: Indication of number of guests in the special section exhibition hall. Lower left:

of building and visitor data such as use statistics, e.g. number of visitors at the present time, most popular exhibits, etc. (see upper left and upper right in Figure 9); (2) peripherally visualize traces of the visitors as lines in the ceiling that reflect visitors' movements through the museum (see lower left and lower right in Figure 9); and (3) present exhibition visuals that employ the façade and the interior walls of the museum to present the current exhibitions.

Findings from using the Overview Map

Overview Maps capture and document the complexity of design processes. Although the only in-depth examination in this paper is that of the specific case of the Warsaw MoMA, our experience of numerous other design projects suggests that most have similar or higher levels of complexity. We have found that through the process of mapping out this complexity, the Overview Map serves well as a platform for in-depth analyses of the expanding and converging design horizons throughout projects. By capturing the multitude of sources of inspiration and ideas in the Warsaw MoMA design process, the overview mapping process implicitly supported comparison of and reflection on their interrelations and effects on the overall flow of the process, by focusing our attention on the major shifts in the process, and by forcing us to identify critical junctures for in-depth analysis. Thus, the Overview Map has been helpful in the retrospective analysis, not only in capturing and freezing the multitude of sources of inspirations and ideas, but also in documenting unmanageable and intangible elements in an operational and concrete way.

The Overview Map also makes clearer the ways in which sources of inspiration work at different levels. One level is that of the linear strands that come into view during the mapping process (see next section). Some sources of inspiration do not lead to any ideas, but only to strands with dead ends, and others influence other strands, even though they might be dead ends themselves. In this sense, the Overview Map captures a greater richness of a design process as the sum of all sources of inspirations and related ideas than does a traditional focus on the result alone. At an analytical level, although the map can stand alone as a tool for reflecting on general trends and design horizons, we find that it functions much better if used in conjunction with Strand and Focal Maps.

Strand Map – focusing on the materialization of ideas

The Strand Map for TCC in Figure 10 illustrates the way in which the idea of integrating colour-changing concrete into the final building proposal underwent changes, from oral, inspirational input early in the design process, to specific use-scenarios and illustrations in the final proposal. The numbers of the clusters on the map (1–9) refer back to the Overview Map in Figure 7. This specific Strand Map takes off at the beginning of the process, and continues to the end. In relation to our overarching research goal, the Strand Map highlights specific transformations, from the notion of TCC as an abstract source of inspiration, through explorations of various design materials in which the ideas were variously elaborated, up to the final ideas being incorporated into the architectural proposal.

Figure 10. The Strand Map for TCC.

The rationale for focusing on the concept of using thermo-chromatic concrete in this particular Strand Map is straightforward, namely that the TCC technology and potential ways of implementing it in interactive buildings became the crux of most of CAVI's design work from an early stage of the process. Retrospective analysis offers a privileged perspective, with regard to identifying the sources of inspiration that are eventually of most influence in terms of the final result, in that knowing the end result of the process facilitates 'reverse engineering', in which the ideas embedded in the final design can be traced back towards the point at which they first appeared in the design process. Whereas Overview Maps may be better suited to identifying which specific design idea dominates the design process, Strand Maps support analyses of how the design idea was transformed through a series of design representations, implemented in a diversity of design materials.

TCC was first mentioned in relation to the contest during the initial meeting with BIG, and at this early stage BIG showed an interest in the material, and the team agreed to use TCC, together with other sources of inspiration, in the collaborative process. Therefore, TCC was selected as one of a total of 15 technologies and materials that formed the basis for inspiration cards for the subsequent workshop (Figure 10, cluster 2). The TCC inspiration card had a short text (Figure 10, 2.1) and a picture of TCC in two different use-scenarios (Figure 10, 2.2). Furthermore, a video was used (Figure 10, 2.3) to illustrate the colour-changing properties of TCC.

In the subsequent inspiration card workshop (Figure 10, cluster 3), the TCC inspiration cards and the video in particular caught the team's attention, and dominated a significant part of the workshop as a recurring subject. BIG was especially fascinated by the possibility of literally integrating a slowly updating screen into the building's construction, which quickly led to sketches of principles for controlling TCC's temperature, and a discussion of the precision of this unique type of display. One of the ideas was to use the layout of water pipes in the walls as the basis for controlling the TCC (see Figure 10 3.2 and the sketch in Figure 11).

Despite the narrow focus on TCC after the workshop, the other undocumented ideas helped clarify the overall goal for the team members, who had diverse backgrounds and

Figure 11. Layout of water pipes in the wall.

interests. Despite, or perhaps because of, the narrow focus, we wished to explore potential uses of TCC, and a series of illustrations (Figure 10, 4.1) and animations (Figure 10, 4.2) was produced, in order to do so. The various visuals illustrated TCC in relation to the museum's façade, the building's entrances, and the lobby area.

During a subsequent meeting with a digital artist, focusing on ways of using TCC in the context of the museum, the complexity of TCC's possibilities led to an unmanageably wide design horizon for TCC, which was put into a systematic overview in terms of a matrix diagram (see Figure 12).

The visual material from cluster 4 and the systematic approach in cluster 5 were combined during an alignment meeting with BIG (Figure 10, 6.1). From a design research perspective, we found that a combination of easily understandable visual scenarios (Figure 10, 4.1 and 4.2) and the more abstract but open-ended systematic representations provided a productive platform for the subsequent work with TCC, although for our partners at the architectural firm it was easiest to relate to the visual scenarios.

For a final time we broadened the TCC design horizon (Figure 10, cluster 7). The systematic approach (Figure 10, 5.1) generated quite a handful of ideas, which were subsequently evaluated with regard to a set of criteria we received from BIG, which had made the final decision concerning the overall concept for the building structure (Figure 10, cluster 8). This was the final alignment to be agreed upon, and made it possible for us to work in a focused manner on three different possibilities for TCC in the specific situation and museum setting (see the Focal Map in section 5 for further details).

Findings from using the Strand Map

Strand Maps capture and visualize the various articulations and materializations of specific design ideas that have emerged from sources of inspiration. In our research, we have found Strand Maps especially useful in the following respects: (1) The very act of making the maps generates insight and establishes shared understandings among researchers, regarding how a design idea has evolved. There can be a tendency here to lose perspective and become absorbed in the immediate materialization of a design idea but Strand Maps may help overcome this tendency by making clear the evolution of the idea. (2) The Strand Maps highlight the multiplicity of digital and physical design materials being used, and how each of these addresses a specific aspect of the design idea. Some of the materializations address a specific aspect of the design idea, and others, like the matrix, provide insight into the complexity of the design space. (3) The Strand Maps point to specific transformations in the gaps between two or more identifiable materializations, and thus lead design researchers to make more detailed inquiries into the phenomena and events that may have brought about these changes inquiries that may well be explored through the creation of Focal Maps.

Focal map: from experiments to ideas

Having analysed the design process using Overview and Strand Maps, we now present

LOCATION	SITUATION	INTERACTION SENSING	INTERACTION STYLE
Facade	Passing by	Autonomous	Movement
Plaza	Arrival	Passive	Gesture
Park	Transit	Active	Touch
Metro	Resting		

Figure 12. Excerpt from the matrix.

three Focal Maps employed to analyse a specific situation identified on the TCC strand, namely a series of interrelated experiments into the properties of TCC, which occurred in the latter part of the process (in the phase marked VIII in the Overview Map, Figure 7). Focal maps can be employed in a large number of situations, ranging in time and scope from specific, small-scale design experiments to longer stretches of design considerations and events. With regard to our overarching intention of examining the interrelations between sources of inspiration, design materials, and experiments and ideas, focal maps are specifically intended to support documentation and reflection on experiments and their role in shaping design ideas. The rationale for presenting the three selected Focal Maps in this section in detail, is, in part, to illustrate the level of detail of the maps, and in part to offer insights into how these specific experiments transformed our understandings of the uses of TCC.

Experiments into the expression and perception of TCC

The series of experiments described here occur at a point in time at which CAVI and BIG had agreed to work on three ideas for the integration of TCC in the museum proposal. TCC being a new and unknown technology, CAVI conducted a number of experiments to further explore the potential of this material. These explorations included a number of experiments into the expression and perception of the TCC.

We will focus here on a triad of experiments, which followed one another in rapid succession. The specific object of the experiments was to explore the appearance and perception of images as they could be expressed using TCC. This was a highly relevant experiment, since the material had not previously been used in the way proposed by CAVI. This phase of experimentation was initiated by a series of rapid-fire experiments (see Figure 13), in which we tried out a number of filters, a photo manipulation application to test potential visual expressions of TCC; applying and evaluating each filter took less than a minute. This type of experiment may, in Schön's (1983, pp. 145 146) terminology, be conceived of as an explorative experiment in which the designer acts not with a specific end in mind, but rather to explore the potential of the situation. Having carried out these rapid-fire experiments, we moved on to three more detailed experiments into the potential appearance of TCC. These experiments may be conceived of as hypothesis testing experiments, in that we had now formed conceptualizations and hypotheses of potential TCC expressions, and needed to then test them.

These experiments began with the composition of a series of collages combining concrete imagery and a Van Gogh self-portrait (deemed relevant to a museum setting), using computer graphics software (summarized in the first Focal Map in Figure 14).

This resulted in a Van Gogh portrait of various degrees of opacity, illustrating the transition from low heat intensity (completely transparent image/plain concrete) to high intensity (clear image of Van Gogh) (see the first part of Figure 15).

This approach was chosen since we were familiar with the computer graphics software, and expected it to yield results. The insights from the first experiment indicated that the TCC visual effect was successful; however, the Van Gogh portrait bore an uncanny resemblance to Lenin, which we deemed unsuitable for a Polish museum competition, due to historical considerations. Thus, a second, very similar experiment was carried out, using the image of Leonardo da Vinci's Mona Lisa portrait, summarized in the second Focal Map in Figure 14.

The procedure and rationale behind this experiment were the same as in the first experiment, resulting in an effect and imagery (see the second part of Figure 15) that we chose to further explore in the design process. This prompted the third experiment, in which the imagery was rendered in an approximated 3D model of the museum surface (summarized in the third Focal Map in Figure 14). A human model was placed into this, and a series of 3D images, ranging from a close-up to a more distant view, was rendered (see the third part

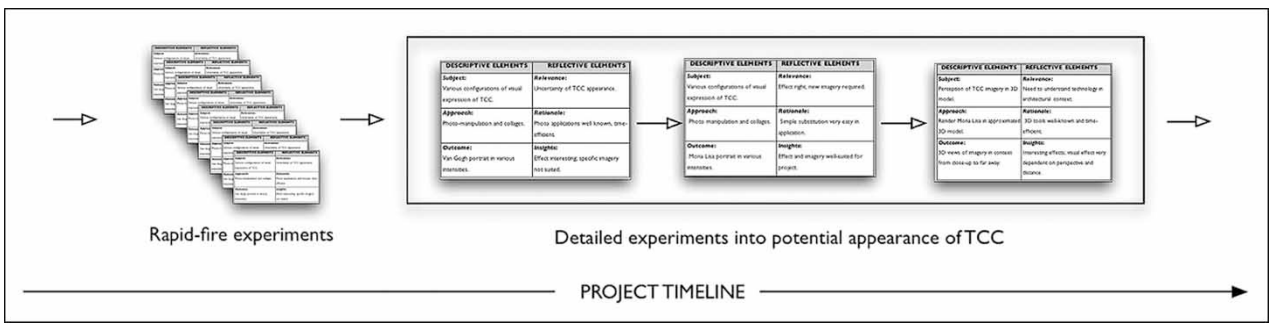

Figure 13. Strings of experiments into the expression and perception of TCC.

DESCRIPTIVE ELEMENTS	REFLECTIVE ELEMENTS 1
Subject: Various configurations of visual expression of TCC.	**Relevance:** Uncertainty of TCC appearance.
Approach: Photo-manipulation and collages.	**Rationale:** Photo applications well known, time-efficient.
Outcome: Van Gogh portrait in various intensities.	**Insights:** Effect interesting; specific imagery not suited.

DESCRIPTIVE ELEMENTS	REFLECTIVE ELEMENTS 2
Subject: Various configurations of visual expression of TCC.	**Relevance:** Effect right, new imagery required.
Approach: Photo manipulation and collages.	**Rationale:** Simple substitution very easy in application.
Outcome: Mona Lisa portrait in various intensities.	**Insights:** Effect and imagery well-suited for project.

DESCRIPTIVE ELEMENTS	REFLECTIVE ELEMENTS 3
Subject: Perception of TCC imagery in 3D model.	**Relevance:** Need to understand technology in architectural context.
Approach: Render Mona Lisa in approximated 3D model.	**Rationale:** 3D tools well-known and time-efficient.
Outcome: 3D views of imagery in context from close-up to far away.	**Insights:** Interesting effects; visual effect very dependent on perspective and distance.

Figure 14. The three Focal Maps describing the visual experiments into TCC.

of Figure 15). Again, part of the rationale behind the chosen method was based on our familiarity with the required software. The insights gained were that, from a distance, TCC imagery is clear and recognizable but, as observers move closer, the pixelation makes it harder to recognize. The combined experiments yielded an understanding of imagery using TCC, when perceived from various distances and angles, and the results were convincing enough for this idea to be incorporated into CAVI's final contribution to the museum proposal.

Findings from using Focal Maps

Focal Maps prompt reflection on the experiments that are at the core of moving from initial sources of inspiration towards fully formed design concepts. Our use of the maps reiterates the notion that many design experiments serve to understand, explain, and frame challenges, rather than to solve them. This is a key characteristic of executing design in practice, which is by nature an undertaking influenced by multivariate factors; i.e. even if we try to bracket our design experiments to focus on specific aspects, we are often presented with results that go beyond what we set out to explore. For this reason, the transformation of design ideas through materializations often has the character of strings of experiments, as outlined in this section. We have shown how the maps may be used in a micro-analytical fashion, to point out specific iterations of experiments into the various expressions of TCC; however, we speculate that Focal Maps may also be employed to analyse experiments at a higher level of abstraction.

Of practical relevance to design researchers wishing to use the maps, our use of the maps has led us to appreciate a number of benefits, primarily that (1) the reflections they prompt are natural extensions of the reflections that emerge from using Overview and Strand Maps, (2) the format of Focal Maps is very easy to respond to, in that they lay out the reflection process in a straightforward manner, by coupling descriptive and reflective elements in a clear-cut line of inquiry and argument, and (3) a Focal Map, if it is completed immediately after the event it maps, captures insights into events that may be skewed or distorted in later, retrospective analysis.

Conclusion

Having explored the specific use of the maps for design reflection in the Warsaw MoMA

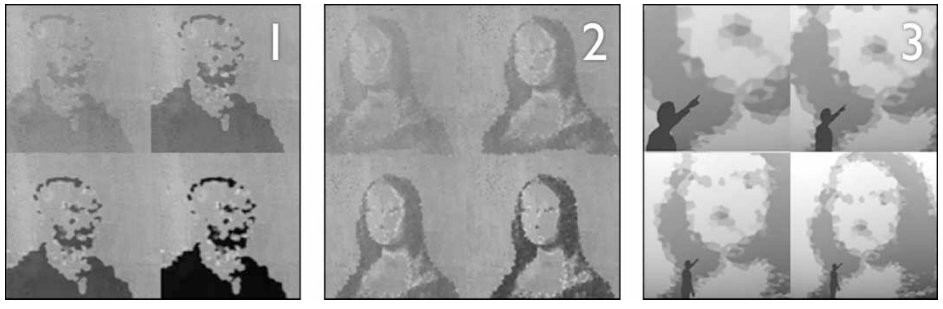

Figure 15. Illustrations from the three visual experiments into TCC.

case, we sum up the findings from using each type of map. We then broaden the scope and discuss the use of the maps in combination, suggest ways in which design researchers might use the maps, and discuss the advantages and drawbacks of doing so.

The Warsaw MoMA Overview Map presents a thorough, albeit abstract, account of main events in the project, with a particular focus on sources of inspiration and the emergence of ideas. In spite of the high level of abstraction, it is hard for observers outside the project to get an overview understanding of the project by means of the maps. They are primarily intended for use among design researchers; for the purpose of conveying a design process to outsiders, they must be supplemented with other accounts of the process. The complexity of the design process is such that the collection of maps presented in this paper by no means represents all aspects. Although CAVI contributed only to the interactive elements of the final proposal for the museum, the design process proved too complex to represent exhaustively, and even seemingly simple design moves in projects can contain interesting elements of insight, depending on the interests of those employing the maps. At a practical level, a software application for creating and updating Overview Maps would be helpful, because of their complexity. To this day, we use standard illustration and image editing software; however, a more dedicated solution would be preferable, especially if maps are to be created and updated by several researchers. At an analytical level, although the map can stand alone as a tool for reflection on general trends and design horizons, we find that it functions more effectively when used in conjunction with Strand and Focal Maps.

Although we have developed the maps in a design case in which we ourselves were design participants as well as researchers, our subsequent work with these types of maps indicates that it is also possible to use the method to capture processes in which the researchers are not directly involved; that is, the maps may be constructed from the outside as well as from the inside. However, direct engagement in design processes offers access to a number of aspects which may be difficult or downright impossible for outside observers to study. On the other hand, an engaged inside perspective invariably implies affinities and blind spots, which are not present from an external perspective. In our use of the maps so far, we have focused on presenting and analysing a multifaceted case study. Thus, we have used the maps to present knowledge that unfold the details of rich design situations. Whether or not use of the maps can lead to more generalizable knowledge about design processes will depend on focused future uses of the method.

Due to the general complexity of design processes, employment of design reflection maps consequently relies on the design researchers considering the relevance criteria for their use. Since the maps are primarily intended as tools for reflection and analysis, they are intentionally flexible and negotiable, e.g. an Overview Map may guide the attention towards key points in the overall process, but establishing what constitutes a noteworthy strand for analysis and reflection is ultimately up to the design researcher(s). The maps are intended to create awareness, and allow for explication of design moves that have influenced the process, rather than to suggest how these moves be interpreted.

Strand Maps capture and visualize the various articulations and materializations of specific design ideas that have emerged from sources of inspiration. The Strand Maps have been especially useful with regard to the way in which various aspects of the main design idea have been explored in a multiplicity of digital and physical design materials, each addressing a specific aspect of the design idea.

Focal Maps prompt reflection on the experiments from initial sources of inspiration through 'a web of moves, discovered consequences, implications, appreciations, and further moves' (Schön, 1983, p.129), towards fully formed design concepts. Given the complexity of design processes Focal Maps aim to pinpoint and capture specific incidents, which might otherwise be obscured by complexity. Different types of experiments contribute to the design process in different ways. With the scope of the paper in mind, we have focused on exploration and hypothesis testing experiments in order to illustrate the combination of descriptive and reflective properties of Focal Maps; we speculate that further systematic use of the maps by design researchers may support comparison and expansion of the notion of design experiments.

Each type of map has specific uses and limitations, and an understanding of these is crucial for the rewarding use of the maps. For example, Overview Maps highlight main trends and shifts in the design process, but do not facilitate detailed understanding of specific design moves; Strand Maps support comprehensive reflection on specific design ideas over stretches of time, but do so at the cost of other potentially influential elements in the design process; Focal Maps allow for in-depth analysis of specific design moves, but do not facilitate conceptions of how these moves affect the overall process. The three types of maps are therefore well suited to development and use in combination i.e. an Overview Map may indicate that something important happened at a certain point in time, which prompts the use of Strand or Focal Maps to explicate detailed connections and moves, and the use of a Strand Map may highlight a certain pattern whose importance can be clarified using an Overview Map, or further analysed using Focal Maps. Thus, when using the maps, we recommend a tactic of 'zooming' in and out between levels of abstraction, based on the predetermined relevance criteria for the research process.

While this has concrete advantages in the design research process, as outlined through-

out this paper, we must stress that there are elements of the design process that are obscured or possibly ignored in this perspective. For instance, by placing the main emphasis on sources of inspiration, design materials, and experiments, the importance of dynamics and relations between different actors and stakeholders in the design process is momentarily downplayed. The insights of the maps may, however, help identify such relations, through the changes in design ideas. For instance, in the Warsaw MoMA case we can identify a radical convergence of effort in one specific event, the workshop presented in section 3.3. This major shift is the outcome of negotiations, relations, and decisions amongst stakeholders in the project, aspects that are largely outside the scope of this paper. Thus, we do not propose that the maps for design reflection should be the sole design artefact for researchers, but rather that they provide insights into specific aspects of design processes and, to reiterate the point, that design researchers apply them in light of the relevance criteria set up for their research inquiries. We have found that the maps offer a structured approach to capturing and understanding interrelations between sources of inspiration, design materials, and experiments in ways not supported by other methods. Although we have not worked actively to develop alternative maps, it will very likely be of interest to other design researchers to create maps that highlight other aspects of the design process, such as mapping stakeholder relations and contributions, end-user involvement, or other aspects entirely.

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Designing for Inquisitive Use

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ABSTRACT

This paper presents the concept of inquisitive use and discusses design considerations for creating experience-oriented interactive systems that inspire inquisitive use. Inquisitive use is based on the pragmatism of John Dewey and defined by the interrelated aspects of experience, inquiry, and conflict. The significance of this perspective for design is explored and discussed through two case-studies of experience-oriented installations. The paper contributes to the expanding discourse on experience design on a theoretical level by exploring one particular facet of interaction, inquisitive use, and on a practical level by discussing implications for design prompted by insights into inquisitive use. These implications are presented as a set of design sensitivities, which provide contextual insights and considerations for ongoing and future design processes.

Categories and Subject Descriptors

H.5.2 [**Information Interfaces and Presentation**]: User Interfaces – *Theory and Methods, User-Centered Design.*

General Terms

Design, Human Factors, Theory.

Keywords

Inquisitive use, User Experience, Interaction Design, Pragmatism, Design Theory.

1. INTRODUCTION AND BACKGROUND

The past decade has seen an ever-growing interest in understanding user experience in the field of interactive systems design. This has prompted a number of contributions to the field in which over-all frameworks for understanding experience are presented, as well as ways of operationalizing these understandings in design practice. Although differing perspectives on experience abound, there is a consensus that the topic is highly complex. In this paper, I examine a specific facet of user experience within the field of interactive systems, namely that of *inquisitive use*, and discuss considerations for designing for inquisitive use. The incentive for focusing on a singular aspect is that, in light of the contributions to establish a general understanding of user experience, this allows for examining in depth one strand of this intricate phenomenon. It further provides room for discussing practical implications for designing systems intended to bring forth certain experiential qualities. The motivation for addressing the specific concept of inquisitive use is to unfold the resourcefulness of users in their interaction with experience-oriented systems and to discuss consequential design considerations.

The structure of the paper is such that, after situating the paper in the broader field of user experience studies, I present a pragmatist perspective on inquisitive use, characterized by the interrelated aspects of *experience*, *inquiry*, and *conflict*. The concept is then explored through the study of two cases. This leads to a discussion of considerations for designing for inquisitive use and notes on future work.

1.1 User experience and interactive systems

User experience in interactive systems lends itself to scrutiny from a wide array of perspectives, and there is no consensual definition of the concept. Depending on the definition, the term experience can thus refer to phenomena on various levels, ranging from tacit personal knowledge to societal issues. In [9] Davis argues that, in light of the complexity of the subject, "experiential systems design must be radically interdisciplinary". This entails bringing together insights and methods from disciplines such as engineering and computer science, psychology, and the humanities. Within the interactive systems design community, approaches to understanding user experience include experiments with new technologies as a starting point for exploring experiential qualities (eg. [26][29]), and explorations into what makes for pleasurable products (eg. [30][36][40]). One comprehensive example of the latter is Desmet & Hekkert's "Framework of Product Experience" [17] which explores the interrelations between aesthetic experience, the experience of meaning, and emotional experience in the general frame of product experience. On a higher level of abstraction, another approach is to establish a general theory of experience (eg. [1][9][21][22]). En explicated example of this approach is Forlizzi & Battarbee's "Understanding Experience in Interactive Systems" [21] in which a framework for user experience of interactive systems is established on the basis of a typology of interactions (fluent, cognitive, and expressive) which may yield various types of experiences (continuous experience, particular punctuated experiences, and co-experience). A related approach is to focus on aesthetic aspects of user-system relations and experiences (eg. [2][18][19][37]), as do McCarthy & Wright in "Technology as Experience" [32] in which they establish a framework of four 'threads' of experience (emotional, sensual,

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compositional, and spatio-temporal) and six practices for making sense of experience (anticipating, connecting, interpreting, reflecting, appropriating, and recounting). A more modest approach is to focus on particular dimensions of experience or aesthetics of interaction, as do for example McCarthy *et al* [33] with regards to the concept of Enchantment, Landin [31] with regards to fragility, and Hummels *et al* [28] with regards to resonance. This paper is positioned within the latter approach by focusing on the specific concept of inquisitive use. Theoretically, the paper is based upon pragmatist philosophy, and as such it shares a kinship with Forlizzi & Battarbee [21], McCarthy & Wright [32], and Petersen *et al* [37]. The latter draws upon the pragmatist aesthetics of Shusterman [41] in order to build a framework for aesthetic interaction that brings to the fore the bodily situated nature and aesthetic potential of everyday experiences.

1.2 Conceptualizing users and use

The perspective on inquisitive use presented in this paper posits users as inquisitive and resourceful actors, capable of exploring and experimenting with interactive systems in the course of their experience of them. This perspective is significant because interaction designers' conceptualization of the users of their future systems have extensive implications for both design processes and resulting systems and products, including how to gain knowledge about users and the use domain, the involvement of users in the process, the creation of specifications and requirements, the design of user interfaces as well as underlying structures, and the introduction of the systems and products to users. An introductory disclaimer: The term *user* is contested ground, and may connote a functionalistic perspective on persons interacting with systems. As will become evident, a pragmatist perspective on interaction goes beyond functional aspects; given this disclaimer, I shall however stick to the term *user* in lack of a better denomination at this time.

Methods and techniques based on cognitivist understandings of users (eg. [4] and [35]) initially dominated the field, but these have been challenged from a number of positions, including those mentioned in section 1.1. An important source of inspiration for the concept of inquisitive use presented in this paper is Gedenryd's critique of the cognitivist perspective underlying these methods and techniques [23]. Gedenryd makes the argument that an understanding of the potential of human activity should not be reduced to "the study of human mental imperfection". On the contrary, this potential is characterised by our continuous exploitation of our bodies and our environment in order to complement and enhance our intramental (ie. mental cognitive) capabilities. Competent users will "go out of their way to avoid intramental thinking" [23] by employing what Gedenryd dubs *situating strategies* in which the full range of the situation – users' minds and bodies, co-present humans, physical surroundings etc. - is explored and utilized to affect intended changes in the world. It is in this light that this paper addresses the concept of inquisitive use. The concept is one that encourages conflict, challenge and risk in experience-oriented installations, which in turn will prompt users to adopt inquisitive approaches and actively engage the installations. The rationale for designing for inquisitive use is that this mode of engagement may bring about more fulfilling experiences, a stance discussed here on the basis of pragmatist philosophy.

2. INQUISITIVE USE

The concept of inquisitive use has a pragmatist foundation and is primarily based on the work of John Dewey [10]. Pragmatism, a movement consisting of related though not fully congruent theories, was established by Charles Sanders Peirce, William James and later taken up by Dewey (incidentally, the three originators all objected to the label pragmatism). The movement is so labelled due to the assertion that the meaning and "truth" of ideas is to be determined on the basis of their practical implications, a position often referred to as *the primacy of practice*.

In Deweyan pragmatism, the world is characterized by flux and contingency, and the ideas and theories we form are practical instruments for transforming our apprehension of problematic situations into fulfillment by resolving them. This perspective has been influential in the design community and has inspired studies of the reflective design process [1] as well as well as aesthetics of interaction [37]. In this paper, I seek to further examine the implications of adopting a pragmatist perspective in interaction design with the particular focus on user inquiry, engagement, reflection and action in use situations. Deweyan pragmatism presents an interesting frame for reflecting upon these aspects given the primacy of practice which prompts a contextual and processual mode of inquiry into understanding phenomena in the world[11]. It is a perspective deeply concerned with practice as it unfolds, and one that invites to form, test, and transform theory through practice.

The concept of inquisitive use presented in this paper consists of three interrelated aspects: experience, conflict, and inquiry. These were briefly introduced in [7] and are unfolded in greater detail in this paper. Although they are in many ways overlapping, these three aspects are presented separately for the sake of clear presentation. Upon this their convergence in inquisitive use is explicated. The division of inquisitive use into three separate aspects should be construed as a means for comprehensible, linear presentation. It does not imply that they can analyzed in isolation, and their systemic interrelations will become clear in the discussion and application of the design sensitivities.

The concept of inquisitive use may be of of value for the interaction design community on two levels: first, it provides a framework for understanding use of interactive systems; second, it gives rise to *design sensitivities* [5][27] for designing for inquisitive use. I use the term design sensitivities in the sense that they "suggest relevant issues and inspire creative design, rather than imposing rigid rules on the design." [5]. Each aspect is thus first introduced in general, followed by three resultant design sensitivities. The introduction to the aspects will primarily summarize Dewey's concepts, while the design sensitivities can be construed as syntheses of these concepts related to the specific concerns of designers of interactive systems.

The account of pragmatist concepts given in this paper is by no means an exhaustive one (the collected works of Dewey alone are comprised of 37 volumes on issues including education, art, experience, democracy and more [10]), and it may benefit from further expansion and discussion in the future. The specific aspects of experience, inquiry, and conflict are expanded upon due to their relevance for understanding inquisitive use.

2.1 Experience

An elucidation of the concept of experience is crucial, since this paper is concerned with inquisitive use within the field of experience-oriented interactive systems. The general usage of the term experience varies, as has been outlined in the previous paragraphs, and I will establish a pragmatist terminology of experience. I shall use the term experience-oriented when I refer to the broader discourse within the field of interaction design.

In Deweyan terminology, there is a clear distinction between *experience* and *having an experience* [14]. Experience is a continuous and ubiquitous aspect of human existence, a flow that binds together all situations we encounter. This continuity implies that "every experience both takes up something from those which have gone before and modifies in some way the quality of those which come after." [15] Regarding experience-oriented interactive installations, the concept of *having an experience* is often the intended outcome of use. This refers to specific, distinct experiences that are often perceived as problematic or aesthetic. In Deweyan terminology, *Problematic experiences* are those that challenge our pre-formed conceptualization of the world and require inquiry and action if they are to be overcome and transformed. *Aesthetic experiences* arise when past experience and present circumstances converge in a way that creates a sense of meaning and fulfillment. These two types of distinct experiences can be convergent since the process of overcoming a problematic experience can result in an aesthetic experience. A number of recent contributions to the field of interaction design studies have adressed pragmatist understandings of aesthetic experience, including [32] and [37]. Whereas [37] thoroughly discuss aesthetic experiences in their development of what they call *Aesthetic Interaction*, it is equally important to bring into light problematic experiences when considering inquisitive use: First, because it is often problematic experiences that prompt inquiry; second, because problematic and aesthetic experiences are reciprocal in that aesthetic experiences often arise from problematic ones.

For inquisitive use of interactive systems, the pragmatist perspective on experience fosters design sensitivities regarding the following:

Experience in practice

Experience is radically rooted in practice: Users experience the world through acting in it with their minds and bodies, knowledge and understanding arises through active investigation, reflection is in itself a practical activity, and experience unfolds temporally through transactional practice that potentially transforms users and circumstances. To facilitate inquisitive use, interactive systems can support emerging exploration by providing modes of interaction that prompt ongoing user action and cater to both reflective and physical capabilities.

Continuous experience

The continuity of experience prompts designers to consider the integration of their systems not just into the flow of physico-spatial surroundings, but also into the flow of users' past and future experience. For interactive systems to tie into a user's experience, they have to present a recognizable link between the past and future in the sense that they resonate with established patterns of thought [28] and indicate that they may lead to an expansion of the capabilities of experiencing the world.

Distinct experience

Experience-oriented interaction design projects are often intended to bring about interactive installations that can evoke aesthetic experiences. However, designers must recognize the interrelations between problematic and aesthetic experiences. For an experience to be perceived as special and outstanding – as fulfilling aesthetic experiences are – they must necessarily be disparate from habitual ones. This can be the case with instantaneous experiences when elements in a situation suddenly fits together in richly gratifying way. Often, however, what leads to an aesthetic experience is at first a problematic situation that contains elements of conflict and prompt inquisitive action for it to be transformed into a meaningful and gratifying encounter. Interaction designers must thus recognize the potential in perturbing users' habitual conceptualizations with regards to framing, content, and modes of interaction. The potential of invoking aesthetic experiences for users should prompt designers to explore what may constitute such experiences in the specific domain, and how they may be brought about through the course of interaction

2.2 Inquiry[2]

Dewey's concept of inquiry[16] is closely tied to experience, for we may intentionally seek to create specific experiences for ourselves through inquiry, eg. when one starts learning to play a musical instrument. Inquiry is a particular mode of understanding and engaging phenomena in the world prompted by encounters with problematic situations. *Situation*, in Deweyan terminology, is a systemic concept: "What is designated by the word 'situation' is *not* a single object or event or set of events. For we never experience nor form judgments about objects and events in isolation, but only in connection with a contextual whole. This latter is what is called a 'situation'." [13]

When habitual action in a given situation does not result in the desired outcome, it is in Deweyan terminology labelled a *problematic situation*. When faced with problematic situations that we wish to resolve, we form simultaneous thought experiments with and articulations to understand what it is that makes the situation problematic. These conceptualizations form the basis for hypothesizing about how we may reconstruct or transform the situation before carrying out physical actions. This process is often one of iteration: we imagine and/or try out a number possible ways of reconstructing the situation, all the while re-evaluating the way the situation talks back to us in our interaction with it. We experience this back-talk as effects that qualitatively change our view of the situation. A problematic situation may be resolved by the transformation of the inquirer, the circumstances, or both (which together make up the situation). An integral component of inquiry is that which Dewey coins *transaction*, the ongoing and transformative interrelations between the experiencer and his/her circumstances: the flow of experience incessantly influences the experiencer, who in turn transforms with the circumstances in order to pursue certain experiences. For interactive systems design, it is worth noticing that, in Deweyan terms, transaction is distinct from *interaction*, which denotes an encounter in which the experiencer and the circumstances are not reciprocally transformed.

[2] This section is based primarily on [16].

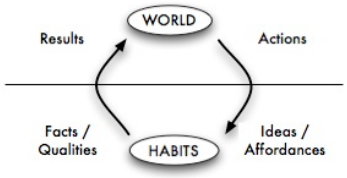

Figure 1: Model of inquiry (Translated from [3])

This process of inquiry is explored in detail in Donald Schön's work on situational back-talk and design as reflexive practice [39], which is heavily inspired by Deweyan pragmatism. For the design of experience-oriented interactive systems, the concept of inquisitive use posits that users may adopt an inquisitive mindset when confronted with problematic situations, and that they are capable of employing situating strategies [23] in order to understand, explore, and transform such situations.

For inquisitive use, the pragmatist perspective on inquiry fosters the following design sensitivities when designing for inquisitive use:

Situated intentionality

Although some experiences occur without an expressed intent on the side of the experiencer, in the case of experience-oriented interactive systems they primarily arise when experiencers interact with them by their own accord. I use the term *situated intentionality* to denote a directedness towards an object or objective. This directedness, as well as the object or objective, can be more or less well-defined depending on the situation. Eg. in an art museum one may interact with an information kiosk with the specific objective of finding the dating of a certain piece, or one may use it more broadly in the serendipitous hope of learning more about the aspirations of the artist whose works are on display. Designing for inquisitive use implies addressing situated intentionality by exploring users' pre-existing desires to have specific experiences in the setting and by bringing into play elements that pique the interest of users by tapping into their past experiences so that these intentions arise. This arousal of interest and intention is the platform for inquisitive use. Strategies for doing so range from transparent (eg. it is made clear what type of experience to expect) to enigmatic (eg. information is kept hidden to arouse curiosity).

Concurrent action-reflection

Inquisitive use is a process of testing and transforming conceptualizations about the world by acting in it. Inquisitive use situations should contain both semantic elements of stability and recognition as well as elements of change and uncertainty: The experiencer needs the stable semantic elements as scaffolding for exploring the unfamiliar, lest everything appears in flux. In inquisitive use situations, reflection will occur in action, but it may also be fruitful to design for intermissions (temporally as well as spatially) in which reflection upon the interaction can unfold.

Reciprocal change

Meaningful experiences instill change in the experiencer through effects that shape future conceptualizations. In inquisitive use situations, the impact of an experience is in part dependent on the change which the experiencer may effect on the system or situation: it is through these transformations that the inquisitive user experiences situational back-talk on her actions that enables her to evaluate the commensurability between her conceptualizations and the situation. Such transformations can be short-termed or permanent. Strategies for reciprocal change range from expressive systems that allow for short-term alterations (eg. installations such as Laser Tag [25]) over progressively unfolding systems (eg. computer games with advancing levels and narratives) to adaptive, collaborative systems that are deliberately unfinalized by designers and made valuable by users' interaction and input over the course of time (eg. collaborative software such as del.icio.us [39]).

2.3 Conflict

In a Deweyan understanding, conflict prompts an inquisitive attitude, drives engagement with situations, and leads to learning:

"Conflict is the gadfly of thought. It stirs us to observation and memory. It instigates to invention. It shocks us out of sheep-like passivity, and sets us at noting and contriving. Not that it always effects this result; but conflict is a sine qua non of reflection and ingenuity." [12]

Conflict as it is commonly understood is a concept laden with negative connotations. This is not the case in a Deweyan perspective, in which it rather denotes tension or unresolvedness in the reciprocal relations between the experiencer and the circumstances. Conlict is a fundamental characteristic of our being in the world, and it is the very existence of conflict and instability that, through human engagement, makes possible experiences of resolution and fulfillment:

"Because the actual world, that in which we live, is a combination of movement and culmination, of breaks and re-unions, the experience of a living creature is capable of esthetic quality." [14]

Conflict is not positive and fruitful in all situations, and it may be detrimental to future experience and cut off intended courses if not resolved; however, it is a necessary catalyst for bringing about genuinely new types of experiences through inquiry. In order for a conflict to be perceived as such, there must be something at risk. Conflict is not implicitly something that is thrust upon the experiencer against her will; it may also be something that she intentionally seeks out, eg. in order to expand her horizon, to gain new insights, to be thrilled or moved etc.

Depending on the design domain, conflict may be a more or less preferable property. Eg. in the design of workplace systems, it may be detrimental to the use of the system to incorporate elements of conflict. A major part of research into designing interactive systems may indeed be construed as finding ways to minimize conflict between the experiencer and the system. This is not to say that interaction with workplace systems are bereft of meaningful or aesthetic experiences, merely to point out that designing for functional, habitual use is often the primary objective in the workplace context.

For the design of experience-oriented interactive installations, however, conflict is a critical and somewhat ignored aspect that can be at odds with traditional methods and techniques that strive for ideals of transparency, usability, and user-friendliness. Conflict can exist on multiple levels, eg. it may appear in the interface, in the selection and structuring of content, in the temporal unfolding of interaction etc. Typically, strategies for designing conflict in use situations aim at creating straightforward user interfaces and challenging trials on a content or narrative level (eg. in an arcade driving game). However, designing for

conflict on an interface level (as eg. Dunne [19] has explored) can also make for remarkable use experiences. Integrating the concept of conflict in interactive systems design implies exploring ways of challenging users in ways that may ultimately hinder them in successfully using the systems.

For inquisitive use, the pragmatist perspective on conflict fosters design sensitivitites regarding:

Challenge

Conflict arises when elements in a situation challenge established patterns of understanding. Hence, designing for inquisitive use entails a process of building up anticipation by facilitating some form of initial sense-making by tying into existing experience. Instilling an initial sense of challenge is thus closely related to situated intentionality. A crucial dimension in establishing meaningful challenges is to balance the difficulty of the challenge to the capability of the experiencer. Optimal correspondence between the two leads to an experience described by psychologist Mihaly Csikszentmihalyi as *flow* [6]: "Every action, movement, and thought follows inevitably from the previous one, like playing jazz. Your whole being is involved, and you're using your skills to the utmost."[24]. In this sense, flow can be understood as the convergence of conflict and inquiry.

Risk

The potential reward for experiencers in terms of overcoming a challenge is in part dependant on the perceived level of risk. When the experiencer has the sensation that something important is at stake, this can make for more intense and engulfing experiences. For designers, this prompts considerations about how to establish uncertainty of how and if a problematic situation can be resolved. As with challenge, risk has to be balanced between presenting enough risk to make a situation interesting for users to engage in it, though not so much as to make users shy away from it ahead of time. Suspenseful narratives characteristically employ strategies for balancing this by first presenting a status quo, establishing identifiable characters and/or values, and then thrusting these into uncertainty. Well-constructed narratives employs the audience's identification to up the ante and create tension and doubt. This can be effectful even though the audience may know how conflicts will eventually be resolved. Interactive systems can take this further by putting users in partial control of how a situation unfolds. A typical example of this is to establish a relatively high level of challenge and risk and countering this with the ability to replay situations, as is a common approach in computer game design. However, this strategy must be carefully considered, since replay options ultimately diminish the sense of risk.

Resolution

In accord with situated intentionality, inquisitive use is directed towards some form of perceived resolution. The intentions and the perceived resolution may well change over time, as users' conceptualizations as well as the situation evolve. The user's sense of what the resolution of a situation may be can be very vague, especially if enigmatic strategies for drawing users in are employed; eg. a crime story has to build the expectation that a mystery will be solved, but must still keep readers guessing until the resolution is presented. Dewey denotes a resolution in which situation and experience fuse in perceived unity as the *consummatory phase* of experience; this is the basis for aesthetic experiences. Such consummation entails a re-adaptation of the individual with the situation. In Deweyan terms, most experiences are, however, *inchoate*: they provide no sense of closure, they simply stop. This is can be the case not just for random everyday encounters, but also for carefully crafted events (eg. "... it was a great movie for the most part, but I was really let down by the cop-out ending"). However, it is inchoate experiences that form the contrasting background for outstanding experiences, for "Where everything is already complete, there is no fulfillment"[14].

2.4 Designing for inquisitive use

The converging concepts of experience, inquiry, and conflict form form a foundation for understanding inquisitive use which may be represented as in Figure 2: Model of inquisitive use:

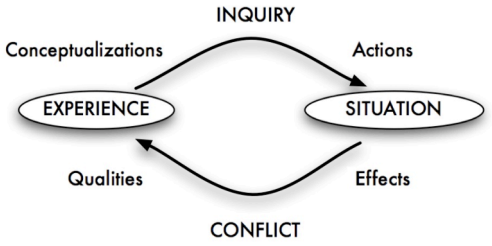

Figure 2: Model of inquisitive use

Inquisitive use is instigated by problematic situations that challenge our conceptualizations. These situations may present themselves without the intent of the user, or she may actively seek them out. Through iterations of inquisitive action and situational back-talk, the user-situation transaction unfolds until resolution occurs, be it in an inchoate or consummatory way.

On this basis, the nine design sensitivities laid out in the previous paragraphs suggest considerations to be taken into account when designing for inquisitive use. The design sensitivities necessarily have a high level of abstraction, in that inquisitive may occur in various forms in a multitude of situations. Awareness of the sensitivities support designers' reflective practice when carrying out design experiments and moves through what Schön [39] labels *reflection-in-action*, as well as *reflection-on-action* when designers analyze past design moves and outcomes and weigh them against intended future results. In other words, the framework can be used both pro-actively and retrospectively. Together, the conceptual framework and the design sensitivities form a perspective on users as resourceful, inquisitive co-creators of experience.

In order to explore the interrelations between experience, inquiry and conflict, and the implications of employing the design sensitivities in the design process, I will introduce and discuss two case studies of experience-oriented, interactive installations: *Balder's Funeral Pyre* and *Silence and Whispers*. The author has participated in the design of both installations and thus has insight into the design considerations underlying their development and the specific design decisions made in the development process. Both installations seek to evoke specific moods and ambiences, instill user curiosity, and convey narrative elements. Whereas they are similar with respect to experiential design sensitivities, they however differ radically with regards to participatory and transactional aspects of use: Balder's Funeral Pyre comes off primarily as a contemplative installation, while Silence and

Whispers prompts engaged user participation. This invites a discussion of inquiry-related design sensitivities underlying the two installations and the contrasting user experiences they may bring about. The installations should thus be construed as vehicles for discussion rather than prime exemplars of inquisitive use.

3. DISCUSSION: INQUISITIVE USE EXPLORED THROUGH TWO DESIGN CASES

The discussion of inquisitive use in the two cases is structured as follows: the two installations are presented; then the concept of inquisitive use is discussed in each case in relation to the practical circumstances of the cases (eg. setting, involved stakeholders, time constraints etc) and the *intentions* and *values* underlying the design processes, and finally the elements of inquisitive use in the two cases is compared. Regarding intentions, I refer to the purposes of creating the installations in terms of function and use, while values refer to the experiential qualities embedded in and evoked by the installations, (see Dalsgaard & Halkov [8]). The practical circumstances, intentions and values are brought into play since they form the foundation for discussing the design sensitivities in practice.

3.1 Case presentation: Balder's Funeral Pyre

Balder's Funeral Pyre is a custom-made interactive installation at 7th Heaven, a center for children's literature. It was created at the Center for Advanced Visualization and Interaction (CAVI), University of Aarhus, with the participation of the author. The *intentions* underlying the installation is to arouse children's interest in literature by introducing them to Norse mythology without retelling the stories from this universe word by word. This approach to knowledge mediation aims at encouraging children to read and explore stories from this universe themselves after visiting the center.

In Norse mythology, the death of the god Balder marks a crucial narrative turning-point: Balder is slain by his own brother through the treachery of the deceitful Loki. Upon his death, Balder's body is placed upon a ship that is ignited and set off to sea. These events spell the beginning of the end of the mythological world, culminating in an apocalyptic battle, Ragnarok, which lays waste to the heavens and the earth.

Figure 3: Visitors experience Balder's Funeral Pyre

The Balder's Funeral Pyre installation appears to visitors as a narrow, 7 meter long corridor in which one of the sides is rear projection of fire (see Figure 4 for a diagrammatic overview). The fire is vizualized by mixing video feeds of fire with a particle generation system. This imagery is coupled with pressure sensors in the floor which enables visitors to interact with the fire. When no one is in the corridor, the flames simmer near the floor, but when someone enters the corridor, a fire shoots up at their location. As the visitor proceeds down the corridor, the growing fire appears to envelop them. The software controlling the interaction has built-in delays in order to minimize the visitors' awareness that they are in direct control of the fire. The installation is one of many in the 7th Heaven Norse mythology exhibition, and visitors typically encounter it halfway through their visit. Thematically, the story of Balder's funeral can also be conceived as the middle of an unfolding narrative, before which the stable Norse universe is presented, and after which Ragnarok occurs.

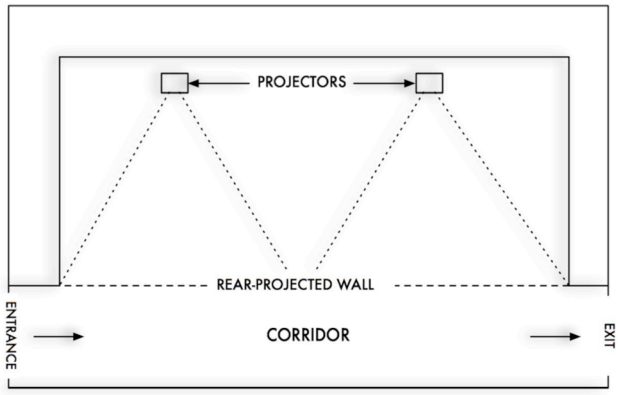

Figure 4: Diagram of Balder's Funeral Pyre

3.2 Case presentation: Silence and Whispers

Silence and Whispers is a conceptual mixed reality installation created in 2006 as a cross-disciplinary collaboration between four interaction design researchers, including the author. Silence and Whispers was developed and located on Suomenlinna, a series of islands in the Helsinki harbour entrance. Suomenlinna served as a naval fortress and 1748 until the end of World War I, and simultaneuosly the islands housed detention camps. Today, there is a close-knit community of inhabitant on the islands that also serve one of the most popular public recreative area in Finland. Furthermore, Suomenlinna hosts an open prison facility whose inmates carry out maintenance and restoration work on historic monuments and sites.

The primary *intention* underlying the design of Silence and Whispers is to collect and convey stories that reflect this multi-layered cultural history. Near King's Gate on the southern island of Gustavssvärd, faint whispers stem from a shadowy cave. When visitors step inside the cave, they hear audio fragments of ominous stories and folklore from Suomenlinna. These stories, collected from resident islanders and visitors with strong relations to Suomenlinna, tell of events and myths not presented in official historic documentation. In addition to the audio fragments, stories and rumours are written in chalk on the cave walls (see Figure 6 for a diagrammatic overview). Some of the written fragments retell the same stories as the audio snippets.

Figure 5: Visitors explore *Silence and Whispers*

The further visitors move into the darkness of the cave, the more disturbing the stories. In order to view the gloomiest stories, visitors can light matches to reveal them in short glimpses. Pieces of chalk are left in the cave, and visitors can write down their own stories. In this way, the installation evolves and expands over time as old stories are erased or washed away and new ones are added to the cave walls.

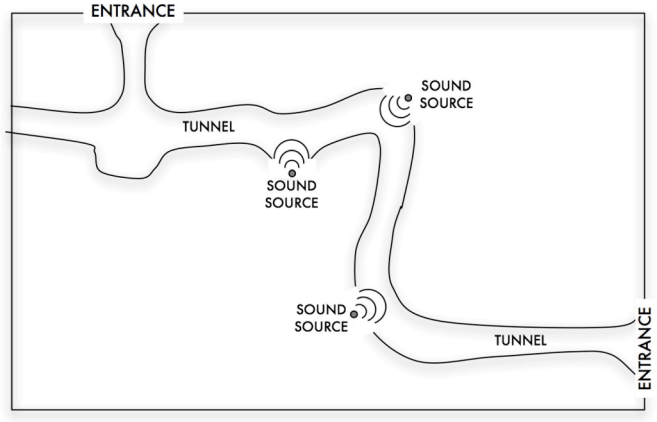

Figure 6: Diagram of *Silence and Whispers*

In the following, I will discuss how the interrelations between experience, inquiry, and conflict in inquisitive use were explored in the design of Balder's Funeral Pyre and Silence and Whispers.

3.3 Discussion of Balder's Funeral Pyre

During the initial concept development phases of Balder's Funeral Pyre, we (the designers at CAVI) in collaboration with 7th Heaven formulated three core experiential values to be evoked by the installation: It was to interactively engage visitors and *convey a solemn mood*, *nurture deliberate slowness* and *provide room for reflection*. These values emerged during joint design sessions, including initial brainstorming sessions and inspiration card workshops [34]. In terms of experiential design sensitivities, these values were addressed in a way that emphasizes the interaction between users and installation seen as a situated whole: By providing room, both physically (by making a large space for moving/standing still) and mentally (by placing the installation in a isolated section of the exhibition flow), and through a deliberate slowness in the interface (regarding the built-in delays) the installation aims to convey the sombre weight of Balder's story and invites visitors to stop and reflect upon it. Hopefully, this will lead visitors to revisit the story later and continue the experience of Norse mythology in reading. The installation thus addresses experience in practice by combining physical exploration (through movement in the corridor) with sense-making (in recognizing the installation as a visual interpretation of Balder's story) with the aim of bringing forth a *distinct experience* that ties into the *continuous experience* of visitors, both in light of the other exhibits in the center and visitors' previous and subsequent reading and under standing of Norse mythology.

These sensitivities turned into practical implications for design primarily vis-a-vis aspects of *conflict*. We aimed for a simplicity in the visual expression, opting for a dark display with fiery imagery, supplemented by audio tracks of crackling fire mixed with sounds of creaking wood and waves crashing onto a ship. A more complex visualization, with dissolving imagery from Norse mythology, was discussed and discarded, since it would not leave enough room for reflection. Several prototypes were tested with children as subjects. Among these was a version that was initially more popular than the one we eventually settled on. The popular version had drastic fiery explosions that responded instantly to children's movements and interaction: This encouraged playful interaction from the children who would run down the corridor, playing and hooting; this version was recognizable to the children as something out of a computer game or an action movie, according to their responses. Thus, opting for a quieter and ultimately more demanding version that only revealed itself through a longer duration of engagement and inquiry (which interaction-wise was done by introducing delays and visualizing slowly emerging fires around users) turned out to pose more of a *challenge* to the children, in that they experienced it as something new, somewhat frightening and definitely extraordinary. The decision to implement this version however meant that not all children would experience the same things – some were too frightened and hurried through the corridor, others were too impatient and moved along before the installation revealed itself to them, making for *inchoate experiences*. The children who remained in the installation long enough to watch events unfold, however, were for the most part very affected by it and experienced it as a *consummatory resolution* to their exhibition visit thus far.

Figure 7: Design discussions around Balder's Funeral Pyre

With regards to inquiry-oriented design sensitivities, Balder's Funeral Pyre plays into *the situated intentionality* via a strategy of intrigue: visitors are intended to make the connection between the

fairly abstract installation and the story of Balder, which they most likely know. The interactive emergence of the fire plays into *concurrent action-reflection*, paradoxically by encouraging slowness or stillness once activated. The installation exhibits reciprocal change to a very limited degree, by rewarding calm modes of use with scripted responses.

3.4 Discussion of Silence and Whispers

The Silence and Whispers installation was developed much more rapidly than Balder's Funeral Pyre since it was primarily intended as a design experiment rather than a finished product, and the use of interactive elements in the installation is restricted to playing back pre-recorded audio narratives. Given more time, the plan is to present visitors with ways of verbally narrating their own stories as parts of ongoing audio collections to be played back in the caves, possibly edited by installation curators.

The primary values underlying the design process was to *instill an explorative mood*, *promote narrative sense-making coupled with physical movement*, and to prompt *simultaneous story exploration and -telling*. These values were all coupled to giving a richer sense of the multitude of situated narratives tied to the specific location of Suomenlinna. Some of these are over-arching shared narratives, eg. the official history of the island, some are collective but tacit, eg. the fact that a prison camp presently exists on the island, and some are personal, eg. residents' scary stories from their childhood.

Silence and Whispers presents visitors with snippets of narratives, both auditively and visually, that have stereotypical traits. Eg. an audio track would tell of the silhouette of a strange man that lurks around the island, scaring children, and written in chalk is a snippet of a story about a girl who fell down the rocks outside of the cave. Although these were real events from Suomenlinna, we deliberately cut them to a level of generalizability so as to couple visitors' *experience in practice* through physical exploration (ie. moving though the caves) with a mental state of *inquiry* by inviting them to "fill out the blanks" in the narratives by connecting them to their own previous experiences and preconceptions. These design moves reflect experiential design sensitivities in which a balance is intended between the *continuous experience* of visitors (ie. general knowledge of the stereotypical traits and narratives, and potentially personal experience with certain of these stereotypes) and the *distinct experiences*, potentially aesthetic, situated in the specific setting of the Suomenlinna underground.

These deliberate omissions and fragmentations also posed visitors with a manner of *conflict*, in that the narratives were not necessarily resolved, but rather called upon the visitors to engage in *inquiry* to find out how they might conclude, either by finding other fragments and snippets by navigating the caves and the soundscape, or by making them up themselves. Thus visitors are immediately *challenged* to engage in the inquiry into the installation if they want to find out more. This challenge is closely coupled design considerations regarding *situated intentionality*: in that the setup is aimed at piqueing and arousing the curiosity of visitors and make them want engage in the emerging narrative space.

Figure 8: Stories written in chalk in *Silence and Whispers* cave

The installation was primarily intended for an adult audience, but even so many users found it more frightening than Balder's Funeral Pyre due to the fact that it was situated in caves that for a large part were completely dark, save for a few flickering candle lights illuminating select narrative fragments. To many visitors, this was clearly an element of *risk*; in some cases the it proved too much of a risk in that it made visitors abandon the installation. The users who ran the risk engaged in phases of *concurrent action-reflection* by moving about the cave tunnels to piece together the narrative snippets. This was however only possible to a certain extent due to the intentionally fractured character of the narratives; some of them were deliberately left incomplete. One potential *resolution* is for visitors to piece together a coherent narrative; another resolution is for visitors themselves to fill out the blanks in the narratives; this was a common strategy, and in some cases a necessary one due to the unfinalized narrative snippets. Both of these resolutions are laden with the potential of evoking experiences of fulfilment and consummation. On the other hand, there was also the clear risk of inchoate experiences, in that some visitors would not complete the storylines. The installation, both in it's prototypical and intended complete form, support *reciprocal change* in user-system transactions. Visitors hopefully form different conceptualizations of Suomenlinna, and potentially of their own past experience, that expand their future experiences on the island. At the same time, they can leave behind traces and snippets themselves. We (the designers) do not conceive of the installation as a finished product, rather we view it as an experiment that will on the one hand elicit more stories about Suomenlinna, on the other hand provide empirical data about how an auditive and physical narrative space frames visitors' behaviour, experiences and desires to express narratives themselves.

3.5 Comparing inquisitive use in the two cases

When comparing two installations with regards to inquisitive use, it is clear that Balder's Funeral Pyre only invites inquisitive use to a quite limited extent: It arouses the interest of users and rewards a specific type of behaviour with a pre-defined response that fits nicely into the flow of the over-all Norse mythology exhibition. However, it may be more accurate to describe it as contemplative installation that seeks to craft a certain type of user behaviour, namely one in which the visitor exhibits a stillness of movement, hopefully instilled by the solemn mood and leading to reflection upon the story of Balder. The aspects of inquisitive use that are only present in the system in limited measure are principally those of challenge and reciprocal change: challenge in the sense that there is in fact only a very limited degree to which you are

challenged, once you have overcome the first hurdle of understanding the interaction, there is not much left to do in terms of inquiry (although the contemplative aspects may reward repeated use); reciprocal change is even less present, in the sense that the system always responds in the same manner, and although design moves like the in-built delays are made to blur this, the only possible change over time occurs in the visitor's conceptualizations, ie. no transaction occurs. This is not to say that the installation is not well-designed: it is an interesting example of an interactive system that may evoke distinct, potentially aesthetic experiences in the specific context, and which may act as a catalyst for instilling in users an inquisitive attitude towards further exploring Norse mythology, either in the rest of the 7th Heaven center or in other contexts.

Silence and Whispers represents is a better example of inquisitive use, since, in optimal situations, it ties into existing experience, evokes distinct experience, connects to practice, prompts reciprocal change, challenges the user and presents elements of conflict and risk, and allows for resolutions through resourceful and engaged use. Compared to Balder's Funeral Pyre, the main difference is the space left open for the user to explore and affect: There is a potential for establishing a longer-lasting experience of flow, and for reciprocal change in the user's option of "feeding into the system" her own conceptualizations, thus affecting both her own experiences of consummation and future users' perception of the installation. With regards to the resolution of the experience in Balder's Funeral Pyre compared to Silence and Whispers, a key point with regards to inquisitive use is that there is a close relation between the commitment and engagement users invest in inquisitive use of a system, in spite of challenges and risks, and the feelings of fulfillment and potentially aesthetic experiences that visitors may achieve through use. So even though aesthetic experiences are inherently individual phenomena that arise from the confluence of personal experience with a lived situation, designers can actively pursue strategies bringing these about (such as the those suggested by the design sensitivities in this paper) by developing systems that offer up the potential for inquisitive use.

Inquisitive use, however, can be a 'hard sell' in design collaborations. Because of the elements of conflict, challenge and risk, stakeholders in design projects are often reluctant to adopt strategies of inquisitive use. Case in point is 7th Heaven and Balder's Funeral Pyre, in which 7th Heaven opted for a very understandable inclusive strategy with regards to visitors: As many children as possible should be able to experience the stories of Norse mythology, and this means imposing limits on how challenging the installation mey be. A major hurdle for inquisitive use thus lies in the very early stages of the design process in which these founding principles for the project are determined. In the case of Silence and Whispers, it was much easier to experiment straightforwardly with aspects of inquisitive use because it was first and foremost an experimental design research project.

4. SUMMARY AND FUTURE WORK

This paper has presented the concept of inquisitive use on the basis of Deweyan pragmatism. Furthermore, design sensitivities for designing for inquisitive use have been presented and discussed to demonstrate how the concept may form a productive approach in interaction design practice.

Inquisitive use represents a stance towards interaction design that encourages designers to regard users as resourceful co-creators of experience in the use interactive systems, capable of finding ways of making sense of installations that are not self-evident in their structure, presentation, or operation. A key point of the paper is to highlight the importance of conflict in designing for remarkable use experiences, for conflict is a key component in inquisitive use, and a sine qua non of aesthetic experiences. The concept of inquisitive use is not thought to replace traditional conceptualizations of the use of interactive systems; it is rather a critical attempt to challenge views on use that do not take into account the potential resourcefulness of users and their ability to employ situating strategies for experiencing and inquiring, nor their aesthetic aspirations.

Inquisitive use denotes a systemic understanding of the reciprocal relationship between experiencer and circumstances in a situation. This is intrinsic to understanding the way that inquisitive users co-create experiences, and it mirrors Dewey's understanding of the *work of art* (as opposed to the static *art product*) as a reciprocal relationship between an expressive artist and an appreciator who actively assimilates the art product: "The work takes place when a human being cooperates with the product so that the outcome is an experience that is enjoyed because of its liberating and ordered properties." [14]

The framework for inquisitive use has been developed concurrently with the practice of designing the two installations *Balder's Funeral Pyre* and *Silence and Whispers*. This cross-fertilization of design theory and design practice has been beneficial in allowing for the framework to be subjected to practice-based scrutiny all the while directing the design of the installations towards inquisitive use; on a critical note, this also implies that the installations can be conceived as cases constructed to support the theoretical concept of inquisitive use. However, this point of criticism is countered by the fact that both installations have been developed in cross-disciplinary design teams governed by various perspectives and interests.

It is the plan to further explore and expand the pragmatist perspective presented here, both through application of the framework in design practice, and through analyses of other types of interactive systems than the installations presented in this paper. As a specific expansion proposal, the inquisitive use framework laid forward here is predominantly concerned with individual interaction; an expansion of the framework to embrace collective interaction and experience will be a sound next step. Given the pivotal role of conflict in inquisitive use, it will also be interesting to examine how studies of narrativity may inform the framework. On a more concrete level, it will be interesting to employ the design sensitivities more pro-actively in early stages of design processes and examine if they translate into specific recommendations and guidelines in particular design domains.

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PEEPHOLES AS MEANS OF ENGAGEMENT IN INTERACTION DESIGN

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We present and discuss the concept of *peepholes* as a means for creating engaging interactions. By peepholes, we refer to aspects of interactive artifacts and environments that utilize the tension between what is hidden and what is revealed to foster engagement. As a foundation for discussing the qualities of peepholes, we outline a *pragmatist perspective on engagement*, emphasising the reciprocal relation between people, technology, and environment. We articulate peepholes as an example of a concrete *means of engagement*. Through a range of examples and two design cases, we explore peepholes as a means of engagement and discuss the pragmatist conception of engagement.

INTRODUCTION

As technologies become woven intro the fabric of everyday life, we are urged to consider in what way these technologies promote human engagement and invite us to invest our skill, knowledge and time in interaction. In our own research, the issue of *engaging interaction* has been a central tenet emerging from our effort in domains ranging from urban settings to museums and libraries. Museums, as an example, strive to engage visitors in exploring cultural or natural history. In their efforts to do so, many museums have looked in the direction of interactive technologies in the hope that this will provide new ways for visitors to relate to exhibition spaces and new avenues of learning. Research efforts have illustrated that there is indeed potential in using new technologies and interaction styles to promote engagement. However, it seems that interaction design, as a field of research as well as practice, is in need of a richer conceptualization of the potentials of interactive technologies in promoting engagement. This challenge can be addressed both on a general level by developing theories about engagement and on a concrete level by exploring particular interaction styles, concepts and technologies. In this paper we move across this span of abstraction by first presenting a general conception of engagement based on pragmatist philosophy, followed by a discussion of a particular means for creating engagement, namely the concept of *peepholes*. By peepholes, we refer to aspects of interactive artifacts and environments that utilize the tension between what is hidden and what is revealed to foster engagement through curiosity and inquiry. Keyholes may be the archetypical peepholes – they provide a limited view into a larger context, revealing some aspects but not providing the viewer with the entire situation. Peepholes provide a glimpse of a hidden, secret or even forbidden world. They play on our imagination and our inquisitive nature as we are

drawn to disclose the world that is hidden. Peepholes are well known in the worlds of art and architecture as means of shaping curiosity. Here, we will articulate peepholes within the field of interaction design as a particular means of engagement that invites people to engage in mixed reality environments. As we will discuss throughout these paragraphs, peepholes may be realized through a range of modalities such as visual, tactile, etc. We seek to shed light on the qualities of peepholes, as well as to illustrate the potentials in a pragmatist conception of engagement as a foundation for discussing both over-arching conceptualizations of engagement as well as particular qualities of designed interactive environments.

The structure of the paper is such that we first outline the concept of *engagement*. We draw upon related work from the field of interaction design and move towards a *pragmatist* conceptualization of engagement. The pragmatist perspective gives rise to an understanding of engagement as emergent and relational, constituted not only by the relation between a subject and an interactive artifact, but as a phenomenon that develops in the complex transactions between people, physico-spatial surroundings, socio-cultural practices, and technologies. Building on this perspective, we develop the notion of *means of engagement* as the particular constructs that are intentionally shaped through design to mediate our engagement in the world. We briefly discuss four existing interactive installations that employ *peepholes* to foster engagement. We then present in more depth two experimental design cases in which we have employed and developed the notion of peepholes.

ENGAGING INTERACTION DESIGN

Our motivation for addressing the notion of *engagement* with interactive systems is to highlight and explore the ways in which people invest their talents, time, curiosity and resources in relation to interactive artifacts and environments. In a broad sense, engagement is a general perspective that highlights certain qualities or aspects of peoples' lives. Our interest here is to unfold a concept of engagement that will shed light on peoples' relation to interactive systems and the environments in which these exist.

Within the field of interaction design, academic contributions addressing experiential phenomena have to a large extent focused on arguments for the necessity of addressing experiential aspects and on establishing definitions and frameworks for understanding the concept of experience (e.g. McCarthy & Wright 2004, Batterbee 2004). Recently, Löwgren (2007) argued that the field would benefit from articulating particular experiential qualities of digital artifacts. Löwgren (2007) has provided examples of this approach in discussing the qualities of 'fluency' (Löwgren 2007A) and 'pliability' (Löwgren 2007B), as has McCarthy et al. (2006) with regards to 'enchantment'. We do not see engagement as an experiential quality on par with e.g. fluency or pliability. Rather, it resides on a higher level of abstraction and as such may be regarded as a meta-quality that encompasses a number of distinct experiential qualities. E.g. in a given situation, an artifact with a fluent and pliable interaction gestalt may promote engagement, whereas other situations may be un-engaging in spite of the presence of fluent and pliable gestalts.

In the following, we will weave our own observations and related work from interaction design and beyond in order to outline a conception of engagement.

SITUATED AND RELATIONAL PROPERTIES OF ENGAGEMENT

Engagement with interactive systems is fundamentally embedded in particular situations and cultural practices. When we design an interactive installation for e.g. a library, we need to explore the various components that constitute the library situation as encountered by guests, including physical spaces, cultural forms of practice, mediating artifacts, rhythms of movement and social interactions. A focus on the qualities of the "object" alone is thus too narrow to capture the forces at play in the transactions of engagement. This point is developed in depth by Arnold Berleant and his work on aesthetic theory. Berleant (1991) proposes the explanatory concept of engagement as the participatory alternative to the aesthetic concept of disinterestedness and illustrates throughout his work the essentially participatory nature of appreciating art, nature, and the human built environment. Some forms of participation are overt in nature and require people to physically interact with the artwork – e.g. an artwork may require people to physically interaction in order to experience the artwork. Yet, Berleant argues, even more "traditional" artworks require *participatory engagement* in that they are realized in the reciprocal relation between person and artwork. When we are immersed in aesthetic appreciation of an artwork, e.g. a painting, it is a process of participatory engagement in which we may imaginatively enter and explore the space of the painting. Moreover, engagement, according to Berleant,

unfolds within a complex field of forces – the aesthetic field - that shape peoples experience Berleant (1970)

MOTIVATION AND ENGAGEMENT

Engagement is fundamentally tied to motivation; what drives or inspires us to invest our resources in a situation. The issue of motivation is complex as it encompasses both long term, high level motivation that gives direction to peoples lives as well as particular situations and objects in our everyday dealings that may motivate us to engage in particular activities. Working from cultural-historical psychology, Hedegaard (1995) explicitly distinguishes between "motivation" as the dynamics that characterizes a person's activity and relation to the surroundings in concrete situations and "motives" denoting the long term goals that have impact on a person over extended periods of time. Moreover, as argued by Hedegaard (1995), individual motivation is developed through our participation in cultural forms of practice that in them selves are crystallizations of historical motives.

Motivation concerns the issue of investment; what people put at stake in the situation whether this is time, belief or other forms of resources. In his seminal work on optimal experience, Csikszentmihalyi (1990) showed how the flow experience is achieved when there is an optimal fit between challenge and skills. In this sense, flow describes the balances between what is invested in a situation and how the situation responds – the transactional process.

Here, we shall not attempt to cover the depth of the concept of motivation but note that motivation may spring from long term goals or interests and may be more situated and opportunistic in nature; certain surroundings may motivate to invest our skills and knowledge in particular activities. Arguably, motivation most often spring from the relations between these two archetypes.

So far, we have discussed engagement as a relational phenomenon that is dependent to what people bring to the situation in terms of motivation. In order to more fully articulate the concept of engagement, we do however need to account for engagement as an emergent property extended in time.

DEPTH AND UNFOLDEDNESS AS PROPERTIES OF ENGAGEMENT

Borgman (1995) argues that settings that inspire engagement have a certain *unfoldedness* and *depth*; a wealth of experiential properties and their disclosing powers. In continuation of the motivation underpinning our engagement in situations, this can imply both the motivation to uncover or unfold new phenomena in our surroundings, or to explore in more depth seemingly well-known phenomena. Borgman uses the example of the artefacts that inhabit the kitchen of a gourmet cook – burners, pots, chopping blocks etc. – and the way in which the handling of these artifacts disclose their experiential properties. The sound of the pot as food is stirred at just the right temperature. This environment invites people to invest their skills, time and resources and to be engagement in the activity of preparing the meal.

Borgman's example also highlights the evolving character of engagement – qualities are disclosed through the transactions between the chef and the artefacts in her kitchen. McCarthy et al. (2006) further address this issue of unfoldedness or depth in relation to the potentials for enchantment in interactive systems. They note that interactive systems that are to evoke enchantment should offer potential for the unexpected and the opportunity for discovering new aspects or qualities of the system.

The unfoldedness and depth of particular artefacts is however closely tied to socio-cultural forms of practice in any given situation. In the example of the kitchen, the use of the artefacts is closely tied to the practices of the kitchen. The trainee chef's engagement with the artefacts is fundamentally shaped by the instructions given by more experienced chefs and particular task with which s/he is assigned. Again, this is a reciprocal relationship as we may see the artefacts themselves as crystallizations of particular forms of practice. This example does, however, highlight another fundamental issue in talking about engagement, namely *what it is* we are engaged with. The trainee chef is arguably engaged with learning to use the filet knife in the proper way. In another sense, the trainee chef is also engaged in the activity of preparing a meal where the tools are the means with which to achieve this. Heidegger's well known distinction between ready-at-hand and present-at-hand has been used extensively to explore how artefacts and interfaces may become transparent and allow the user to work *through* the artefacts while artefacts sometimes become the very object of attention when their working breaks down. As argued by Verbeek (2005), the answer does however not have to be either-or – present-at-hand or ready-at-hand. Verbeek (2005) argues that we may understand this as a continuum in that artifacts may mediate our engagement with the

world but at the same time require our attention and the exercise of skill.

TEMPORAL AND TRANSACTIONAL PROPERTIES OF ENGAGEMENT

Berleant's concept of participatory engagement urges us to consider the *continuity* between people and the forces at play in our environment – as transactions between mutually determining forces. Yet it is obvious that some artifacts, situations and environments seem to be more conductive of engagement and successfully capture people – be this art, technology or nature. As we have now begun to conceptualize engagement as an emergent quality we have yet to consider how engagement unfolds as a process extended in time. From our conceptions so far, it is obvious that we are dealing with a dynamic concept and we are forced to account for this dynamics in order to more fully articulate the concept.

To this end, we turn to the concept of transaction as laid out by pragmatist philosopher John Dewey, whose work has heavily inspired the aforementioned contributions from Berleant and McCarthy et al. We regard the concept of transaction as being capable of capturing the dynamics of how engagement unfolds. One of the pivotal concepts in the work of Dewey (1934) is inquiry; the mode of experience and action by which the subject seeks to make sense of challenging situations and resolve or overcome the tensions they present; in Deweyan terminology, this is described as a transformation of indeterminate situations into determinate ones. In this perspective, the subject is an active and integral part of the situation, not an outside party to it. Situation in this perspective encompasses the subject, other people, the physical things in the world, and socio-cultural constructs. This notion of situation is analogous with Berleant's (1970) understanding of *the aesthetic field* as the inseparable and mutually influential forces that shape engagement.

The transactional perspective in Deweyan pragmatism highlights the reciprocal relationship between people and the situation – through inquiry people coordinate and shape the situation and in turn, people are shaped themselves. Building upon Dewey, Schön (1983) showed by way of example how we might conceive of design as a movement, where people make inquiries or "moves" within a situation and the situation, in turn, talks back. In the same sense, engagement unfolds in time as the iterative transformations between people and situation as inquiries shape both.

In inquiry, we often rely upon various resources in the situation in order to proceed. These resources include our repertoire of past experiences and habitual ways of relating to the world, as well as contextual resources, e.g. artifacts, physic-spatial surroundings, other people in the situation, socio-cultural norms etc. Inspired by Deweyan pragmatism, Gedenryd (1998) employs the term *situating strategies* to this resourceful approach; in his work, he emphasizes that competent practitioners develop a multitude of ways of bringing these resources to supplement and augment their reflection and action. In line with this, Hickman (1990) has explored in depth the role of instruments and tools in Dewey's conception of inquiry. Hickman explicates that Dewey's conception of technology is inclusive, denoting all of those resources that we bring to bear in the resolution of tensions and challenges in a situation. Since inquiry is central to Deweyan pragmatism, and technology is an integral part of inquiry, Hickman thus suggests that we may consider pragmatism a philosophy of technology. Although it may seem a digression from our exploration of engagement, this understanding of technology as an integral component of inquiry is in fact crucial to our line of argument: technologies are not just functional tools employed to carry out intended operations, they also influence our initial perception of a situation, our experience of inquiry, and our feeling of fulfilment when a challenging situation is resolved. In this manner, interactive artifacts and environments may function as means of engagement

A PROVISIONAL DEFINITION OF ENGAGEMENT

On the basis of the above, we may define engagement as an emergent and relational quality of the interplay between people and their environment – a view shared by Berleant, Borgman, and Dewey.

Engagement unfolds in inquiry, the mutual process in which the user in an interactive environment encounters a problematic framing of her experience, motivating an exploration of the situation through interaction with the intended outcome of transforming the perceived practice. This is instigated in situations that are perceived to have a certain depth underlying the immediate impression.

This resulting transformation unfold in time and may be understood in a very literal sense e.g. that an agent transforms her physical surroundings; it may be relational – e.g. that new social structures are established between people in a situation; or it may concern aspects internal to one party in the situation – e.g. that an agent gains new knowledge about the situation which transforms it from problematic to comprehensible. The notions of inquiry and

transformation as key aspects of engagement prompts designers to consider the ways in which they can challenge users – e.g. through evoking curiosity and motivation or establishing a competition between several users - and to examine to which extent the different parts of the situation assemblage can be altered through interaction, either literally, relationally, or internally. Technology plays a pivotal role in engagement as it both frames our understanding of the situation and serves as means for transforming it.

MEANS OF ENGAGEMENT

We employ the term *means of engagement* to denote the resources that inspire engaged interaction and serve as instruments for scaffolding the experience of engagement. In light of our pragmatist foundation, we consider means of engagement to have a twofold nature in that they both frame experience and as means of transforming it. The term is broad in that it can generally characterize artifacts and surroundings that we create through design that to a greater or lesser extent are conductive to engagement. In this sense, means of engagement are the structures that are intentionally shaped through design to mediate our engagement in the world. A similar line of though has been pursued by Verbeek (2005), who discusses, from a phenomenological point of view, the idea of how things can mediate engagement. In developing the idea of means of engagement, we want to bring attention to the multitude of aspects that mediate engagement. Thus it is a concept that cuts across the physical and interactional features of artefacts and socio-cultural forms of practice that are particular to a given domain.

These means can take on many shapes; in this paper, we are interested primarily in the particular qualities of interactive systems that act as means of engagement. In our further discussion, we will thus limit our focus to interactive artifacts and environments and explore means of engagement as the intentional constructs that are produced through design, which encompass or relate to the features of the situation that are relevant in conducting engagement.

To explore this concept further, we will present and explore peepholes as one specific type of means of engagement.

PEEPHOLES AS MEANS OF ENGAGEMENT

Building upon the definition of engagement laid out above, a key feature of peepholes as means of engagement is, that they at the same time instil curiosity and inquiry, and that they offer ways of unfolding or exploring the depths of the content they hint at. In this respect, peepholes must maintain a balance of tension between recognition / openness and obscurity / concealment. There must be something for a potential user to perceive, and it must be recognizable enough for them not to discard it. Yet, it should also be clear that not all is revealed, and that engagement is required in order to uncover what hides beneath the surface.

Given our specific interest in digital technologies, a fundamental quality of digital peepholes is the potential of interactivity; that loops of feedback and response among user and system may gradually work to reveal more and more of what the user first got a hint of. As we will discuss below, this may take on a number of forms. The examples we will use are more broadly recognized under the terms *mixed reality* or *augmented spaces*. The concept of *mixed reality* was introduced by Milgram & Kishino (1994) as the combination elements with physical and digital/virtual properties. The term mixed reality is an interesting designation in relation to the concept of peepholes since it underscores the potential of shifting between different realities, or domains of inquiry. In many peephole installations, mixed reality is employed to create what Manovich (2006) has termed *augmented spaces*; environments in which layers of data are added to physico-spatial surroundings. Although this notion applies to many types of situated symbols, digital technologies hold unique potentials for expanding the dynamics of augmented spaces.

Having outlined the notions of engagement and peepholes as means of engagement, we will now present and discuss installations that may be understood as employing peepholes. These cases help illustrate the richness of the modalities with which peepholes may be realised and how these serve a variety of purposes.

PEEPHOLE INSTALLATIONS

In the following, we will briefly introduce four peephole installations and then go into more detail with two experimental design cases in which we have explored the use of peepholes as means of engagement.

JURASCOPES

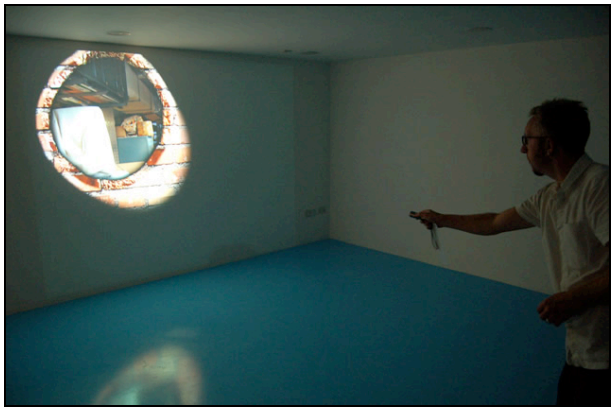
The first example is from Berlin's Museum of Natural History, where ART+COM developed *Jurascopes* for the exhibition (picture 1). By looking through the Jurascopes, appearing as a pair of digital binoculars affixed to observation points in the exhibition, the

dinosaur skeletons in the exhibition space come to life; inner organs, muscles and skin appear and the dinosaur becomes alive. An animation is shown of the dinosaur in its original habitat. Visitors can use the Jurascopes to explore the variety of skeletons in the exhibition space. In this sense, the Jurascopes work as peepholes in time allowing visitors a sneak view into the age of dinosaurs. The installation very much plays on the relation between the lifeless skeletons in the exhibition space and the "hidden" life of the extinct creatures.

Picture 1: Jurascopes

OUT OF BOUNDS

Our second example is *Out of Bounds* (O'Shea 2007), developed by Chris O'Shea for Design Museum London (picture 2). Out of Bounds plays with the idea of being able to see through walls. Visitors use a torch to "shine" onto a wall surface. When the torch is pointed at the wall, a hole in the wall appears and the visitor can see through to the other side. As the torch is moved, visitors are provided a small glimpse into the hidden world.



Picture 2: Out of Bounds

Jurascopes and Out of Bounds are examples peepholes that rely on visual means; however, there are also examples of installations that employ other modalities to create peepholes as means of engagement.

AUDIO WALKS

In a series of so-called *Audio Walks* (Cardiff 2005), artist Janet Cardiff explores the layering of narratives in space (Picture 3). Users put on headphones and are guided through specific locations, e.g. the streets of New York, or the Louisiana Museum in Denmark, much like in a traditional guided tour. However, the audio content is not related to the present, but to stories in the past, effectively employing the present as a stage upon which the recorded story unfolds. Cardiff explains that "*The virtual recorded soundscape has to mimic the real physical one in order to create a new world as a seamless combination of the two. My voice gives directions but also relates thoughts and narrative elements, which instils in the listener a desire to continue and finish the walk*." (Cardiff 2005). Although the audio walks do not employ interactive technologies, we have included the example since it represents a prime example of an auditive, narrative-driven peephole environment.

Picture 3: A photograph used as a prop Cardiff's audio walk *Her Long Black Hair*.

KHRONOS

The Khronos Projector (Casinelli & Ishikawa 2005) is an interactive art installation that combines visuals and touch-based interaction (picture 4). Film clips are rear-projected onto an elastic surface. When users touch the surface, a camera tracks the deformation and the film is rewound, giving the impression of reaching back in time, e.g. a user may touch part of a daylight cityscape and see it grow darker and fade into night.

Picture 4: The Khronos Projector

These examples highlight different modalities of peepholes and a range of purposes. To further explore the concept, we now turn to two design cases and discuss in more detail the use of peepholes.

HYDROSCOPES

The first example of our own work derives from our research on designing engaging exhibition spaces at museums and science centres. More specifically, we will look at one of the prototypes designed for the Kattegat Marine centre. The Kattegat Marine Centre is in many respects a typical marine centre displaying marine life from all over the world. The centre is primarily inhabited by large aquaria with glass sides that allow visitors to explore the variety of marine life. As part of our research efforts, we designed a prototype installation for the centre where visitors where invited to construct fish for a virtual ocean. Fish where constructed using a physical construction kit with embedded RFID chips. The construction kit contained the heads, bodies, fins and tails of a variety of existing species of fish. Starting from these pieces, visitors could create imaginary fish that combined the particular qualities of existing species. As visitors created the imaginary fish, they where invited to release the fish into a virtual ocean that was inhabited by the fish that others had created. The only way to explore the ocean was by using digital hydroscopes (picture 5). The hydroscopes provide a view down into the virtual ocean and allow visitors to explore the ocean by pushing the Hydroscopes along the floor surface.

Picture 5: Children using a Hydroscope

The Hydroscopes are a very literal manifestation of the Peephole concept as they provide a visual glimpse into a hidden universe beneath the surface. Our evaluation of the hydroscopes at the Kattegat Marine centre may in several respects help us begin to conceptualize peepholes as a particular means of engagement. From our studies of the prototypes in use, it was clear that the Hydroscopes had an ability to attract the curiosity of visitors. Partly this may be ascribed to the fact that they were somewhat unfamiliar objects in the exhibition space. Visitors would typically stroll towards the Hydroscopes and discover that they could observe life in the virtual ocean. From this point, some visitors would stand still and observe the hydroscopes for a while and then leave. Most visitors, however, would figure out that it was possible to navigate the ocean by moving the hydroscopes around. Some realized this by gently touching the hydroscopes to discover that the image then moved. Others observed fellow visitors using the hydroscopes and were encouraged to try it for themselves. As such the Hydroscopes seem to have an initial attractional quality (Edmonds 2006) and indeed sustained engagement as visitors searched various parts of the ocean. Relating to our discussion of means engagement in the previous section, the hydroscopes may help articulate the some of the general qualities of peepholes. As the hydroscope only reveal a small part of the hidden ocean visitors are invited into what Dewey termed a process of functional coordination; making inquiries in the situation and being shaped by the results. The quality of the peepholes is, that it very literally invites people to invest effort intro the interaction by suggesting that something will be revealed. Moreover, the peephole in general and the hydroscope in particular has an innate quality of unfoldedness as discussed by Borgman and McCarthy & Wright in that they gradually disclose their qualities and content as visitors invest their resources. In a sense, this concerns a certain depth in the interaction as visitors disclose more of the hidden universe.

In order to more fully appreciate the properties of the hydroscopes we however, as argued by Berleant, need to look beyond the artefact itself to the situation or field in which the artefact exists. In the case of the Hydroscopes, these were part of a larger installation where visitors could construct fish and release these into the virtual ocean.

The first point to make is that the Hydroscopes exist in a particular context that plays a central role in their working. The idea of looking down through the surface into a hidden universe is aligned to the Kattegat Centre as an institution concerned with life in the ocean. In a certain sense, the Hydroscopes utilize a common understanding of life in the ocean as being hidden from our direct view. Moreover, the hydroscopes exist alongside several other elements in the exhibition space.

As argued by by Hindmarsh et al. (2002) it is vital to understand museum technologies as being parts of larger assemblies if we are to understand visitor experiences. Having read about fish and their characteristics elsewhere in the museum the hydroscopes provide peepholes to how imaginary fish might look like.

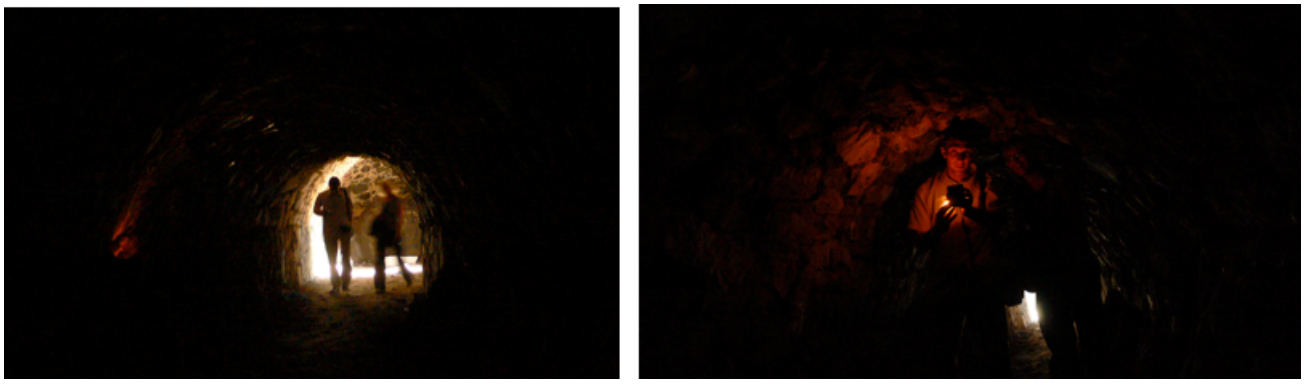
Viewing the hydroscopes as an example of a peepholes, sheds light on how peepholes as a means of engagement encourage inquiry and have a fundamental quality of unfoldedness at the hidden is gradually revealed. Moreover, the hydroscopes exemplified how peepholes, and means of engagement in general, work as parts of larger situations; the hydroscopes play on the metaphor of the hidden life in the ocean. The hydroscopes, however, do not in themselves provide visitor the opportunity to change or manipulate fish in the virtual ocean. As such, the engagement is only sustained as long as visitors are intrigued by searching the ocean. To the extent that visitor engagement was sustained at the marine centre, we have to look to the other elements of the exhibition. The construction table, where visitors construct fish for the ocean provided a means for sustained engagement. This view of the various means of engagement at the exhibition very much supports Hindmarsh et al's (2002) point of viewing installations as parts of larger assemblies – in our case, the individual means of engagement work as a larger assembly. The Hydroscopes are examples of a very literal interpretation of peepholes and indeed a very visual one. Our second case, Silence and Whispers, illustrates a less literal exploration of the peephole strategy through the use of audio rather than video.

SILENCE AND WHISPERS

Silence and Whispers (also treated in Dalsgaard, 2008) is an experimental mixed reality mock-up developed in 2006 as a cross-disciplinary collaboration between four interaction design researchers, including the author (picture 6). The installation employs a peephole strategy to engage visitors in collaborative storytelling on Suomenlinna, a series of islands near Helsinki, Finland. Suomenlinna, which is today a Unesco World Heritage site and serves as a public park, has a rich and complex history. During shifting sovereigns it has housed military fortresses and prison camps. In present day, it is home to a small community of inhabitants and an open prison, as well as being one of the most visited parks in Finland.

Silence and Whispers is an experiential prototype in the form of an audio installation intended to assemble and pass on narratives that reflect this multi-layered cultural history. A series of stories about the islands' past and present have been assembled and recorded. These recordings have been edited and cut into fragmented storylines. The installation is placed in a series of underground caves connected by corridors. The narrative fragments are played back on a number of speakers distributed throughout the caves and corridors. In addition to these auditive segments, snippets of the stories are written on cave walls in chalk. The caves are almost entirely dark, only lit up by a few flickering candles. Whispers from the installation emerge from the caves, luring people to enter. Once they do so, they can move freely about in order to assemble the story segments. Pieces of chalk are scattered around the caves, and visitors can write compose their own stories on the walls. In addition (although not implemented in the prototype of the installation) an audio input option was planned for visitors to tell their own stories, which would then also be fragmented and spread throughout the caves. The intention was for the installation to evolve and expand over time as old stories fade away and new ones are added to the cave walls.

Silence and Whispers employs peephole strategies to engage visitors both in a very concrete sense - in that it is situated in an 'alternate' underground setting, accessible by cave entrances, luring visitors nearby by use of auditive whispers - and in a more abstract sense, in that the narratives are deliberately fragmented and the



Picture 6: Visitors move through the dark corridors in Silence and Whispers to explore fragmented narratives.

installation plays on visitors' curiosity by demanding that they explore the caves in order for them to bring together the snippets into complete storylines. The installation thus seeks to combine appreciation and engagement beyond immediate fascination by hinting at stories to be appreciated, yet requiring both engagement through action and reflection in order to reach a stage of fulfilment.

Silence and Whispers explores the notion of mixed and multiple realities through the stories, which represent layers of experiences and interpretations tied to the islands. It plays on the metaphor of the subconscious as that which is hidden below the surface, that which one can dive into to discover otherwise hidden aspects. It was designed to evoke an ominous atmosphere, to bring about a sense of respect for the history of Suomenlinna, and to instil a sense of co-participation through the ongoing accumulation of stories about the place. The latter is perhaps the most interesting facet of the installation in relation to the notion of peepholes: by presenting fragmented narratives, visitors are prompted to 'fill out the blanks' themselves; the fragments hint at certain genres, e.g. they may be ghost stories or love stories, and in recognizing these genres, visitors are prone to relate them to their own experiences. Our brief evaluations of the experiential prototype showed that several visitors would continue unfinished stories on the basis of prior experience. In this respect, the installation can be construed as a reverse peephole that fosters introspective engagement.

Being an experiential prototype developed as part of a research course, the installation was not fully developed. We are currently exploring ways of facilitating collaborative situated storytelling, encouraged by our experiences from employing the peephole strategy of fragmented audio narratives. However, not all settings lend themselves to such installations in the same way as the caves of Suomenlinna, which in retrospect was an ideal match for the metaphor of the sub-consciousness of the place.

CONCLUDING REMARKS

Through our cases, we have dealt with the issue of engagement on a very concrete level by discussing peepholes as a particular means of engagement and on a more general level by framing this discussion in a pragmatist conception of engagement. We have highlighted the quality of peepholes as inviting inquiry, having a gradual unfoldedness, and suggesting that visitors' active involvement would render more of the hidden worlds visible. As argued, these qualities do however exist in complex situations and along side other means of engagement that fundamentally shape the actual quality of the peepholes.

As explored by Edmonds (2006), we may speak of several levels of engagement; some are immediate attractions, while other are sustained forms of engagement. As argued by Borgman (1995), a central feature of engaging environments is the unfoldedness – that the situation gradually reveals its experiential qualities. In the case of the Hydroscopes, these did in themselves rarely provide sustained engagement. Primarily they prompted curiosity and only sustained engagement as long as visitors where intrigued by exploring the ocean. However, this observation neglects the point of viewing means of engagement as parts of larger assemblies. The Hydroscopes did in some respect provide sustained engagement as part of the installation where people created their own fish and released it into the virtual ocean. This nuance does lead us to place more precisely the contribution of looking at peepholes in particular. Through our discussion on peepholes we have concentrated on this single means of engagement and its qualities, articulated in a pragmatist conception of engagement. This will hopefully provide detailed insights and inspiration for other interaction designers. It is however necessary to weave together the qualities of peepholes with other means of engagement that are employed in any particular design situation.

We seek inspiration in pragmatist philosophy since we find it well suited for framing and articulating the potentially reciprocal interaction that occurs when people engage the environment. Although formulated long before the advent of digital technologies, these notions are as relevant as ever, given the uptake of interactive technologies into experience-oriented domains.

One crucial finding that spans the range of examples we have explored is to establish a thorough understanding of the setting for which one designs. For mixed reality peephole installations to establish a convincing glance of an otherwise hidden world, it has to be well-aligned with the domain; not necessarily by presenting a mirror of what is present in the situation, but by establishing a connection that can spur the imagination of the people in the specific setting. Being interaction design researchers, we have a particular interest in exploring the potentials of interactive technologies. There are excellent examples of peephole installations that do not

employ digital technologies, such as Cardiff's audio walks. However, interactive technology possesses by nature certain qualities that designers can take advantage of to develop and stage dynamic layers that can be combined with our physico-spatial surroundings to create augmented spaces, and this has been our focus in the present investigations. At the same time, we are aware of the inherent dangers for interaction designers to become enamoured with technological fixes that may result in installations that draw people close by virtue of their innovative interfaces, but lack the power to sustain engagement. Because of this, there is good reason to extend the gaze further back to consider exceptional non-digital peephole examples, which we plan on doing alongside our further experimental explorations of interactive peepholes.

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Staging Urban Interactions with Media Façades

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Abstract. Using media façades as a subcategory of urban computing, this paper contributes to the understanding of spatial interaction, sense-making, and social mediation as part of identifying key characteristics of interaction with media façades. Our research addresses in particular the open-ended but framed nature of interaction, which in conjunction with varying interpretations enables individual sense-making. Moreover, we contribute to the understanding of flexible social interaction by addressing urban interaction in relation to distributed attention, shared focus, dialogue and collective action. Finally we address challenges for interaction designers encountered in a complex spatial setting calling for a need to take into account multiple viewing and action positions. Our research-through-design approach has included a real-life design intervention in terms of the design, implementation, and reflective evaluation of a 180 m^2 (1937 square feet) interactive media façade in operation 24/7 for more than 50 days.

Keywords: Media facades, urban screens, multi-user, public space.

1 Introduction

Research in human computer interaction has during the recent years progressed from predominantly focusing on the workplace setting [1], to other spheres of activity reflecting that only a fraction of the microprocessors produced today go into desktop computers whereas the majority become an integrated part of our physical environment [2]. Enabled in particular by ubiquitous computing technologies [3], HCI researchers have turned their attention to the expanding use of digital technologies as part of other aspects of human life including the home, entertainment, the school, museums etc. Urban life, with its social and cultural practices, differs from other aspects of human life, and has different kinds of spatial and material circumstances which pose new challenges for interaction designers. McCullough [4] has in his account of the intersection between architecture and interaction design drawn to attention the importance of addressing the situatedness of urban computing and has as part of that purpose compiled a tentative list of thirty situational types (e.g. watching, idling, cruising, attending, gazing) indicating the complexity and particularity of the urban setting. Greenfield & Shepard [5] have also explored the terrain of urban com-

puting with a particular concern for the local and context sensitive aspects of what they call ambient informatics in contrast to urban computing.

In this paper, we focus on one particular kind of urban computing, media façades, which is the general term for incorporating displays as an integrated part of a building's façade [6]. Within the domain of media façades, a number of genres may be identified of which *advertising* together with *news* is by far the most common. The buildings surrounding Times Square in New York and Hachiko Square in Tokyo are some of the archetype examples of commercial advertising used as a media façade. *Architecture* has throughout history been constantly on the lookout for ways of renewing itself with new expressions and use of new materials. Use of mechanical devices are among the ways of dynamically altering the facade expression as seen on Institut du Monde Arabe in Paris [7], where iris-like shutters automatically open or close to adjust to the lighting conditions. *Art* is the genre where artists are the driving forces behind the creation of the media façade, like in the case of "Body Movies", an installation by artist Rafael Lozano-Hemmer [8]. *Games* are often used along with other genres such as art or community media. Blinkenlights [9] is a classical example of such an installation where artists placed lamps behind each window in a building in Berlin and used the pixel matrix as a screen for playing pong and displaying low resolution animations. *Community media* and *news* is the media façade version of community media and live events as explored as part of BBC Big Screens all over the UK leading up to the 2012 London Olympics. *Public Service* is driven by the need to provide information to citizens in urban areas, for instance in terms of bus schedules, weather forecasts or traffic info.

Using media façades as a subcategory of urban computing, our research focus revolves around coming to grip with sense-making and social mediation as part of identifying key characteristics of interaction with media façades in an urban setting. Our approach strongly relies on design research-through-design [10, 11] by conducting real-life design interventions where we have taken advantage of our engagement in specific design practices in order to explore aspects of urban computing. The specific case that provides the fuel for our discussion is *Aarhus by Light*.

Aarhus by Light was a two-month social experiment with an interactive media façade at the Concert Hall Aarhus in Denmark. In the façade lived small creatures of light. When you approached the concert hall, you entered their world, which was also a part of the city. They were social beings always (or mostly) happy to see you. On the central path leading visitors towards the concert hall were three illuminated zones, each covered with carpets in bright colors (pink, blue, and yellow). In these zones, camera tracking translated the visitors' presence and movements into digital silhouettes on the façade, and through the silhouettes, visitors could caress, push, lift and move the small creatures. The creatures would wave back, fight, sleep, climb, jump, kiss, and occasionally leave and come back, thereby creating a relation to the visitor which was not only physical and embodied but also emotional and narrative.

Our research proceeds along the path pursued by Peltonen and colleagues [12], who have drawn to attention the fact that interactions with large screens in urban settings is a new and fairly unexplored area of research. Their research is in many ways related to ours by focusing on the social organization of interaction but with notable differences in scale, location and duration: Peltonen et al. introduced a shop-window-sized display on a shopping street during an eight days period, whereas Aar-

hus by Light was an 180 m^2 (1937 square feet) interactive media façade in a central public park which ran 24/7 for more than 50 days. Another closely related study is that of Paay & Kjeldskov [13] who present a detailed examination of social interaction in urban space with a concern for the situated aspects of interaction which they use as the platform for the evaluation of a mobile prototyping system.

The structure of this paper unfolds as follows. First, we introduce our practice-based research methods followed by a presentation of our design intervention, Aarhus By Light. Following this, we account for our data collection consisting of observations, interviews and log data which provide the platform for our analysis of the emerging spatial interaction, sense-making and social mediation.

2 Method

Our research method has been a practice-based explorative approach known as research-through-design [10, 11] carried out as a reflective design practice, not only focusing on the design artifacts themselves but rather using design artifacts as a means to get insights into the kinds of interactions emerging in an urban context.

We have addressed our research question from a multidisciplinary perspective enabled by a series of collaborative workshops and other kinds of design activities, including field studies, experiments [14] and design workshops [15] that produced a series of materialized artifacts [16].

While navigating the research-through-design process, we selected various design methods and tools trying to overview, structure and foresee the consequences of the intervention. E.g., we conducted field studies to get insight into the complexity of the urban domain and existing use patterns, continuously refining design values for the design artifacts and using structured workshops to develop concepts for interventions; all in dialog with the materialization of sketches, 3D models, and prototypes.

We have studied and analyzed the interventions and their influence on the lived life in a specific urban context primarily using qualitative methods including observations and interviews [17]. In addition to video-logging of use during the entire period, the media façade software logged activation and other important events in terms of quantitative data which was used in the analysis of patterns of engagement and use.

In the subsequent analysis, we finally linked and summed up on all the material throughout our work to distil the findings in relation to our research question. Progressing from the research question toward the presented findings has not been an entirely linear process, neither a fully pre-designed research process in the narrow sense, but rather a continuously navigation through the design aspects uncovered. To a certain extent, the research activities have been iteratively interweaved through versions of design artifacts and workshops informing and shaping each other.

3 Design Intervention: Aarhus By Light

As mentioned briefly in the introduction, Aarhus by Light (AbL) was an interactive media façade, engaging local citizens in new kinds of public behavior in order to

explore new possibilities of digital media in urban life. The large glass facade on the building was fitted with 180 square meters of semi-transparent LED screen that was distributed in a non-rectangular pattern behind the surface of the Concert Hall Aarhus towards to the adjacent public park. Visitors in the park were met with the spectacular view of animated creatures crawling around the structure of the glass facade along with a constantly moving outline of the skyline of Aarhus. When visitors walked through the park, they passed through three interaction zones marked with colored carpets. Once on the carpet, a sensor picked up the outlines of your body hereby creating a silhouette on the screen. This silhouette encouraged a curious and playful investigation of the expression among the users, while enabling them to interact with the creatures by pushing, lifting and dropping them.

The motivation behind AbL was driven by research interests and curiosity, but was also supported by the concert hall's interest in challenging its own rather conservative image. They did not, however, in any way want to influence the actual design.

As the platform for a systematic introduction to AbL, we apply a *design space explorer* [18] for media façades, a light-weight framework for addressing key aspects of media façades in an urban setting. The design space explorer consists of two parts: aspects listed in the top row and a number of design choices for each aspect in the columns below. As discussed in [18], the set of aspects may be adapted for each specific design case. In the case of AbL, the aspects are: Materials, Form, Location, Situation, Content, Interaction, and Values (Table 1).

Table 1. Design Space Explorer for Aarhus by Light.

Materials	**Form**	**Location**	**Situation**	**Content**	**Interaction**	**Values**
Semi-transparent & low-res LED panels	Irregular	Façades	Visitors arriving	Creatures	Camera-tracking of movement and gestures	Playful
	Elongated	Public park		Skyline		Integration
	Spatial	Lobby	Passing by	Silhouette		Eye-catching
Carpets		Adjoining cultural institutions				Social

Material: AbL was based on 180 m^2 low-resolution LED panels. Each panel consisted of 25x50 pixels (4 cm dot pitch) that were assembled to a display counting 1250x150 pixels. The panels themselves were semi-transparent and were hardly visible from a distance. However, when the LEDs were lit, they constantly created awareness by emitting visuals in bright colors. In addition to the façade, a pink, a yellow, and a blue carpet were used in the park area to stage and call attention to the interaction zones.

Form: The rectangular LED panels in AbL matched the glass façade modules of the Concert Hall and were configured as a 50x6 meters irregular and elongated shape mainly placed alongside the main façade towards the park. The shape of the LED panels was deliberately designed to break away from a rectangular TV screen look, and a smaller part was wrapped around the facade corner in a spatial configuration.

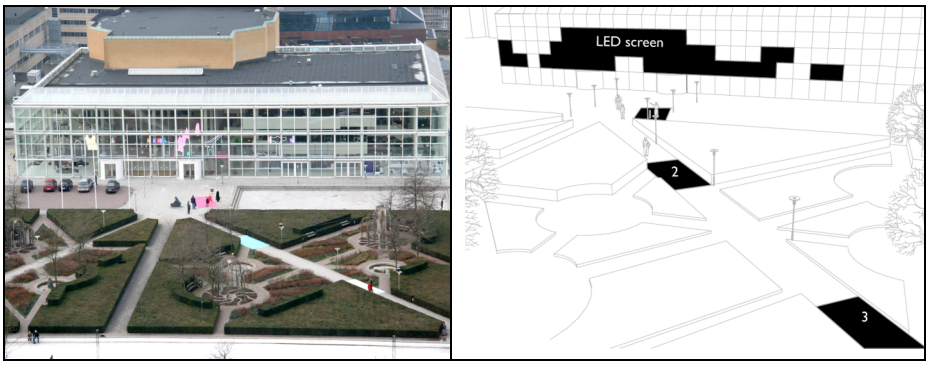

Fig. 1. Concert Hall Aarhus with the media facade installation and the three interaction zones.

Location: Location is closely related to situation but refers to the spatial arrangement rather than the practices taking place within it. The LED panels that dominated the AbL installation were integrated in the 700 m2 glass façade of the Concert Hall, which is situated in the centre of Aarhus, the second largest city in Denmark. The public park in front of the Concert Hall is defined by a series of adjoining cultural buildings – among them an art museum, and the town hall. The panels were hung from the inside of the façade and the visual content was mainly visible from the park during daytime. But during night time, the light from the LED panels was mirrored in the glass façade visible from the foyer of the Concert Hall. The mirrored light hereby created a complex visual and spatial relation between the interplay of the panels and the glass façade together with the park and the foyer (Figs. 1 and 2).

Situation: Since AbL ran 24/7 for more than 50 days, it was designed to take multiple situations and use scenarios into account. Among them were people passing by versus dedicated visitors of the Concert Hall in relation to scheduled concerts and activities, all together with possible distances, perspectives, and visual obstacles in the public park and the lobby area.

Fig 2. The installation in use. The LED panels themselves are almost invisible.

Content: There are three main content elements in AbL: (1) A one pixel wide lineart skyline of Aarhus landmarks which slowly emerge and disappear independently of other elements, (2) 30 luminous creatures which move around on the lattice of the facade; each creature is autonomous, though guided by specific rules which influence their behavior, and (3) silhouettes of users, which are displayed on specific parts of the facade in correlation with the users' position in the interaction zones in the park.

Interaction: In the case of AbL, users can interact by entering one of the three designated interaction zones in the park. When they do so, their silhouettes are tracked and displayed on set areas of the façade. The luminous creatures are drawn toward the silhouettes, and users can shove them around. The creatures will respond in a friendly manner – by waving at, dancing with, or crawling onto users – or hostile manner – by kicking the silhouettes. When no users are present, the creatures will go about their own routines, sleeping, kissing, fighting, crawling, and dancing. The intended duration of use ranges from <1-20 minutes. The interaction was implemented by having one big, digital canvas powered by a single PC running a custom-made C application. The canvas consisted of three layers. In the front most layer, the application processed input from the three cameras (one for each interaction zone) and produced silhouettes or rather blobs on three corresponding parts of the facade. The middle layer was populated with animated creatures, and the background layer held the changing skyline. The software ran unattended, calibrating the filter continuously for optimal silhouette-generation during shifting conditions.

Values: Values are the basic positive (or negative) considerations that have governed the design of the installation, reflecting the goals of the design and what is considered as important. AbL's final form and function is a crystallization of three main values which we have actively sought to incorporate into the installation: (1) *playfulness* as the key experiential quality which we sought to embed; this is reflected most evidently in the content-interaction fusion (use your bodily movement and gestures to play with the video game-like creatures, (2) *integration* into the existing setting, both relating to integration of the LEDs with the architecture of the Concert Hall, as well as the integration of the interaction into the existing practices and situations, and (3) an *eye-catching* expression making evident to passers-by that something new was afoot.

The design choices for each of the seven aspects have been interdependent. For instance, the choice of materials in terms of low resolution LED had implications for content in term of the line-art skyline and style of the luminous creatures. Likewise, the situational types of people passing by coincidentally or being on their way to an event at the Concert Hall Aarhus had implications for the interaction style.

4 Data Logs, Observations, and Interviews

In order to monitor the running status of the media façade and to capture events for later analysis, we set up a time-lapse camera as well as logged the activation of the interaction zone sensors. The time-lapse camera was placed in the bell tower of the nearby city hall. Throughout the duration of Aarhus by Light, it captured a still image

every six minutes as an extra source of documentation (with no personal identification possible).

The media façade software produced a log recording every activation as well as other important aspects like for instance software updates. An activation is defined as a blob identified in a camera image by the software identified producing a corresponding silhouette on the facade. Figure 3 shows the number of activations of the three cameras summed up for each hour of the day during a 21 day period.

Activation of a camera generally indicates use, but there is no simple correlation between the number of activations and the number of persons triggering the activation. First of all, the number of activations each person generated varied greatly, since some only passed by whereas others spent considerable time interacting. Furthermore, there were some causes of activation that were not due to humans. In order to assess the proportion of human activation, we validated the log data by comparing selected time periods with two other sources: (1) the time lapse camera feed, and (2) a baseline of log data during and after the installation period where we knew positively no or very few people passed through the area. The validation revealed that when it was dark and wet, reflections from the media façade would feed back into the cameras and generate non-human activation. We also found that the yellow carpet was generating more non-human activations during dark and wet conditions even though it was farthest away from the facade.

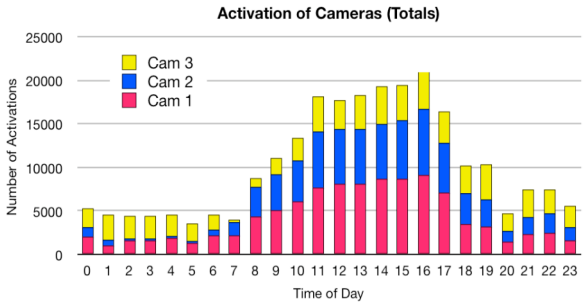

Fig. 3. Total number of activations of the three cameras over a period of 21 days.

Having subtracted the estimated 'background', non-human activation, the overall use patterns that stand out from the validated log data is the following: People engage with installation primarily during daytime, beginning around 7 a.m. and increasing without dropping until 5 p.m. Then there is a significant dip until a second smaller peak between 9 and 11 p.m. The latter peak fits with the exit times from events in the concert hall, which are more concentrated than arrival times. During evenings without events in the concert hall, significantly less people are passing by the area.

Analyzing the data supports our thesis that the installation encouraged an interlude in the movements of the public. Especially the interaction zones generated a lot of movement, but also the area next to it seems to have been a popular spot for observing others interacting.

In addition to data logging, we carried out observations in two ways: First, we did a number of in-situ observations of the installation in use. These observations were often carried out in conjunction with qualitative interviews with users. The primary

focus for these observations was on social interactions and exchanges as well as user experience, for instance if users displayed distaste or satisfaction with the installation. Second, we gathered video material of the installation in use for various purposes. The extensive amount of observations both from the interview sessions and video footage further highlights the rich variety of interaction forms and patterns spurred by the media façade. The observations show that all kinds of people interact with the façade, ranging from young boys and girls to older men and women. Observation video was shot quite openly with handheld cameras.

Last but not least, we carried out 25 structured interviews during the two months of operation. The interviews were carried out at different times of day and on different weekdays, and they were supplemented with observations before and after the interview itself in order to get a richer understanding of the interviewees' interaction with and experience of the installation.

Each interview consisted of 37 questions (not counting follow-up questions) and had a duration of 15-25 minutes. The questions were grouped into four categories: (1) occurrences prior to interaction, like the interviewees purpose for visiting the Concert Hall park, and whether they had heard of AbL before; (2) experiencing and interacting with AbL, for instance immediate impressions, accounts of what was represented on the façade and how to interact; (3) social aspects, including whether interviewees were interacting with other users, if these were strangers or familiar faces, and which types of social encounters this prompted; (4) identity and effect, like how AbL fit into the interviewees' general impression of the Concert Hall and the park, what kind of effect the installation had on the perception of a public space etc. Subsequently, the responses from the interviews were entered into spreadsheets for processing and comparison, and recurrent themes were condensed and analyzed.

5 Analysis and discussion

Our analysis revolves around four themes: interaction patterns, space and interaction forms, sense-making and social mediation.

5.1 Interaction Patterns

During our analysis of the video and observation data, we have identified a number of recurrent interaction patterns. The most prominent patterns are shown in Table 2.

Table 2. Interaction patterns.

Initiation	Interaction Style	Relation
Pass and notice	Basic exploration	Individual
Pass and interact	Visual engagement	Group
Walk-up-and-use	Embodied engagement	Family
Watch and join	Narrative and empathic engagement	Social
Watch and take over	Showing off	
Return	Hacking/unintended use	

Initiation refers to the ways in which people encountered and engaged with the installation. These span from passing and noticing the presence of Aarhus by Light through various modes of entering into interaction to returning after prior interactions.

Interaction style refers to the different modes in which people explored the installation when past the initiation phase. These encompass simple initial trials of the basic functionality and engagement in the visual expression, but also more immersive interaction through embodied interaction coupled with narrative and empathic interpretations; ultimately, a number of visitors appropriated the installation in unexpected ways, 'hacking' it and/or showing off in front of other users.

Relation denotes the social interaction patterns which we observed in the use of Aarhus by Light. Some users interacted with the installation individually, but, interestingly, the main part of users entered into social relations of some sort through interaction, either by being part of a previously formed group, possibly a family, or by entering into new social relations with strangers using the installation.

5.2 Space and Interaction Forms

An important part of understanding how people experienced AbL is to have a closer look at the interplay between the interactive media façade, the surrounding space, and the actual architecture. The integration of AbL into the Concert Hall's façade formed the basis of new use patterns in and around the Concert Hall. In this perspective, the interactive media façade, in combination with the Concert Hall and the park area, became a stage for new forms of interactions. Partly intentional interaction forms but also unforeseen and unintended use-patterns and consequences. In this section, we discuss the most important themes in relation to interactive and spatial aspects of AbL; among them, how people interacted with the media façade and how this affected the use of the park area and the very identity of the Concert Hall.

The park has gone from primarily being a place of transition with a few heated spots in connection to the entrance to a more diverse place where people still pass by, but with additional explicit hotspots in the interaction zones and the nearby areas. This indicates that the interactive zones have created new behaviors within the park, and based on the log data and the event program for the Concert Hall, we estimate that 500 persons have interacted with the installation during an average day. Furthermore, our observations as well as the log data specify that the interaction zone nearest to the concert hall has been the most used one, followed by the middle and furthest interaction zones in respective order. This is a strong indicator of the success of AbL as a new stage for urban interactions: The two latter zones were situated along what was prior to AbL the most used transitional path, whereas the interaction zone closest to the concert hall was previously almost not used at all. The new patterns thus reveal a strong interest for people to engage in interacting and experiencing the media façade.

Regarding the types of interactions, a clear pattern is that people attract more people: when there are already users interacting with the media façade, this attracts others to observe or engage in interaction. The people who interact thus become a part of the interactive installation attracting attention. Another characteristic is that a great num-

ber of people seem to return to the installation to try out new interaction forms, or to show other people how the façade works.

The interaction style patterns reveal a variety of use forms surrounding the media façade. A large group of the people who interact are primarily concerned with discovering the basic functionality, trying to identify the relation between the interaction zones and the media façade. Another dominant pattern of use is visual engagement in which the main focus of attention is the figures, the skyline, and the silhouettes on the façade, For many of the people interacting, the silhouettes they cast on the façade are more interesting than interacting with the figures; the silhouettes alone seem to make them want more, to explore how they can themselves be visualized on the screen. Another strong pattern of interaction is bodily engagement, interactions in which the focus is on the choreographic possibilities among the people who interact. People come together trying to coordinate movements on the carpet mimicking each others'silhouettes – or just to make choreographies on the carpet. It is clear that the carpet and the silhouettes legitimize physical activity in urban space that would otherwise have been seen as downright strange and inappropriate.

The above findings indicate that AbL did change the spatial relation in and around the Concert Hall, and by turning our attention towards how people came to think of the identity of the Concert Hall while the installation ran, it can help us get closer to how people experienced the space and the interaction forms. Especially the interviews indicate a new interpretation of the Concert Hall. With only a few exceptions, the interviewees found that the new interactive content augmented onto the façade, imparted a new view on the Concert Hall, ranging from more playful and inviting and in better contact with the younger visitors, to a more mystified impression balancing between the new and unknown and comparing it to other types of electronic media such as a 1980es computer game in an unexpected context.

These new interpretations of both the identity of the Concert Hall as well as the reading of the content of the media façade led to the next section where we will have a closer look at sense-making.

5.3 Making sense of large-scale urban interactions

A particularly intriguing aspect of how people experienced AbL was their efforts to make sense of this strange intervention into the urban space. In their *Technology as Experience* [19], McCarthy & Wright propose that sense-making is at the core of how we experience technologies; following this line of thought, we will discuss the most salient sense-making themes relating to AbL in order to explore and elucidate users' experience and appropriation of large-scale urban installations.

Most notably, interviewees presented us with a number of varying interpretations of what the installation was about and how to interact with it. Every respondent was able to distinguish between the three different types of representations – silhouettes, luminous creatures, and skyline. Judging by the responses, the luminous creatures were of most interest to them, followed by the silhouettes and the skyline. The most general impression of the installation was that it was, or was similar to, a video game; this was attributed primarily to the general low-resolution visuals of the façade as well as the representation and behavior of the luminous creatures. This interpretation is

evident in statements such as 'It is like Pacman meets the concert hall' and 'It reminds me of Commodore 64' (a popular home computer in the 1980s). This finding highlights two interesting aspects of interactive media façades. First, that the visuals of the installation, rather than the interaction form, architectural concerns, or social relations, were the most immediate point of reference in making sense of the installation. A particularly strong indicator of this tendency was that, when asked how the façade worked, interviewees answered along the lines of what it connoted – i.e. a computer game – rather than describing the technical and factual function of it. Secondly, that spectators clearly drew upon their repertoire of existing experiences with electronic media in order to understand what they were observing, and the computer game genre was deemed to have the closest resemblance to the installation. As Manovich [20] has examined, the development of new types of media lends extensively from genres and conventions from preceding media. This goes not only for media authors, developers, and designers, but also for the audience spectators and users. With regards to making sense of the interactive elements of the façade, people had fewer references to preceding media to draw upon. Since there were no explicit instructions of use, users had to adopt an experimental approach to understanding the installation, save for the instances when they could 'lurk' and observe already active users. As a result, many interviewees adopted an approach consisting of simultaneous trial-and-sense-making. The mirroring of users' silhouettes in three different colors corresponding to the three physical interaction zones functioned as a very direct introduction to the mode of interaction, and both interviews, in situ observations and video observations show strong evidence that users' understood this mapping easily.

Turning now to the relations between the three elements represented on the media façade, we observed a striking pattern of sense-making in interviewees' responses, namely that many of them presented us with accounts that went beyond what the installation was actually programmed to do. Most interviewees constructed narratives about what the creatures were doing, how they were interacting with each other, with users' silhouettes, and with the skyline. Some of these were in line with the programmed responses of the installation, e.g. how creatures would greet new users. Interestingly, however, many of these narratives went beyond what the installation was actually programmed to do. For instance, several interviewees presented us with narratives of social interactions among the creatures, or creature responses to visitors, which went beyond the programmed responses of the creatures. This finding is substantiated by studies in cognitive development which propose that we have a tendency to remember experiences in the form of narratives, and that we may in fact re-order components or fill out blanks in order to make the narrative conform to expectations (e.g. Nezworski et al. [21]). In the case of AbL, this tendency was in fact also evident not only in interviewees' subsequent accounts of what they had experienced, but also in the ongoing sense-making among interacting users. For instance, there was no pre-programmed interaction between the creatures and the skyline, yet several users told us how one had influenced the other. In one instance, a girl told that she was trying to crawl up on a tower on the LED to rescue the figures. In another instance, several children told us, while playing with the installation, that the creatures were building the skyline, and that they could tear it down with their silhouettes. This ascription of intentions and motivations mirrors Heider & Simmel's [22] seminal study of the attribution of causality, in which they demonstrated how observers of an animated clip of

simple geometric shapes attributed behavior and intention to the shapes. For the children, this attribution of causality was reinforced by the ongoing sharing of their interpretations by which consensual narratives were created and maintained.

It should be noted that we do not view these potentially inaccurate accounts as problematic. Rather, we see this tendency to construct narratives beyond the designed ones as important input into a broader discussion of sense-making in complex urban environments. In such settings, heterogeneous factors, like architectural, habitual, technological, and social aspects, will almost always co-determine the experience of technological artifacts and installations. Thus it may in many situations be very hard, or even impossible, for designers to take into account all of these factors, let alone create an installation that commands the focused attention of users.

We propose that the balance between framing and open-endedness in AbL played an important part in its success. It presented users with recognizable representations in the shape of computer game-like creatures, the city skyline, and their own silhouettes, yet provided room for appropriation with regards to the emerging interactions. This proposition is in line with Thackara's [23] discussion of designers' proposing vs. imposing experiences and Greenfield's [24] similar examination of highly designed experiences.

5.4 Social Mediation

One aspiration of staging engagement in public space is often to provide a medium or a platform that invites people to connect socially. As we have seen, there are not many cases of interactive media façades facilitating social interaction, and there is no dominant, coherent framework to address the situation facing designers of interactive media façades. One reason is that the technology is still waiting to be deployed, but another and probably more important reason for the lack of interactive media façades is that they are not very easy to embed into the socio-cultural fabric of urban space. It is simply not obvious what kinds of social mediation are desirable and acceptable.

We may address this issue in the case of AbL by extracting observations and patterns in the interviews, observations, and log data, as we have seen above. As a platform for an attempt to further generalize and characterize these patterns and observations, we build on Ludvigsen's [25] framework of social use in public spaces, especially the notion of "situational interaction flexibility*", SIF. This framework is simpler than e.g. MIRANDA and SOPHIA [26], which are based on McCullough [4], but still captures salient features in a way that are easy to communicate and discuss.

SIF is based on Goffman's [27] concepts of behavior in public space: occasion, situation, and encounters. SIF then proposes another set of related concepts – levels of social interaction (Table 3) – that help answer the following types of questions when evaluating a design for social interaction: What is the level of social interaction? What do we want it to be? How is this specific level of social interaction supported? May the user(s) take the level of social interaction to another level?

* We have rephrased the original term 'mobility' to 'flexibility' in order to reduce semantic confusion

Table 3. Levels of social interaction according to Situational Interaction Flexibility.

Level	Scope	Example
Distributed attention	Each person is in a separate 'bubble' of attention	People passing by
Shared focus	People observing the same thing, not unlike broadcast media	Watching, exploring together
Dialogue	"shared activity in which [people] are investing themselves and their opinions"	Showing off, intensive explorations
Collective action	People engage and work towards a shared goal	Choreography, mass explorations, hacking/unintended use

Looking at quantitative and qualitative data through the optics of these levels, we may argue that the AbL is demonstrating a high degree of situational interaction flexibility. This means that not only is the installation mediating social interactions, it is facilitating a very wide range of social interactions and transition between these levels of interaction.

If we connect this claim with our initial question of how interactive media façades may embrace the socio-cultural practices of the occasion, to use Goffman's term, we get at least some answers in the form of qualified examples.

The relation patterns highlight the fact that most of the interactions are part of larger social relations. Even though there are examples of individuals interacting with the media façade alone (but still in public space), most of the interactions take place in different social groupings – families, groups hanging, or other social gatherings. The sociality of the interaction both relates to the carpet, where two or more people come together to interact, and when people are affecting other people by looking at or commenting their interactions.

6 Conclusions and Future Work

Using Aarhus by Light as the principal case, we have zeroed in on some of the challenges when designing for large media façades in urban space. We have in particular addressed the open-ended but framed nature of interaction, which in conjunction with varying interpretations enables individual sense-making. Moreover, we have contributed to the understanding of situational interaction flexibility by addressing urban interaction in relation to distributed attention, shared focus, dialogue, and collective action. In addition, we have elaborated on the challenges for interaction designers encountered in a complex spatial setting calling for a need to take into account multiple viewing and action positions. Space and time have only allowed us to build our argument around a single, though complex, case at the expense of having multiple cases to compare and generalize from. The complexity of the urban interaction surely calls for additional research into the distinctive spatial, material, and situational circumstances of urban interaction with media façades.

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Performing Perception—Staging Aesthetics of Interaction

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In interaction design for experience-oriented uses of technology, a central facet of aesthetics of interaction is rooted in the user's experience of herself "performing her perception." By drawing on performance (theater) theory, phenomenology and sociology and with references to recent HCI-work on the relation between the system and the performer/user and the spectator's relation to this dynamic, we show how the user is simultaneously operator, performer and spectator when interacting. By engaging with the system, she continuously acts out these three roles and her awareness of them is crucial in her experience. We argue that this 3-in-1 is always already shaping the user's understanding and perception of her interaction as it is staged through her experience of the object's form and expression. Through examples ranging from everyday technologies utilizing performances of interaction to spatial contemporary artworks, digital as well as analogue, we address the notion of the performative spectator and the spectating performer. We demonstrate how perception is also performative and how focus on this aspect seems to be crucial when designing experience-oriented products, systems and services.

Categories and Subject Descriptors: H.1.2 [**Models and Principles**]: User/Machine Systems—*Human factors*; H.5.2 [**Information Interfaces and Presentation**]: User Interfaces—*Theory and methods*; J.5 [**Computer Applications**]: Arts and Humanities—*Performing arts (e.g., dance, music)*

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1. INTRODUCTION

In what used to be a church in a park in London, a man is walking on water. Slowly, he progresses into the huge basin, concentrating on watching his steps. If he falls or misses his steps, he will not be hurt, but he will get soaked. We are watching an interactive installation called *Bridge* [Cross 2006] by Michael Cross (Figure 1) comprised of submerged mechanical steps that raises by the weight of the man.

We are witnessing a man experiencing what it feels like to walk "as if walking on water, eventually reaching the middle of the lake, thirty steps and twelve meters from the deck. There they will stand alone and detached, stranded in the middle of a plane of water" [Cross 2006]. He is not all by himself, though. A guide or guard is walking in the water pool just next to him, and on the deck leading to the pool, several people are awaiting their turn (Figure 2). As this man reaches the end of the steps, he turns around and walks back on the now raised steps towards the deck When he steps out of the pool, the people awaiting their turn applaud him.

Bridge is an exemplary case of how participating in an interactive experience is more than just being there for the thrill and the enjoyment of it. It is more than what happens between the user and the system, it is more than what happens as a consequence of the user's actions, and it is more than the setting or surroundings. Participating in an interactive experience—and especially when it comes to experiences happening in public space—is also about how what you do is experienced by someone else, and of how you know that other people are seeing and experiencing that you are experiencing something.

When discussing the aesthetics of interaction, this aspect of perception as a performance and not just an individual experience is highly important for people's relations to and perception of an interactive system. The user of *Bridge* is more than just a user, because using *Bridge* is a matter of being an operator, a performer and a spectator all at once: as a user walking on water, you are both operating an interactive system, performing for other people while operating, and, most importantly—because you are both operating and performing—you are also an implicit spectator of your own actions since your own actions will be the ones that other people are experiencing.

In this article, we will argue that what we observed when we went to experience *Bridge* happens in all meetings between users and interactive systems. We will demonstrate that the user continuously and simultaneously acts out three kinds of participant roles and that her awareness of all three roles shape her experience. This is what we saw when observing *Bridge* and in this article we will investigate the consequences in real-time co-located situations related to experience-oriented applications of IT. Simultaneous participant roles is a valid principle in a wide range of areas from which designers of interactive systems can learn: Many everyday experiences implicitly encompass different roles, just like many artworks—analog or digital—put this mechanism of multiple participant roles into play. These artworks intentionally integrate the simultaneous roles into the form and expression of the object and the participant's perception process. Consequently, we will elucidate the subject by drawing upon examples

Fig. 1. Michael Cross' *Bridge* at the exhibition space Dilston Grove, Cafe Gallery Projects London, London, UK. Photo: Michael Cross.

Fig. 2. Spectators watching Bridge at Dilston Grove, London, UK, Oct 2006. Photo: Lone Koefoed Hansen.

from a range of areas not normally referred to within HCI and design literature simply because few succesful attempts have been made to integrate the user's performance of her own perception into the system.

In the following, we will present the concept of the user performing her own perception by drawing upon work within the field of HCI on to system-user-spectator relations, performance theory, phenomenology, and sociology, coupled with analyses of different examples, ranging from everyday interactive products to art installations such as *Bridge*.

2. RELATED WORK IN HCI: RELATIONS BETWEEN USERS, SYSTEMS AND SPECTATORS

The increase in public and semi-public interactive systems of late has prompted a number of contributions to the HCI community with regards to the relations between systems, users, and spectators. With the particular theme of this article in mind, we will introduce and discuss contributions that highlight: (1) tensions between system and user (user < = > system), (2) tensions between the system-user interaction and spectators thereof (spectator < = > [user < = >system]), and (3) tensions between user and spectators (user < = > spectator).

An introductory note on terminology: We use the term "user" to denote a person interacting with a system. We use the term "system" to denote the artefacts with which the user interacts; this may be a discrete entity or a constellation of multiple artefacts. We use the term "spectators" to denote persons somehow observing the interaction between user and system; this observation may be co-present or it may be mediated in various forms. In particular, the use of the term "*user*" is contested ground. A main line of argument in this article is that the user takes on various roles throughout the interaction process. For this reason we initially refrain from using the term "performer" instead of "user," for this is just one of the roles played by the user.

2.1 User < = > System Relations: Towards Embodiment and Contextual Interaction between User and System

Human-Computer Interaction has from the outset self-evidently been chiefly concerned with the user-system relationship. In the canonical, Grudin [1990] describes five historical foci of interface development. This development begins with interfaces at a hardware level and evolves through interfaces as programming tasks, terminal interaction, interaction dialogues and (anno 1990, when the paper is published) extends into the interface as the work setting, encompassing multiple end users interacting with systems in collaboration. Thus, contextual aspects surrounding the user-system interaction have gained increasing prominence in HCI.

More recently, Dourish [2001a, 2001b] discusses the concept of *embodiment* as a foundation for context-aware computing. Taking his departure in what can broadly be labeled tangible computing (e.g., Ishii and Ullmer [1997]) and social computing [e.g., Dourish and Button [1998]; and Suchman [1987]). Dourish [2001a] presents the argument that the these two fields of inquiry share a common basis with respect to the importance they ascribe to the context in which

interaction takes place. As a foundation for understanding and exploring interaction in context, Dourish [2001a] posits the concept of embodiment. Embodiment stems from the philosophical position of phenomenology and implies not merely physical presence (although that certainly is a key aspect of embodiment), rather "embodiment denotes a participative status, the presence and occurentness of a phenomenon in the world. So, physical objects are certainly embodied, but so are conversations and actions." [Dourish 2001a, unpag.]. We perceive and act in a world laden with meaning, and meaning is constantly being enacted and renegotiated through our interactions with each other and the world.

In terms of the trichotomy of system-user-spectators, Dourish [2001a, 2001b] conceptualize the situation of interaction holistically, in that embodiment implies always already being in a reciprocal relationship with the context (encompassing both users, interactive systems, spectators, co-users, physical surroundings and the meanings ascribed to these entities) in which you interact. In that sense, embodied interaction deals not only with the system-user-spectator constellation, but also with the broader context within which it is situated.

Pertinent to the theme of this article, we can however deconstruct the systemic concept of embodiment to gain an understanding of some of the tensions between user and system. First and foremost, it is a relationship characterized by the user's exploration of the meaning of the system. When social and tangible computing systems appear "natural" or "intuitive" to users, it is often because they offer users ways to "uncover, explore and develop the meaning of the use of the technology as it is incorporated into practice." [Dourish 2001a, unpag.]. Second, meaning is not a constant, rather arises from the user's interaction with the system. With regards to designing interactive installations and staging experiences such as *Bridge*, this implies that one cannot control what the system means to the user, only influence the construction of meaning: "What a user means by engaging in some action [· · ·] may have little to do with what the designer imagined" [Dourish 2001a, unpag.].

The aforementioned extending foci of interface development described by Grudin [1990] has now, 17 years on, led to HCI becoming increasingly interested in not only how contextual aspects influence the user–system relationship, but also how the user–system relationship is perceived by spectators in the interaction context and, as we will elaborate on in this article, how this awareness of being in a user-system-spectator trichotomy affects the user.

2.2 Spectator <=> (User + System) Relations: On Designing Spectator Experiences

Reeves et al. [2005] addressed the issue: "How should a spectator experience a user's interaction with a computer" [p. 748]. Borrowing on terms from performance theory, the paper denominates the user as performer and the interaction between performer and computer as performance. It is the spectators' relation to and experience of the performance that is at the heart of the paper.

In their exploration of this relation, Reeves et al. [2005] made the distinction in performances between *manipulations*: what actions does the performer carry out to operate the computer, and *effects*: what are the observable results of these actions for the spectators. A central aspect of designing spectator experiences is the degree to which manipulations and effects are concealed or revealed, and Reeves et al. classify performances according to how both manipulations and effects may be hidden, partially hidden, transformed, revealed, or amplified. For example, the use of computers for composing emails most often entails hiding both effects and manipulations (which makes for a nonexisting spectator experience), watching a Powerpoint presentation relies on amplified effects and partially hidden manipulations, whereas much of the fun of observing someone playing a game of *Guitar Hero* or *Dance Dance Revolution* comes from the interplay between revealed manipulations and revealed effects in the player/performer's mastery of the game.

Reeves et al. [2005] leaned upon these distinctions in their discussion of possible strategies in designing spectator experiences which they denominate secretive (hidden effects and manipulations), expressive (revealed or amplified effects and manipulations), magical (hidden manipulations and revealed or amplified effects), and suspenseful (hidden effects and revealed or amplified manipulations).

These strategies are presented as a framework for designers when considering spectator experiences, which in our system-user-spectator trichotomy can be described as the observation of the system-user interaction. It is worth noting that in Reeves et al.'s [2005] terminology, this interaction is denoted *performance*, and the engaged user is denoted *performer*. While we find Reeves et al. [2005] a highly interesting paper, the introduction of the spectator–performer terminology is too broad for many purposes as it includes all system-user interactions into the terminology that by inference allows for the term user to always be substitutable with performer. The terms *performer* and *performance* are fit for the purpose of Reeves et al. [2005] as they are broadly defined allowing for the arguments on spectators' engagement to come forward. But on a general level it is not satisfactory to use specific terms for a broad purpose as this leaves us with a crippled vocabulary; it is simply too reductive to use *performer* as a synonym for user and *performance* as a synonym for interaction as it makes us unable to distinguish between people who are interacting in solitude and people interacting with other people present. As we will address below, interacting with other people present makes a big impact on the interaction itself as one is actually performing *for* someone. A user's experience of being a performer in a designed environment for others to observe and the resulting change in the user's relationship to spectators, is only touched upon briefly in Reeves et al. [2005]. This is understandable in the light of the scope and focus of Reeves et al. [2005]; however, as we will argue in this article, the ways in which the user perceives and experiences the act of interacting with a system under the potential scrutiny of spectators greatly influences the interaction as a whole. We will argue that it is precisely this awareness of the (potentiality of a) spectator that transforms a user into a performer. For this reason, the spectator experience most certainly also has to do with the user's

experience. Reeves et al. [2005] mentions this relation in terms of performer *awareness*, a concept explored in a number of contributions to the fields of HCI and Computer-Supported Cooperative Work (CSCW).

2.3 User-Spectator Relations: Mutual Awareness in Interaction

The concept of awareness figures prominently in in a number of HCI and CSCW studies, among these [Bellotti and Bly 1996; Bellotti and Dourish 1992; Orr 1990]. Awareness in these contributions is understood as a reciprocal, socio-functional relationship: "Awareness is an understanding of the activities of others, which provides a context for your own activity." [Bellotti and Dourish 1992, p. 107]. Partaking in activities in social settings often, if not always, requires awareness. For example, in work settings, awareness help you ascertain whether co-workers are available for discussions, what projects they are working on, what their mood is etc. These types of information are made available to us through so-called *awareness mechanisms*, which may be explicit (e.g., I make a note in a document that I am writing with a colleague that I have changed a paragraph) or implicit (e.g., my colleague assumes that since another paragraph has changed since she last saw it, I must have changed it even though I have not made a note of it). When we describe awareness as a mutual relationship, it is due to the fact that skilled participation in a social situation also implies that you yourself provide awareness clues to others. These may come about through conscious deliberation (e.g., I may pretend to be hard at work so I can avoid talking to obnoxious co-workers), although most clues are subconscious, or possibly somewhere in between the conscious and the subconscious.

However, most awareness studies, being rooted within the field of CSCW, focus mainly on the work-related aspects of the user-spectator relationship, for example, studies and design examples address issues such as how to set up automatic it-supported awareness mechanisms for distributed work, how to make clear in which ways co-workers have modified documents, how to find out when it is possible and appropriate to contact co-workers on the phone or via instant messaging etc.

Although we address the dialectics of user-spectator relations, the argument presented in this paper extends the socio-functional, work-oriented aspects of awareness.

Benford et al. [2006] partly touch upon the user-spectator relationship. Extending the strategies for framing spectator experiences in Reeves et al. [2005], the authors examine strategies for blurring the frame of performance in a public interactive game/performance. Performance participants are devided into bystanders (unwitting spectators), audience (spectators participating actively) and performers (the designers and their helpers orchestrating the performance/the game before and during the audience's participation). The paper examines how strategies of blurring frames between bystanders and performers may be used in design of mobile experiences for the audience and it briefly examines the audience's experience of these blurred boundaries.

Like Reeves et al. [2005], Benford et al. [2006] is an intriguing paper addressing important aspects of real-time co-located computer-mediated experiences.

But unlike Reeves et al. [2005], the user is not denoted *performer* even though the user is acting in public space: the user who was a *performer* in Reeves et al. [2005], is called *audience* in Benford et al. [2006] while *performer* is understood in a more classic sense as a person instructed in performing specific actions at specific times during a staged event—even though the particular performances discussed are open for changes according to the audiences' actions. The resemblance to role-playing games in which performers act according to specific rules and plots set up by game masters, is obvious. Still, urban games like the ones described in Benford et al. [2006] differ significantly from urban role-playing in that the former have a fixed timeframe and not least in that even though both audience and designers (performers) are participating in the same space and the same story, they are almost not part of the same game/performance as designer-performers have to make sure that audience-performers are behaving according to the story's timeline. Even though it may not appear so for the audience, they have very little freedom to make their own decisions as the performers are always ready to keep the audience on the right track according to the story.

In a computer-mediated urban performance, this framing is the main factor in establishing the performance, as put forward by Benford et al. [2006], in which case it is of course important to be aware of how to design the frame. Nevertheless, this frame adds aspects of being-a-performer-for-others and being-aware-that-one-is-being-a-performer-for-others to the audience's experience of the performance as the performance is also an experience of being a performer for both bystanders, performers and other audience members. In short, audience members are neither just experiencing or perceiving a story nor just performing a role—they are performing their perception of the setup, the story and the surroundings. We do not see this fully recognized in the framework offered in Benford et al. [2006].

Let us sum up our position and focus in relation to related work within HCI: The main part of HCI literature has evidently addressed the system-user relationship. Contextual perspectives that expand this focus have gained increasing prominence within the field, exemplified by Dourish [2001a], which provides a strong conceptual foundation for understanding the user's relation to systems. The emergence of public and semi-public interactive systems have further extended to studies of spectators' experience of system-user interactions, and in this line of work [Reeves et al. 2005] presents a focused discussion about spectators' experience of the user-system relation. However, these contributions touch only briefly upon the tension in the system-user-spectator trichotomy that has to do with how users experience their interaction with systems in the knowledge that they are potentially putting on a performance for spectators, and how that affects the whole situation of interaction.

The focus of this article in the light of related work is sketched in Figure 3.

3. PERFORMING BEING-A-USER—PERFORMING PERCEPTION

The relation between the system's user (as quite literally inscribed in the system's interactivity design) and the user's actual use of the system can be

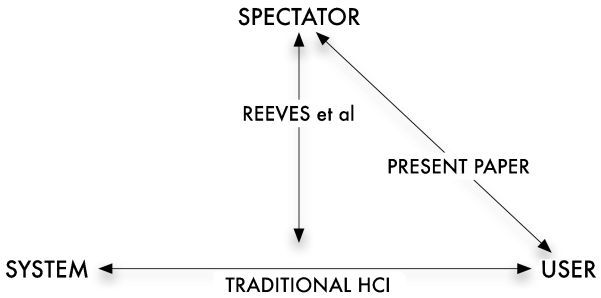

Fig. 3. User-system-spectator tensions and the focus of this article.

characterized as one of double play: the user knows that she is inscribed in the system and she uses this knowledge as a way to understand and play with the system; it resembles a simple cybernetic feedback loop as, for example, Aarseth [1997] has established as a distinctive feature of hypertext. The relation can be described as a correlation between the user's *act of perceiving* and *act of interacting*. As we will show below, the *act of performing* is, however, added when use becomes socially situated—when use becomes possible for others to observe. Among others, Bentley [1964] and Goffman [1959, 1966] have argued that there is always a performing aspect of people's actions even though the extent to which it is essential for an action varies with the setting and the person acting. Regardless, the act of performing is essential when someone is physically experiencing and/or operating a system in front of others and we analyze the use situation from a dramaturgical or performative perspective.

It will be our claim that the tension between the user operating on the system and the spectator watching this operation is imbued with the user's awareness of being in the center of the spectator's focus. She is not only (actively) perceiving the system's possibilities or the performance that takes place by help of the system but her operations and thus her perception is heavily influenced by her knowledge of that her perception of the system is a performance for others. This reciprocity is what what we call *performing perception*.

In this context, we understand performance as a very physical thing; it is the actual actions taking place and not a dramaturgical or narrative term as for example, Laurel [1991] uses the term. As also Iacucci et al. [2005] points out, Laurel uses theatre metaphors and terms to understand how one can design a use experience such as the flow of an interface as if one were setting up a stage for the user to explore or perform in. Following, but slightly specifying how Reeves et al. [2005] use the term, we will use the term performance to denote a situation in which someone is actually performing actions in front of others—the *act of performing*. More specifically we will show below how the user's awareness of how her *act of perceiving* is an object for someone else to perceive affects her *act of interacting* to a degree that may even prevent her from interacting if the system does not acknowledge this interplay (Figure 4).

Performing perception thus describes how the user is simultaneously engaged in three actions: the act of interacting with the system, thus understanding

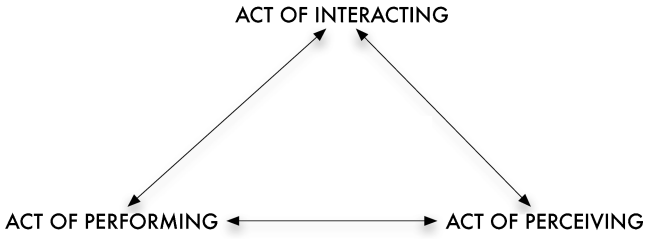

Fig. 4. Model of acts of performing, perceiving and interacting.

Fig. 5. Kaffee Matthews' Sonic Bed in use by Lone Koefoed Hansen at OK Center for Contemporary Art, Linz, Austria during Ars Electronica, Sept. 2006. Photo: Jacob Wamberg.

which possibilities she has and how she can operate the system; the act of perceiving the relation between her and the system and her and the surroundings; and finally the act of performing where she is a performer for others to observe.

The following example will demonstrate how the tension between the act of perceiving and the act of performing can be a vital part of the object's form and expression, and thus how it can be staged as a part of the use situation and the resulting interaction potentiality of an object. Afterwards, we will move on to establishing an understanding of why this is the case.

3.1 Sonic Bed

In *Sonic Bed* [Matthews 2006] (Figure 5), a 12-channel speaker system enables you to listen to music compositions with your entire body while being in a custom-made bed in which the speakers are embedded. *Sonic Bed* is a an

artwork and a display for artworks at the same time—or a music instrument as the artist Kaffe Matthews prefers to call it—to which musicians can compose music. Based on the fact that sound appears because sound waves literally move air, the bed presents the user with embodied music if she climbs the bed and normal music if she chooses to not climb the bed. In order to listen to the music with your body, you climb the bed, lie down and find yourself in a perfect listening position where soon various parts of your body will begin to shake and shiver due to the air pressure generated by the speakers underneath the mattress.

Experiencing *Sonic Bed* is curious; lying in a bed is normally an intimate experience, but here other people are free to enter. Listening to music is not normally an intimate experience (it may, however, be private if only you yourself are able to listen), but in this case, music has an intimate effect since your whole physical body is shaking—sometimes a foot, sometimes a shoulder and sometimes the pelvis or a buttock. In *Sonic Bed*, the user is on display, both due to the fact that the combination of user and bed is the only visuals present and due to the bed frame's literal framing of her—as if the user is a sculpture in a display case or a picture in a frame. The alluring aspect of *Sonic Bed* is that it contains these oppositions; it is neither a fully immersive or contemplative experience since there is always an awareness that you yourself are on display, nor is it a fully public experience since the music you experience is unique to you and your body's position on the mattress.

Sonic Bed is not an interactive piece—the music does not change according to how people position themselves in the bed—but it is a piece where position and movement between positions means everything. The artist created the bed in an explicitly ambiguous idiom but she is still puzzled that people tend to not move at all; that they hesitate to explore the music with all of their body. They get into the bed, position themselves, and the next time they move is when they exit the bed. Alternatively, they could have entered the bed, lied down and then moved around—lying in a diagonal, lying on their back, on their front, elevating parts of their body etc. It appears that not wanting to draw attention to oneself and not wanting to be in the focus of other listeners is a force hard to snap out of, even though this ambiguity of being immersed and being on display is a big part of the experience of the work and even though it is a considerably more intriguing experience when you explore the sound waves with your body.

3.2 Social Behavior

One way of casting light on the always already installed interplay between the user's actions, the situation she is in, and her relations to other people present, is to turn towards the seminal observations and interpretations of the sociologist Erving Goffman. Goffman's research was devoted to observing and analyzing how western people behave in social situations. Goffman applied dramaturgical terms and principles to sociological observations, and viewed the presentation of the self as a dramatic effect applied in a specific time, at a specific place and for a specific audience. As Brissett and Edgley [2006, p. 78] points out, dramaturgical sociology does not study what people feel, but how they behave

when they believe to be "on", thus "reading" cultural conventions from people's actions in specific situations.

Goffman [1959] is mostly known for his accounts of front stage and back stage behavior—of how people try to present themselves while in public space. In this case, however, Goffman's notion of focused and unfocused interaction is much more relevant as it focuses on the implicit negotiations taking place when two people are in the same situation and on how people's actions are primarily based on how they believe their actions would fit into the situation instead of being primarily based on their own idiosyncratic preferences. Situatedness is not a new concept in HCI, but Goffman's definition will, however, shortly prove to be very useful so we will quote it here:

> The term *situated* may be used to refer to any event occuring within the physical boundaries of a situation. Accordingly, the second person upon a scene transforms everything done by himself and by the one already there into situated activity, even though there may be no apparent change in the way the person already present continues with what he had been doing. The newcomer, in effect, transforms a solitary individual and himself into a gathering [Goffman 1966, p. 21]

Goffman's point is that in any given situation, every western individual will be relating to the other people present—also when this awareness of other people is not directly visible. Being situated means being aware of your surroundings to a degree where all actions in the situation are coupled with the awareness of the situation. Goffman's use of the word "gathering" draws attention towards the frame or the stage created and sustained by social relations.

More importantly, Goffman classifies relations in a situation as either focused or unfocused. Focused interaction is "the kind of interaction that occurs when persons gather close together and openly cooperate to sustain a single focus of attention, typically by taking turns at talking" [Goffman 1966, p. 24], and unfocused interaction is when people are in the same situation but without interacting even though they still manage to be somewhat aware of each other's presence: "In this realm of unfocused interaction, no one participant can be officially "given the floor"; there is no official center of attention." [Goffman 1966, p. 34]. Thus, unfocused interaction is all about "fitting in," and it is what most of us spend most of our time doing. When in the bus, when at a talk, when at the gallery or when in public space in general. One of the reasons why people prefer maintaining unfocused interaction in public space is, according to Goffman, that this is a way of maintaining some sort of privacy—some sort of private space. In other words, we get to be ourselves even though that self is always a front stage self when we are in public. In unfocused interaction, people can attend to their own business without having to take other people too much into consideration as it is understood that the situation is neither one of direct interaction nor one where other people will be interested in your actions unless you act in a way that transforms unfocused to focused interaction. Thus, both focused and unfocused interaction is based on a contract; in focused interaction we agree that we are each other's primary contact, in unfocused interaction we implicitly agree on recognizing each other's existence in a common space while not initiating (or wanting to initiate) focused contact.

3.2.1 *Focused or Unfocused Interaction.* Goffman's observations partly explain why we find it necessary to develop further on the notion of the spectator experience presented in Reeves et al. [2005]. Most interactive systems are designed with the specific user in mind—as a result of the desired relation between the system and the one(s) using it. Much recent HCI research is about making a system that works on the user's terms. The system and the use of the system is supposed to (and is considered appropriate and well made if it) "folds around" the user, thus making the user the center of the system. Use of the system is most often supposed to be what [Forlizzi and Battarbee 2004] refer to as "an experience"—something that "has a beginning and an end, and often inspires emotional and behavioral changes in the experiencer" [Forlizzi and Battarbee 2004, p. 263]. If relations to other people are considered, it is always in relation to the use of the system—does it work under specific work conditions, does it facilitate interaction with multiple users, or does it work as the desired social tool.

Essentially, we believe that Goffman's notions of focused and unfocused interaction contribute to an understanding of interactive systems as something that is always about focused interaction even if focus is peripheral as in slow technology [Hallnäs and Redström 2001] You are never supposed to *not* care and the system will always be the "official center of attention" (cf. Goffman [1966]) or at least designed so it can easily become the center should it be necessary (cf. Hallnäs and Redström [2001]). Contrarily, the user's relations to everything unrelated to the use itself is supposed to be unfocused or maybe even nonfocused as she is not expected to reflect on events that are unrelated to her use. Nonfocused is not a Goffman term because according to him, a situation can only consist of focused or unfocused interactions as people will always be aware of other people's presence and they will always act according to how they perceive themselves in the eyes of others. However, when analyzing existing interactive systems and papers describing them, the notion of peripheral spectators is rarely touched upon and if it is, it is considered of minor importance. Benford et al. [2006] and Reeves et al. [2005] are two examples which both touch upon the issue of spectatorship in interactions with public installations, but which do not attribute any significant importance to the spectators' effect on users' interaction with systems. This lack of recognition points toward a premise of nonfocused interactions: Systems and, by inference, system designers are almost never expecting people to experience focused or unfocused interaction towards surroundings that are not part of the interaction or the interaction goal.

However, works or systems like *Bridge* is pointing out how it may be true that you are in a focused relation to the system, but this focused interaction is in itself part of a focused interaction with the surroundings—in this case the prospective users waiting on the deck. Our point being that the user (and in part also the system itself) expects to be in an unfocused (or maybe even nonfocused) relation to the surroundings, but in focused interaction with the system. As a user, you want to interact with the system on your own terms and you expect to be in the system's center of attention and most importantly, you expect to be able to have the experience of the system at the center of your

attention. Typically, systems even set the stage for this interaction individuality as it is typically assumed that interaction with the system is based on focused interaction while other things move to the background. This is also the case with experience oriented systems where the system is made for—and the user is interacting in order to get—experiences.

Unlike artworks like *Sonic Bed* where the juxtaposition of being a performer while also being a spectator purposely contributes to the experience, focused interaction towards the surroundings is rarely built into the interactive system itself and rarely does it become a planned part of the experience. It would appear that many interaction designers implicitly believe that they are creating non-focused or maybe unfocused interaction towards the surroundings if they are not specifically creating a spectacle meant to be a center of attention. However, if we take Goffman's observations and analyses into consideration there is never such a thing as completely unfocused interaction between either of the entities system, user and spectator (cf. Figure 3). Interaction between either of the three will never be nonfocused, it will maybe be unfocused for a while but it will always be focused at some point, and it will always be on the verge of becoming focused again when it is unfocused.

Our point is that unfocused interaction is implausible when it comes to being watched while being a user in experience design systems as the user is precisely "the center of attention" (cf. Goffman [1966]) from the spectators' point of view and the user is very well aware of this. Accordingly, the user experiences a double focused interaction—she is focused on both the system use and her relation to other people present; and in this sense interacting with a system is no different than interacting in other cultural settings.

3.3 Performing a Role

It follows from the above mentioned double focused interaction where the user is performing her own perception of the system, that she has to simultaneously adapt to different roles when interacting with a system. The performing of her perception contributes to the aesthetics of interaction as the user's role play is a result of the system's or object's form, expression and interaction design just like a performance in a theatre play is a result of aspects like script and staging.

BodyBug [Moen 2005] (Figure 6) is an example of an object accomplishing this. *BodyBug* is a prototype aiming at creating a kinaesthetic experience. A small box containing mechanics and electronics runs on a wire attached with velcro to two points on the user's body. Moving her body, the user also moves the wire which triggers the case to respond by moving up or down the wire. According to user studies, *BodyBug* provided users with "an experience of being able to feel beauty in their movement, that is, an aesthetic experience; sensing their bodies, and they had found new ways of moving and make use of their bodies" [Moen 2005, p. 123]. Simultaneously, the user's movements with *BodyBug* was a spectator oriented performance: "The interaction *BodyBug* creates engages not only the mover but also the audience as they often make comments on the movements and the interaction created by the user" [Moen

Fig. 6. *BodyBug* in use by Jin Moen, the inventor. Photo: Peter Knutson.

2005, p. 123]. Interestingly, *BodyBug* integrated these two aspects in a way where users quickly accepted and played with the knowledge of perceiving and performing at the same time, as users "also expressed the insight of people having very individual movement patterns and qualities of motion, as well as an increased consciousness of their own movement pattern" [Moen 2005, p. 123]. In this case, the form, expression, and interaction design deliberately set the stage for the user's acceptance of performing her perception as part of the experience. Here, it could be due to the fact that she had the possibility of interacting in several ways; from extreme movements in space to hardly perceivable movements with the parts of her body that *BodyBug* was attached to. She was, in other words, able to partly control how she came out as a performer.

In accordance with Reeves et al. [2005] and Benford et al. [2006], we believe that the realm of performance studies and theory can be helpful when understanding user interactivity. Also Hare and Blumberg [1988] states: "we assume that there is a continuum ranging from everyday activities that do not have a dramatic quality, through social events that are consciously staged, to theater productions" [p. 14]. Building upon the considerations in Reeves et al. [2005], we will, however, in continuation of our application of Goffman, claim that *it is as important to design for the user's role as a performer as it is to design the user-system interaction and to design for spectators*. This is because spectators are watching a user who is very concious of her role as performer. It thus follows that it is impossible to design for spectator experiences without also seriously considering how to design for users to be performers while simultaneously being operators of a system and spectators of their own performance.

3.3.1 *Playing your Part.* Goffman's observations on focused and unfocused interaction highlight the fact that we are always aware of our immediate surroundings, regardless of whether we are in direct interaction with people around us or not. Goffman's base for analyzing social situations is the dramaturgical realm whose terminology is also important when moving from observing the socialized everyday lived life to designing systems for experiences that are always socially situated when they happen in public space—or in a gathering, to use Goffman's terms. Creating spectacles and hence spaces for gatherings is an important part of most experience design and consequently, we need to look more closely into the dynamics of gatherings; of how we can further understand the dynamics of the different roles played by the user while she participates in an interactive gathering or experience.

SKIN Probes are prototypes by Philips design. Two dresses reflect the wearer's mood and body state. *Bubelle* (Figure 7) comprises two layers of garment, the inner one measures emotions (skin signals interpreted as emotions) and projects light onto the outer layer, thus responding visually to the wearer's emotions.

Frisson (Figure 8) is a body suit that responds with lighting up LEDs when the suit is blown on. Both prototypes are thus fairly direct visualizations of what is normally a private, intimate and bodily experience: blushing and shivering (or the reddening and goose pimpling of skin, respectively), and both prototypes

Fig. 7. The Philips Skin Probe *Bubelle*, promotional photo.

Fig. 8. The Philips Skin Probe *Frisson*, promotional photo.

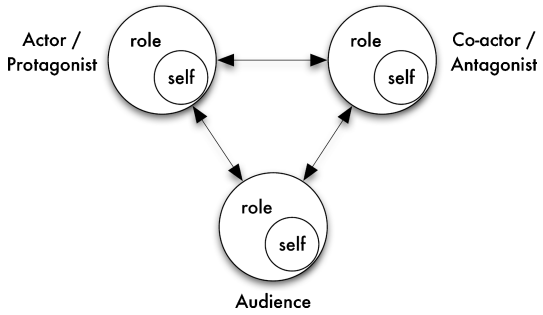

Fig. 9. Hare & Blumberg's model of the performance situation.

transform the wearer from being a person wearing clothes to being a performer literally carrying her "inner self" on her dress.

There are many ways in which this project can be questioned; does it make sense to talk about an inner self, is it actually the wearer's emotions that are being exhibited, or is it a constellation of stimuli or response which do not necessarily cohere. Both dresses are, however, unquestionably examples of highly performative clothing, no matter what is actually being performed.

We can further our understanding of the implicit dynamics in an interactive object like *SKIN Probes* by recalling what theatre critic Eric Bentley writes on the theatrical situation:

> The theatrical situation, reduced to a minimum, is that A impersonates B while C looks on. [· · ·] Impersonation is just half of the little scheme. The other half is watching—or, from the viewpoint of A, being watched. Even when there is actually no spectator, an impersonator imagines that there is, often by dividing himself in two, the actor and his audience. The very histrionic object, the mirror, enables any actor to watch himself and thereby to become C, the audience. And the mirror on the wall is only one: the mirrors in the mind are many. [Bentley 1964, p. 150]

Following Bentley, *SKIN Probe* acts as a stage where A (the wearer or user) displays or performs B (her body and her immediate feelings as seen through *SKIN Probe*'s rendering) to C (the people in her surroundings). As Bentley notes, C is a conceptual rather than an actual entity; A, the performer, is fully capable of impersonating even though there is no audience. In other words, Bentley highlights that the essential part of a performance is not that someone is actually being looked at, but that someone is impersonating or performing someone or something before a potential audience.

Bentley's writings have been picked up by dramaturgical sociologists like Hare and Blumberg [1988] who, following both Bentley and Goffman, have applied performance theory to social situations. Hare and Blumberg [1988, p. 8] expands Bentley's model to also incorporate a co-actor or antagonist and several reference groups (an audience that may only be present in the mind of the actor), thus diagrammatically depicting the performance situation and consequently the basic tensions of social interaction as also Goffman observed (see Figure 9).

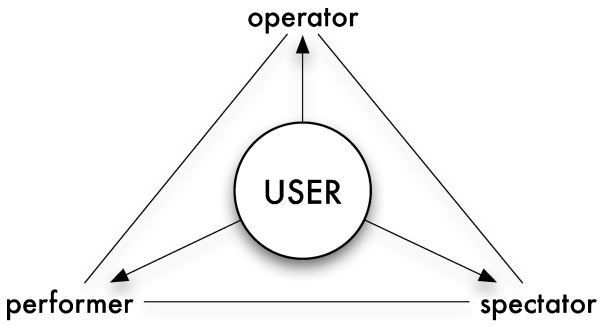

Fig. 10. User roles.

Again, the fundamental part of a performance—someone performing something in front of a (potential or imagined) audience—is the interconnections between the actor/protagonist, the co-actor/antagonist and the audience. All come to live because of the connections to the other entities. Goffman applies these fundamental principles to social interactions, but also reminds us that even normal nonstaged everyday settings are under the influence of social norms and interpersonal interaction paradigms.

It is unlikely that a user interacting with a designed and staged system with the aim of providing some sort of interactive experience will not also be under the influence of these social paradigms—even if the user chooses to disregard them. Thus, understanding the aesthetics of interaction will amongst other things be a matter of finding a way to design for the user to be able to dynamically alternate between different roles.

Combining Bentley's thoughts on how the performer, A, relates to the audience, C, with Goffman's thoughts on focused interaction and Hare and Blumberg's formal application of theatre theory on everyday life, we are given a framework for understanding and ultimately designing for the user's different roles.

In Figure 4, we depicted the relations between three different user actions (the acts of performing, perceiving and interacting, respectively). Relating the statement to the findings of Bentley and Hare and Blumberg, we can now transform the model of actions to a similar model of user roles (Figure 10).

In Hare and Blumberg's model, the dramaturgical situation of a play was analyzed in order to project it onto real-life situations in the spirit of Goffman. The point of both Hare and Blumberg and Goffman is that this is everyday life; we are talking about ordinary people acting in accordance with cultural conventions. The conventions serve a function very much like the conventions of the theatre situation. There's a stage (the situation), a performer (the person) and an audience (the people sharing a situation with the person). Also Lahr and Price [1973] states: "the life performer [· · ·] is continually being placed in cultural scenes in which special performances are demanded" [p. 6].

Consequently, when Reeves et al. [2005] states that it is important to design for the spectator experience, we agree; as soon as interaction with the system takes place in public there will be people looking and sometimes those

people are supposed to be the next users. However, when looking at the dynamics between the performer and the spectator, it becomes clear that designers cannot address the one relation or role without adressing the other. If there is an actual spectator, the user is highly likely to not only be engaged in a focused interation with the system but also with the spectator. And if there is no actual spectator but only a potentiality for an actual spectator, there will still be some sort of focused interaction towards an imagined spectator (cf. Bentley's "the mirrors of the mind are many" [Bentley 1964, p. 150]). Both kinds of spectators—imagined or actual—have great influence on the other roles the user is playing and hence on her use and experience of the system. The user is consciously or subconsciously always performing in front of imagined or real others when she interacts with the system in public space. She puts herself on the line and becomes a performer of her own perception. Implicitly, an interactive system becomes the stage for not only the user's perception of the system but for her perception of her own act of performing in and with the system.

4. CASE ANALYSES AND DISCUSSIONS

Throughout this article, we have addressed several of the aspects of the user's performing of her perception by partly presenting theoretical foundations and partly pointing to issues raised as we have encountered various experiences within the last couple of years. The cases presented have so far been pointed at raising or illustrating a specific issue and not all of the examples have been making use of interactive technology. In the following, we will bring together all of the considerations on what it means to the user that she is simultaneously an operator, a performer, and a spectator and more importantly, what it means to the use situation, that the user is bound to perform her perception. We will bring the considerations into play by analyzing three different examples of how people use an interactive system in public or how they publicly use technology, thus demonstrating how the 3-in-1 of user roles and particularly how the performing perception shapes the user's experience.

They hint at how conventions may change (on the one hand) or how designers may successfully incorporate the aspects into the design (on the other hand).

4.1 Case 1: Physical Computer Games

A vignette from a video games arcade in Trocadero, London (Figure 11):

In the cacophony of rows upon rows of video games, a group of friends take turns playing a game of *Dance Dance Revolution*. Highly choreographed, the player presently playing interacts by moving his feet in well-timed response to the sounds and imagery of the game. He easily navigates the early stages of the game, the tension rising, the beat accellerating, and the applause of his friends escalating. In the latter stages of the game, his mastery begins to falter and after a number of missteps, his game is eventually over. His friends cheer him up, pad him on the back, and a new player steps up, eager to play and impress.

The interaction is clearly focused for the group of friends taking turns playing *Dance Dance Revolution*. The player's attention is directed towards the sounds and visuals of the game, although he is also obviously aware of the bystanding

Fig. 11. Dancing in a video games arcade.

friends, their behaviour, and their impression of his playing. The bystanding friends are attentive towards the player in interaction with the game, and also towards each others' expressions and behavior. This assembly of game, player, and immediate spectators can be said to exist as one situation of interaction, circumscribed by another one, namely that of spectators in the games arcade observing the friends playing. To spectators outside of the group of friends, the group of people taking turns playing make up a performative spectacle in it's own right. The attention of the player and the bystanding friends are somewhat

more unfocussed when it comes to this second layer of performance. However, the group of alternating players are in no way oblivious to the fact that they may be the center of attention for passers-by. The fact that they are more focused on the immediate game situation does thus not imply that they do not act as if they are in a public place in which certain behavioral norms are in place.

If we regard the roles that the immediate player of the game takes on, he is clearly the operator of the game as he responds to the auditive and visual cues by stepping on the input tiles. He is also simultaneously a performer in front of his friends in several ways. First, his immediate interaction with the game is a spectacle in it's own right. Second, he is performing his skills and increasing proficiency at the game, all the while putting himself at risk since he knows that he will eventually reach a stage of the game at which he will be unable to keep up. This risk of putting oneself at stake is one obvious attraction of playing this type of game in public. Third, he also performs certain moves that are not explicitly necessary for interacting with the game, for example, he hums or sings in time with the music, he jiggles his hips, he lifts his arms in celebration when a stage is completed. This points to the third role that he is invariably played out at the same time as the two others, namely that of spectator. He is implicitly aware of his status as the centre of attention for his friends, and potentially for other visitors at the games arcade. This influences his observable behavior, but even more so it affects his whole experience of the interaction situation. In a fairly visceral game such as *Dance Dance Revolution*, we may denote the proficient player's experience as one of immersion, but it is not an immersion solely in the game-player interaction, it is an immersion in the whole situation of interaction: well-timed responses to the game, socio-culturally recognizable gestures and utterances such as raising ones arms in celebration, nods and comments to friends, pleasure in displaying expertise in front of strangers in a public place, adrenaline rushing in the knowledge of the imminent risk of failing.

Revisiting Reeves et al. [2005], the situation can be said to be based on an expressive strategy in which the manipulations and effects of player interaction are revealed and possibly amplified for the spectators. This is certainly one aspect of what makes *Dance Dance Revolution* a successful arcade game. It is however by no means the only one. We argue that the way in which the game and the staging of it engages the user by addressing the trichotomy of user roles—operator of the game, performer in public, spectator to one's own performance in relation to how the friends were or will be doing—is equally important, if not more so, in understanding why and how the game succeeds. The design of the spectator experience is necessarily a question of not just how spectators perceive the performance, but also of how users simultaneously perform their own perception and perceive their own performance (in relation to the other performances). In this case, the user is both a performative spectator and a spectating performer while he interacts with *Dance Dance Revolution*.

Dance Dance Revolution is just one of a steadily rising number of interactive games that rely heavily on designers' understanding and playing into the tensions of the user-spectator relationship. Even many years ago, archade games and pin ball machines were to be found in eg. burger bars and even though

the place was supposed to be for shorter visits only, many customers hung out for hours watching each other play on the machines. More recent examples include *Singstar*, in which the performance aspect is even more prominent as players take turns singing pop songs, and many of the games produced for the Nintendo Wii console. Arguably, the Wii, despite its inferior hardware performance compared to rivalling consoles Xbox 360 and Playstation 3, has proved a hit because the Wii console and games developers have extended their view of console gaming as solely a question of user-system interaction and taken into account the performative aspects of gaming.

4.2 Case 2: Mobile Space

A vignette from Rome Fiumicino airport: An Italian man carries on a number of conversations on his mobile phone in the departures hall. All the while speaking, he keeps his voice down and maintains a certain distance to other travellers. He holds his phone to his left ear, keeping it there with his right hand index finger; this causes his right hand to cup his mouth and further muffle the sound of his voice plus it prevents other people from lip reading. While speaking he engages in eye contact with other people in an almost aggressive manner; he holds your gaze until you look away, but his eyes are not inviting you to engage in interaction with him. In this manner, he maintains a bubble of privacy, all the while being markedly aware of spectators who notice his distinct (and stylish Italian) way of conversing.

It is clear from the gestures and body language from the Italian man that he is looking for a way to not be audibly present in the public sphere while he is interacting with his mobile phone. He is simultaneously present in two domains at the same time as he is both in the domain of the conversation and in the domain of the airport. In terms of focused and unfocused conversation, he is engaged in a focused interaction via the phone. It may be mediated via the phone, but it is still a classical focused interaction in Goffman's terms. As Murtagh [2001, p. 85] points out, most people engaging in phone conversations go out of their way to not engage in focused interaction with people in their physical surroundings by that is, making an effort to not look into anyone's eyes while speaking. The Italian man, however, engages in a peculiar focused but still unfocused interaction with his immediate surroundings. He does look at you, but in a way that make you keep a distance by looking away. He forces onlookers into an unfocused interaction by being focused.

In terms of the roles of operator, spectator, and performer, this Italian man perfectly demonstrates how a person interacting with a device is focused on a lot more than the interaction itself—how a user is always simultaneously an aspect of all three roles. Also, he is the perfect example of how spectators are influenced by the way the user performs his perception of the situation he is in. The Italian man is never only one of the roles, he is always all of them: Clearly, he is *operator* of his mobile phone as he is engaged in a conversation mediated by the phone. Also, he is evidently a *performer* of his interaction and his desired privacy through his gestures and his way of engaging in eye contact. Finally, he is a *spectator*: he is watching other people's interactions towards him, and

Fig. 12. Joe Malia's Private Public. Photo: Joe Malia.

he is very much aware of how both he himself and his interaction comes out to other people thus shaping his performance from his observations and actions which in return shape the way other people or spectators relate to him.

Where Reeves et al. [2005] positions use of mobile phones in the secretive domain (partly hidden manipulations and hidden effects), this classification does not suffice in this situation and maybe be it never does. This particular situation is neither explained nor understood by only considering the operation of the device. The actual operating of the device is secretive (spectators are unable to see which buttons are being pushed and unable to see the display). Also, the effects are hidden if we define the effects as what happens on the other end of the device, that is what happens as a consequence of the interactions with the device. However, there is no doubt that the Italian man is having a phone conversation and as a whole the situation is very expressive or suspenseful. If we only take his button pushing into account, the manipulations are hidden, but interaction with a mobile phone is also audible and gestural and in this particular case the audible interaction remains hidden whereas the gestural aspects are highly amplified. So if we take the Italian man's situated actions into account, his interaction style is suspenseful at the least and sometimes even expressive, as the effects of his gestural performance are also revealed: as spectators, we effectively look away and are forced into not even try to engage in focused interaction with him.

Italian men are not the only ones with an eye on the performativity of mobile phones. Also *Private Public* [Malia 2006] (Figure 12) emphasizes "the privacy we sacrifice when using mobile technological devices in public spaces." *Private Public* is a tube shaped scarf knitted in the round and it doubles as a hat. When

wearing the scarf as a hat, the user's face is hidden from the surroundings while the user herself is able to see through the end of the tube and onto the screen of the device she has fastened to the tube.

Private Public is a portable secretive space that doubles as an expressive interaction. It is an analog and physical manifestation of the same principles as the Italian man was demonstrating, and both are examples of the performativity of interactions and of how Reeves et al. [2005] is right when demonstrating that interactions with technology are also spectator prone. However, artworks like *Private Public*—and the other artworks in this article—highlight how we tend to forget that our interactions with technology are always present for other people to observe and how these observations are always (at least implicitly) shaping our interactions. Even if we have forgotten that the use of mobile phones in public space strangely mixes the private and the public space, we immediately know what *Private Public* call attention to when we see it in use. By making use of the portable space for secretive interaction, the user is in effect amplifying all of her actions. Spectators are not able to see what she is actually doing to which type of device; they only know that something is going on. This sounds like a secretive and almost nonperformative action. However, she will stand out in the crowd and thus be transformed from being able to stay in unfocused interaction to being the center of focused interaction even though her head is hidden. The very act of making the interactions secretive—the very performance of the secretive—instantly negates the secretive and makes it an expressive interaction tied closely to the act of *performing that you are perceiving* something. Thus, the form and expression of *Private Public* is always already embodying the three different user roles just like the Italian man performs them. As an object, *Private Public* manifests how the user is never able to be only operator, spectator, or performer of an interaction but is always all three at once. *Private Public* calls attention to the fact that interacting with technology in public space with other people (potentially) present is always also about when you show what to whom—about how you perform your experience or perform your perception of the interaction.

4.3 Case 3: Gumlink and the Gum Facade

A vignette from the world's largest sweets trade convention, die Internationale Süßwarenmesse (ISM) in Cologne, Germany: An interactive installation on the side of a stand displays a 3D space in which animated pieces of gum drop from the sky onto floating orbs before piling up on the ground (Figure 13). Business people, most of them wearing suits, pass by the stand, looking at the stand and the installation. A few of them notice faces appearing on the orbs—some are surprised to discover that the faces are in fact their own, and that the orbs follow them as they pass by, pushing aside the falling gum. Flustered, some of them quicken their pace, some of them smile at each other, some of them turn their gaze elsewhere.

At ISM, hundreds of manufacturers and re-sellers of sweets display their products and services to tens of thousands of professional visitors. One of the authors, working in a project at the Centre for Advanced Visualization and

Fig. 13. The Gum Facade at ISM 2006. Photo: Peter Dalsgaard.

Interaction (CAVI), has collaborated with Gumlink, one of the manufacturers present at ISM, to design interactive installations attracting attention and displaying information at the convention. Gumlink is a large, international chewing gum research and manufacturing company. One of the resulting installations of the collaboration between Gumlink and CAVI is the *Gum Facade*, which was put into use at ISM 2006.

Gum Facade was found along one of the exterior walls of the Gumlink stand. Camera tracking combined with face identifying software tracked people approaching or walking past the stand resulting in a live representation of the faces of passers-by on a large display on the wall. The faces were represented in the shape of orbs existing in a 3D space showered by small gum tablets. By moving in front of the display, users controlled their orb's interaction with tablets and potentially also other face-orbs. The intention was to get passers-by to stop in front of the stand and move around in order to control the orb in the 3D space and possibly play out mock games with other simultaneous users. Thus, the purpose was to create attention and attract visitors who might otherwise not notice the stand. However, during the convention *Gum Facade* turned out to not have the desired effect. Although most visitors seemed to notice the installation, very few of them paused by it in order to explore the potentials of interaction.

The use context for the installations, the sweets convention, is characterized as being bustling but simultaneously serious and restrained: A large number of visitors are present, however they are all there for business purposes (the convention is professional and not open to consumers), and as such observe

certain formal behaviors, both relating to dress-codes and behavior, that is, they wear suits, keep a professional distance, etc. The users and the use context, coupled with the Gumlink company values, thus put certain constraints on the type of installations that would fit into the domain.

The intended use of *Gum Facade* was a focused interaction in which the visitor would playfully interact with the virtual 3D gum universe. Following Goffman, the visitors were, however, constantly aware of the fact that if they were to interact with the facade, they would be under the scrutiny of their peers. While acceptable or preferable in some settings and situations (such as the aforementioned video games arcade), this was clearly not so in the case of the ISM convention. This setting in a sense already imposed a certain role upon the visitors, one of being serious businesspeople. In this role, a visitor carries out a certain formal performance, and this performance was at odds with the one proposed by *Gum Facade*.

In the role of the visitor-as-businessperson, the visitor is in a well-accustomed situation in which he has a high degree of control over how to appear in the gaze of others by extension of being aware of how to appear in the mirrors of the mind, in the words of Bentley [1964, p. 150]. The role of visitor-as-gum-facade-performer, on the other hand, is one that implies a high degree of risk of being thrust out of the visitor-as-businessperson role. The installation is explorative, in that it requires users to engage in order to make sense of the interaction, and it is furthermore, in the terminology of Reeves et al. [2005], an expressive one, in that it makes visible and enhances the manipulations of the user in front of spectators. Even though the installation did in fact not overly expose the users or caricature them in any way, visitors evidently shied away from it since they could not anticipate if and how they would be able to control how they would come out as performers in front of their peers.

In the design of *Gum Facade*, we made a number of assumptions about the user-system tension and the spectator experience that were seemingly sound. As for the user-system interaction, a fairly complex technical solution was created in order to recognize visitors' faces and display the live video feed of present user faces real-time on the 3D orbs. This allowed for a user to recognize that he was the one in control of the orbs. Based on the designers' previous experiences of users' preference for self-recognition in playful installations, it was intended to further engage the users in their interaction with the facade. As for the spectator experience, the expressive strategy made sense in that it was the expressed purpose of the installation to attract the attention of visitors passing by the Gumlink stand and draw them in.

In terms of the business visitor performing his perception, it is however evident that these strategies are not the ones best suited for the interaction situation. In this setting, it is untenable to position users in a situation that changes the mode of interaction from unfocused to focused, possibly against the will and intention of users. The intended spectator experience is undermined by the fact that the user is very much aware of how his acceptance of the intended *Gum Facade* performance will alter the way in which he appears in front of his peers. Put simply, a lot of effort went into designing interesting user-system relations and spectator experiences, whereas the design considerations

Fig. 14. TouchMeDare, promotional photo.

of the user's understanding of the performer-operator-spectator trichotomy was lacking.

As an explanation of the failure of the Gum Facade, the imposition of focused interaction in a setting with strict codes for unfocused interaction may seem somewhat banal and common-sensical. In continuation, one may fault the designers for the oversight of these seemingly obvious interaction dynamics. Whereas we concede the ostensible straightforwardness of this line of argument, we have two major incentives for examining it: One, the qualms of engaging in interaction with a public interactive system expand beyond settings with apparent formal codes such as a sales convention. These dynamics are at play in most, if not all, public settings; for example, van Boerdonk et al. [2007] who designed *TouchMeDare* (Figure 14)—a playful, collaborative musical device—reported similar problems of user hesitance and exposure, even when the installation was set up at a music festival brimming with party-going youths. Two, the very straightforwardness of the argument is all the more reason that considerations regarding performing perception should be an integral part of designing public and semi-public interactive systems.

Having analyzed the design shortcomings of the Gum Facade, the pertinent question is now which potential solutions the concept of performing perception offer. We shall examine this by suggesting strategies for rethinking the design approach to the situation rather than by presenting concrete design proposals for the situation, for the latter necessarily implies circumvening the contingencies of a re-design process.

Analyzing the lack of success of the installation by way of the user-system-spectator trichotomy put forth in this article, there is an unresolved conflict between the aspects of (1) the user-system tension (in which design decisions

were made in order to make it obvious for a user that he could in fact interact with the system in a playful manner), (2) the spectator experience (in which design decisions were made in order to catch the attention of the ISM visitors), and (3) the user performing his perception (in which he is implicitly aware that by interacting with the installation he will be putting himself at risk of appearing unprofessional and perhaps even ridiculous in the eyes of potential business partners who are all eager to keep up their professional self-presentation).

Addressing one of these aspects will necessarily affect the two other aspects for as we have argued, they are always already reciprocally intertwined in public or observable interaction situations. Since we propose that the user's perception of the interaction situation is of the essence, a starting point for redesign is to reconsider how we may create an interaction situation in which the user is not thrust out of the already established role of businessperson in the ISM setting. Since the aspects are reciprocal, this starting point is primarily analytical in nature, since the design process is necessarily one of alternations between the whole and the part, between the singular aspect and its relation to the over-all interaction situation.

One strategy for preserving the appearance of the user could be to employ one or more mechanisms of anonymization within the existing installation setup. For example, the link between the user interacting with the gum facade and the imagery on the facade could be made more opaque; the user's face could be removed from the spheres in the 3D space, or it could be manipulated to hinder recognition; the movements of the user could be delayed or otherwise modified, etc. Another strategy could be to change the interaction style to more closely resemble something within the domain of professional business users, or at least something more well known within the professional convention domain. The existing interaction style of the installation relies on movement tracking and resembles the style of a Nintendo Wii or a similar games console—a far cry from connoting serious business. If one were to re-design the installation's interaction style, more traditional methods of mouse-input or a touch screen could prove to be more suitable. Visitors would only be "forced" to employ only their hands and arms, making them less available as targets for other people's judgments. This would, however, also have removed the more experimental and spectacular part of the application which was what Gumlink was interested in exhibiting on their stand. A third strategy would have been to distribute the interaction to multiple users in a way where individual users were smaller "targets" during their interaction. Patterns of movement of multiple visitors and staff within the Gumlink stand could have been tracked using this as input for the display, or every single bypassing visitor could have been tracked, thus making everyone part of the spectacle. Each of these three suggestions for possible redesigns distances the user from being an obvious performer on a stage, because the interaction is moved from being expressive to being magical (cf. Reeves et al. [2005]). One possible drawback is that spectators (i.e., possible users or performers) never realize that they can become performers; that everyone believe the installation is a prerecorded video like most other visuals on a convention stand. In this case the real drawback would be that Gumlink—on a communication level—is transformed from being innovative (which is their

raison d'etre) to being like every other company trying to sell new concepts at the convention. Consequently, a redesign has to preserve or even enhance the spectacular part of the installation while reducing the expositional expression currently dominating the installation's form.

Reviewing the design process in light of the concept of performing perception, *the* major design challenge in this case can thus be construed as the overcoming of this dilemma: Gumlink need an exhibition stand that will stand out, draw in visitors, and signal technological innovation and foresight; at the same time, it is highly problematic to engage visitors due to the socio-cultural codes for behaviour and self-representation.

Regardless of which strategy one applies for rethinking the installation so that it takes the user's performance of perception into account, a rethinking of the interplay between user-system interaction and spectator experience is crucial. The goal of the Gumlink installation was to attract potential customers by providing an experience that would not only be fun for the participant but also be an interesting and alluring experience for the spectator. As Reeves et al. [2005] states, spectators can be enticed into queueing at an installation by the user's performance in several ways, but our experiences with the Gumlink installation and the artworks analyzed earlier on, show that the expressive and suspenseful interaction strategies are particularly performative and have to be thought of as a specific category of performative interaction because they involve a more literal performance of the user. This category is important but also especially difficult, when designing eye-catching installations for noninformal settings as the pressure on the participant performing will be perceived as relatively higher when business relations are at stake. So when it comes to redesigning an installation like the one at the Gumlink stand, it can not be done by only taking into account the terminology offered by Reeves et al. [2005] even though the paper offers a nice framework for determining the spectator's experience. The reason for this is that the concept of performing perception seems to dominate the user's interaction strategy and consequently her actions, and if this performative aspect is not taken into consideration, spectators will have nothing to queue for as there will be no users tempting them.

5. SUMMARY

Our aim in this article has been to establish a background for understanding how and why the user's performing of her own perception is a central facet of aesthetics of interaction. The main contribution of the paper is to articulate and describe how *performing perception* can be used as a term to describe how the user is simultaneously engaged in three actions: the *act of interacting* with the system, thus understanding which possibilities she has and how she can operate the system; the *act of perceiving* the relation between her and the system and her and the surroundings; and finally the *act of performing* where she is a performer for others to observe. These three actions can be mirrored into three roles enacted simultaneously by the user: the *operator* of the system, the *performer* for other people present, and the *spectator* of the action in her immediate surroundings. Through analyses of various examples, we have demonstrated

how this 3-in-1 is always already shaping the user's understanding and perception of her interaction and we have shown how it seems to be staged through her experience of the object's form and expression in the social context in which it is experienced.

The notion of the user as a performer is gaining ground within HCI as understanding and designing for experience oriented uses of technology in public is becoming increasingly popular. However, many prototypes seem to be received differently than the designers expected despite having been very consciously designed for interesting and fun experiences.

The inspirations for the framework presented in this article has come from two disciplines: dramaturgical sociology and performance theory. From sociology, we lean on Goffman's accounts of how social interaction is always situated and how people in the same situation always influence each other's behavior. Most importantly, Goffman's account for focused and unfocused interaction proves to be important when we want to understand how interactions take shape from the social situatedness. Goffman found inspiration for his theories in theatre and performance theory, which in itself proves to be important for the notion of the user's performing of her own perception. Performance and theater theories are further relevant because they deliver basic understanding of how different roles work together. With these accounts in mind, it becomes easier to analyze the situation in which users have to navigate different roles played out as they interact with the system.

Of the examples presented in this article, many are contemporary artworks that—as an important part of the object's form and expression—carefully stage the tensions between looking and being looked at, between contemplating and interacting, and between being a performer and being a spectator.

Based on our theoretical and art-analytical endeavors, we finally analyzed three different cases according to how users engage with interactive systems in public. The analyses were carried out in order to bring the considerations into play, thus demonstrating how the 3-in-1 of user roles—and particularly how performing perception—shapes the user's experience. Having analyzed user roles in physical games and mobile space respectively, we have tentatively addressed the question of how to take these considerations into account when designing. It is not within the scope of this article to propose new design methods, but we end by bringing in suggestions for possible strategies in order to demonstrate operational consequences of designing with the performance of perception in mind.

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