THESIS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

Intertwine and Play: Techniques and Tools for Multi-Scaled Interaction Design

- Experiences from Public Library Space

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Department of Applied IT

CHALMERS UNIVERSITY OF TECHNOLOGY

Gothenburg, Sweden 2013

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ISBN 978-91-7385-824-3

Doktorsavhandlingar vid Chalmers tekniska högskola
Ny serie nr 3505
ISSN 0346-718X

Doctorial programme: Human-Technology-Design
Division: Interaction Design

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Printed by:
Chalmers Reproservice
Gothenburg, Sweden 2013

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Abstract

This dissertation addresses the topic of designing with technology as a design material for public libraries and is positioned within the field of interaction design. The topic has been addressed through a research program in 'multi-scaled interaction design' applied in public library space. Multi-scaled interaction design refers to the design of information technology with a focus on digital and spatial aspects in the public library domain, where projects of different scales are used to inform one another. The core of the program is to have a playful approach to designing with technology, to intertwine technology with existing public library spaces, to have multi-scaled design projects as informants, to emphasize the importance of engaging in physical, digital, social and interactional design spaces, and to commit to designing and informing the design process.

The main focus of the thesis is to investigate *how* an increased involvement of multi-scaled interaction design can contribute to the development of public libraries, *why* it is interesting to allow interaction design into the public library domain, and *which* issues are relevant for interaction design in public libraries. The thesis addresses the following issues:

• The complex process of engaging *users and resources* in the design of new library services and buildings, but also in the exploration of how new technologies impact the role and services of the library, by empirical design experiments.
• The ways in which the *methods* and *materials* of interaction design can play a part in both small-scale and large-scale public library projects, by the Four space model, a toolbox for interspace design and a process toolbox for multi-scaled interaction design.
• The ways in which small-scale design projects can be employed to inform a large-scale design process, by defining a research program for multi-scaled interaction design.

The contribution of this dissertation is two-fold. The empirical part of the contribution is that it lays out a model, and a series of techniques and tools based on findings from the presented design experiments. The more theoretical part is the definition of interaction design in the public library context, and a program for multi-scaled interaction design.

Keywords: interaction design, design methods, multi-scaled interaction design, public library

Acknowledgements

I would like to start by expressing my gratitude toward Chalmers University of Technology for hiring me, toward Chalmers Stiftelse for funding this PhD position, and toward Lars Hallnäs for believing in me. I would like to thank both of my departments, initially the Department for Computer Science and Engineering and later the Department of Applied Information Technology, and especially all my past and present colleagues at the Division of Interaction Design. I would also like to extend my thanks to the research school Human Technology Design, which has provided me with interesting discussions and nice stays.

Most of all, I am deeply grateful for all the time and support I have been given by my supervisor Olof Torgersson and my co-supervisors Johan Redström and Kaj Grønbæk.

For all the good co-operations over the years, big thanks to all the co-authors, here listed in alphabetical order:
Charlotte Axelsson, David Cuartielles, Peter Dalsgaard, Christian Dindler, Lars Hallnäs, Thomas Riisgaard Hansen, Ole Sejer Iversen, Stine Liv Johansen, Lone Kofoed, Peter Gall Krogh, Daniel Lindros, Peter Ljungstrand, Martin Ludvigsen, Sus Lundgren, Andreas Lykke-Olesen, Marie Mattsson, Rune Nielsen, Ruxandra Teodoru, Olof Torgersson and Josef Wideström.

My gratitude also goes to all the students at the Master's Program in Interaction design and Technologies at Chalmers University of Technology for daring to participate in my experiments and for teaching me how to teach.

Thanks to all the past and present colleagues and co-operative partners connected to the Center for Interactive Spaces at Aarhus University, and for reserving a place for me to sit.

I would also like to thank all the visitors, partners and staff at the Aarhus Main Library, especially the library consultants and the project group in Urban Mediaspace Aarhus for inviting me onboard on your exiting journey.

Thanks to Magnus Persson at Enodios for editing the thesis.

Finally, to my family, the Swedish base and the Danish adventure. To Andreas, Alfred and Carl.

List of Appended Papers

Paper 1:
Eva Eriksson; Peter Krogh; Andreas Lykke-Olesen (2007).
Inquiry into Libraries - A Design Approach to Children's Interactive Library. In proceedings of Nordes. Stockholm, Sweden, 2007

Paper 2:
Eva Eriksson; Andreas Lykke-Olesen (2007).
StorySurfer – A Playful Book Browsing Installation for Children's Libraries
In proceedings of IDC'07. ACM, Aalborg, Denmark, 2007.

Paper 3:
Peter Dalsgård, Christian Dindler; Eva Eriksson (2008).
Designing for participation in public knowledge institutions. In Proceedings of NordiCHI 2008. Lund, Sweden. ACM Press, New York.

Paper 4:
Eva Eriksson (2010).
U.F.O.scope! - Families Playing Together at the Public Library. In Proceedings of DIS 2010. Aarhus, Denmark ACM press, New York.

Paper 5:
Eva Eriksson, Stine Liv Johansen. (2013)
Playful Technology - Design of Children's Library Services. Accepted for publication at 10th European Academy of Design Conference: Crafting the future, Gothenburg, Sweden, April, 2013.

Paper 6:
Peter Dalsgaard, Eva Eriksson (2013)
Large-Scale participation: A case study of a Participatory Approach to Developing a New Public Library. Accepted for publication at ACM CHI, Paris, 2013.

Distribution of Work

Paper 1:
The paper was authored with equal responsibility between all three co-authors. Participated in the planning, observations, interviews, workshops, visualisations, analysis and in the development of concepts. Performed the literature study.

Paper 2:
The paper was authored with equal responsibility between the two co-authors. Participated in the planning, observations, interviews, workshops, visualisations, prototype construction, analysis, video editing, testing and in the development of concepts. Performed the literature study, and classified and sorted the library database in order to create keywords.

Paper 3:
The paper was authored with equal responsibility between all three co-authors. Responsible for the library cases, and participated in the design considerations and the overall analysis.

Paper 4:
The paper was authored with full responsibility. Participated in the planning, observations, interviews, workshops, visualisations, prototype construction, analysis, data gathering, and in the development of concepts. Responsible for testing of prototype.

Paper 5:
The paper was authored with equal responsibility between the two co-authors. Responsible for the design explorations, and design principles.

Paper 6:
The paper was authored with equal responsibility between the two co-authors. Participated in interviews, explorations, analysis and design considerations. Responsible for the empirical work.

Complete List of Publications

Full Journal Papers:

Eriksson E., Hansen T.R., Lykke-Olesen A. (2006)
Movement-Based Interaction in Camera Spaces – A Conceptual Framework
In the Journal of Personal and Ubiquitous Computing.2006.

Full Conference Papers:

Eriksson E., Wideström J. (forthcoming)
Staging the Interaction – Six methods to Engage Citizens in the Development of Public Knowledge Institutions. Manuscript submitted to NORDES 2013.

Dalsgaard P., Eriksson E. (2013)
Large-Scale participation: A case study of a Participatory Approach to Developing a New Public Library. Accepted for publication at ACM CHI, Paris, 2013.

Eriksson, E., Liv Johansen S. (2013)
Playful Technology - Design of Children's Library Services. Accepted for publication at 10th European Academy of Design Conference: Crafting the future, Gothenburg, Sweden, April, 2013.

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In 'Legende familier i biblioteket – Inspirationskatalog', Borgerservice og Biblioteker, Aarhus, 2011.
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Workshop proposal:
Eriksson E, Torgersson O. (2013)
'Show me yours and I'll show you mine' – Teaching design for children and elderly. Accepted at DHRS Cumulus The 2nd International Conference for Design Education Researchers, Oslo, 2013.

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Eriksson, E. (2005)
Exploring the Aesthetics in Mixed Interaction Spaces. In workshop web-proceedings of "Aesthetics as Critical Computing", "Approaches to Movement-based Interaction", under The Fourth Decennial Aarhus Conference Critical Computing, Aarhus, Denmark, 2005. Located at: http://www.daimi.au.dk/~pkrogh/Aesthetics/

Video:

Hansen, TR, Eriksson, E, Lykke-Olesen, A. (2005)
Mixed Interaction Space. In: Video Proceedings of The Seventh International Conference on Ubiquitous Computing, Tokyo, Japan, Sept.

Award:
Best presentation award at Nordes 2007: P. Krogh presented the paper "Inquiry into Libraries - a design approach to children's interactive library" (co-authored with A. Lykke-Olesen and E. Eriksson) at the Nordic Design Research Conference in Stockholm. The motivation for the "Best paper presentation" award said: "not only was the presentation without exception the best, but behind it was also one of the best conference papers."

Exhibitions:
Springflow and Beatwear, Exhibited at Universeum (Natural Science Discovery Centre), Göteborg, 15-22 May 2002 in the exhibition 'Interactive Futures'.
Team Springflow: Axelsson, C., Eriksson, E., Lindros, D., and Mattsson, M.
Team Beatwear: Eriksson, E., Lindros, D

Springflow. Exhibited 19-24 October in 'Aesthetic artefacts' at NordiCHI 2002, Århus. Team: Axelsson, C., Eriksson, E., Lindros, D., and Mattsson, M

Part 1 – Dissertation Overview

Table of Contents

1. Introduction

In participatory design and user-centered design, there is a long tradition of placing the user at the center of the design process, and use is always present in the mind of the interaction designer. According to architect Alexander, the most difficult aspect of large public buildings is that the design and the building process really has to be remarkable and that the users and the users' needs must constitute the core of the building (Alexander, p.120, 2005). By centering the design process on the user and the use, the process has the opportunity to become more complicated, at all scales. The cases described in this thesis vary in scale, although the Urban Mediaspace Aarhus project, UMS (Aarhus Municipality, 2012), concerns the development of a large public library building and its remarkable design process aimed to involve all users. Traditionally, neither users nor interaction designers are involved in projects of this scale, although voices have been raised by different design researchers and practitioners e.g. Shapiro (2005), Mazé and Redström (2008), Sanders (2010) and Alexander (2005) for these groups to be allowed to participate. Smaller-sized design projects, e.g. the two projects presented in this thesis, "Families at Play in the Library" (2010) and the "Interactive Children's Library" (2007), have benefited greatly from involving users, use and interaction designers in the public library domain. Why not employ this strategy for projects of a much larger scale in the same domain?

This thesis aims to investigate how an increased involvement of interaction design can contribute to the development of public libraries. The key issues addressed here are:

- *how to engage users and resources in the design of new public library services and buildings,*
- *how new technology impacts the role and services of the library,*
- *which of the methods and materials of interaction design can play a role in both small-scale and large-scale public library projects,*
- *how small-scale design projects can be employed to inform a large-scale design process*.

The contribution of the dissertation is two-fold, overarching theoretical design program as well as more concrete techniques and tools for designing interspaces. The thesis defines Multi-scaled interaction, which is explored through a design program based on experiments and inquiries. The

toolbox for interspace design in public libraries concern how to move from individual design to social design, from closed and regulated systems to extendable, evolving and open systems, and from disjointed to intertwined systems. The Four space model has been developed, where four different spaces have been identified in order to design interspaces. Further, a process toolbox for multi-scaled interaction design deals with how to align different paradigms of practice and inquiry and how to capture and anchor insights from design activities. The tools and practical explorations can be used as inspirations and guides for other designers in this domain.

The dissertation is structured in seven main sections. First, a short introduction to the thesis, followed by background information on the public library domain, interaction design, and field of inspiration. Then, interaction design in space, scale and context is presented. This is followed by a section describing the general research approach. The next section presents the cases, both cases regarding methodology and design experiments. This is followed by materializations, consisting of a toolbox for interspace design in public libraries, a process toolbox for multi-scaled interaction design, and the final section is a discussion on the research questions. Lastly, the appended papers are presented.

Research Outline

The word "design" can be both a verb and a noun. In this thesis, both notions will be used, although in most cases it will refer to activities and processes rather than objects and values. Shifting focus to prototype development, the methods and processes are presented in order to make the design process visible to others, allowing them to repeat and to be inspired by methods and processes. The design experiments consist of the presented prototypes and concepts and the reflections are to be seen as the design choices, papers and writing of this thesis. The papers are highly communicative and would not be re-usable if they did not contain descriptions of the practices used when conducting the experiments.

	Prototype	**Process**	**Theory**	**Reflection**
P1 Child. Lib.		X		X
P2 Storysurfer	X			X
P3 Knowledge			X	X
P4 UFO	X			X
P5 Playful		X	X	X
P6 LargeScale			X	X

Table 1.1 Table describing the focus of the appended papers

In Table 1.1 the different focus of the six appended papers are presented. They are all results of a reflection process, and they are also all based on empirical work where design has been used as a

mean to inquire into the context in focus. The work is based on experiences from design interventions, though paper 3 and 4 are more focused on describing prototypes. Paper 1 and 5 are more focused on describing the method and process behind a project, and are more descriptive in character. Paper 3, 5 and 6 are more focused on building theory from empirical testing into a higher and more generalizable level of knowledge. The papers are chosen as they complement each other regarding prototype, process and theory in the context of interaction design and public libraries. In order to better understand the theory, the prototypes and the process are presented as well.

The basic method used throughout the thesis is experimental design research, where prototypes at different stages in the design process along with reflections on the process and design methods lay the foundation for decisions regarding the direction of the next stage of the research. The intention has been to formulate a design program, analyze it, take action by performing experiments, reflect on the results, and then re-formulate the program. The experimental design research process unfolds over time as program and experiments influence, challenge and transform each other (Redström, 2010). The goal is to develop materializations presenting ways in which an increased involvement of interaction design may contribute to the development of public libraries, materializations that comprise theoretical elements informed by practice and analysis. This thesis includes practical design work in the development of interactive systems and the theoretical understanding of IT as a design material.

Research through design experiments is based on many different types of methods and these methods are changed and modified depending on situation and context. The researcher is in dialog with the situation, material and context (Schön, 1983), which makes the choices of design methods an essential part of the result. In this thesis, the appended papers span over prototypes, design methods, and reflections, all considered equally important in the practice-based design research process, and are included to present the reader with better understanding, deeper insight, inspiration, and means to act. Consequently, the artifacts described here are only to be considered part of the results, which are complemented by reflections, methods, research programs, and materializations.

The experiments performed in this dissertation are colored by the constellations of people and stakeholders involved in the different projects, but also by the materials at hand. In the experiments, the design space is spanned not only by the design examples but also by the methods and techniques developed within the experiment. The work and papers presented in this dissertation are written in different research contexts, over a long period of time, and with a variety of theoretical references. Furthermore, the interdisciplinary research field of interaction design in itself draws on a variety of vocabularies. To amend this situation, the introduction provides a description of the main concepts used here.

My contribution in the different projects has been in all phases of the process. I have been doing preliminary literature studies in order to explore the problem space and related work. I have been

active out in the field, planning and performing different types of ethnographic methods, including defining new methods for data gathering such as Mission from mars (Dindler et al, 2005), Bthere (Eriksson et al, 2006) and Four Space model (Eriksson, 2011). I have been planning and leading workshops, and been active in planning, designing, building and testing prototypes. In prototypes, my focus has mostly been with the physical materials and technologies, as well as the data and databases. Regarding reflection and dissemination, I have been a strong driving force in all papers.

Design Program

With design programs for interaction design research, it is here referred to a program that can guide and develop practice by exploring new design spaces (Redström & Hallnäs, 2006) and as a lens that enlarge some aspects and hide others (Binder & Redström, 2006). On a general level, the design program is a description of the design intention, where a position regarding the approach is stated (Redström & Hallnäs, 2006).

The definition of the design program Intertwine and Play! – Multi-Scaled Interaction Design is presented below. The design program has been the implicit base for the design experiments and they have, in turn, explicitly formed the foundation of the development of the design program. The concrete design experiments are presented briefly in chapter 5 and are further described in the different papers, while the materializations based on the program is presented in chapter 6. The goal of the program does not involve coming up with solutions or potential products, but instead aims to open up the design space, question the present situation, and find alternatives to established practices. By performing a series of experiments, it is possible to illustrate the richness and diversity offered by the design program and also opens up a design space for future development and innovation (Redström, 2011). The alternative design examples consist of prototypes, concepts and methods.

Intertwine and Play! – Multi-Scaled Interaction Design

Multi-scaled interaction design refers to the design of information technology with a focus on digital and spatial aspects in the public library domain, where projects of different scales are used to inform one another. With scale it is not only referred to the spatial scales ranging from small devices to large buildings, but also to the variation of potential users, and temporal scales of how use unfolds over time. Multi-scale interaction design is a program for experimental design research and concerns the type of dual design that computational technology introduces: the execution of programs and its manifestation in a physical material. Designing with computational technology as a design material involves components of spatiality where the digital, interactional, social and physical aspects of computational technology are central issues. This motivates experimental work

where special attention is paid to spatiality as a basic design parameter in projects of different scales, rather than design for efficient use which focuses on digital aspects and individual users.

Multi-scaled interaction design supports communication through computational technology where the interaction is based on movements in physical space. Through explorations of the physical, digital, social, and interactional space, the program aims to take advantage of the potential of the material. Multi-scaled interaction design is a design research program that inquiries into issues of different scales regarding design practices, development and everyday life at the public library. Through design interventions that criticize certain situations and introduce alternatives for those situations, the aim of multi-scaled interaction design is to influence the practice of designing with technology as a design material by investigating the context of and interactions in the public library space. The design interventions and the design methods together become a platform for exposing existing and hidden habits, norms and materials, as well as for proposing alternative actions and views in different scales. The examples are developed through practical experimentation and guided by the design program.

To use that which already exists in the context of public libraries such as materials, values, traditions, norms, expectations, problems, behaviors, organization, genius loci, and technology and to intertwine them with a playful interaction design approach is an essential and a vital part of the design program. Also, intertwining materials, competences and research fields is one part of interaction design and here this is done with a focus on intertwining the physical, interactional, social and digital materials and opportunities in the library space, as well as intertwining the results from various projects with other projects, regardless of scale. The program further acknowledges play as a basic design parameter in the context of public libraries: playing with design, using play in designs and in designing itself.

2. Setting the Stage

In this chapter, the stage is set by introducing the background of different important elements for this dissertation. First, relevant aspects of the public library domain are shortly introduced. Next, the field of interaction design is described, and finally some fields of inspiration are presented in brief.

The Public Library

The public library is a public institution, funded by public means, e.g. municipal tax. Public libraries are freely accessible to the public regardless of gender, social status, ethnicity, or age and exist to serve the general public. The public library differs from the school library and the university library in that it should provide the general public with basic services for free. The public library houses all types of printed materials, such as books and journals, as well as music, film, games and other kinds of media in both physical and digital form. Moreover, libraries have been significant not only as institutions supporting literacy and education and disseminators of knowledge and information, but also as places for public engagement, which is why the presence of physical public libraries has been an important factor in society. Furthermore, children's libraries are the oldest cultural institutions for children, having been key players in the development in children's culture for over a hundred years (BS, 2008). The public library enjoys a high level of trust with the general public and nearly 90% of all Americans believe it to be as valuable as or more valuable than other tax-supported public services (Jaeger et al., 2011).

The public library is balancing on the threshold between the public space and the semi-public space. Public libraries are different from public spaces such as open parks and city squares in that they have restrictions on opening hours and the use of materials, but also in that someone has an agenda for them. Traditionally, public libraries are information providers and repositories for materials and are systematic, democratic and free; the modern library, however, also wishes to be interactive, social and partly self-organizing. It is only natural that the different public libraries, even the different departments within the libraries, set up different aims for their libraries, e.g. for the public library to be more like the city squares of medieval villages in Italy, i.e. to act as a livingroom for the general public, or for a university library to focus on study groups and silence. Different behavior is connected to different zones in the public library, e.g. kids playing loudly is

looked down upon or even forbidden in the reading room, whereas their behavior is fully acceptable in the children's department.

It may be difficult to create your own place in public libraries or use it in your own way. This tendency is also partly supported by the development of new technology, e.g. by pushing information, providing wireless network, increasing surveillance, or giving directions for people to find their way around the library. Increased use of private mobile devices as well as technology provided by the library, divides the public library into small bubbles of private spheres. Large displays push information and display advertisements for events for visitors to consume, consciously and unconsciously. The trend today is that more and more surveillance is applied to public spaces, including libraries and safe environments are definitely considered preferable, although there ought to be a balance between freedom of expression and control. Any part of public libraries can be misused and introducing new technologies will perhaps influence the extent of the misuse. However, as new systems are developed and introduced in public libraries, there will be some degree of self-organization that will prevent the content from causing offense to the majority of the public. Many types of activities in public libraries upset or provoke one or several individuals, such as open lectures on religion, loud music, play activities, etc., although these activities also contribute to a lively and inspiring environment, still regulated but partly out of control. To increase the connection between the public library and its users, the ground for place-making should be established (Harrison & Dourish 1996) as should belief in self-organizing behavior. The goal is to create designs that encourage and support social interaction in public libraries without dictating any terms of use, which will instead follow the genius loci of the place.

The public library is faced with many challenges, both regarding identity and, not least, materials. It is more and more often being transformed from a traditional repository for books into a media space where many different types of citizen services and cultural events take place. As more and more publications are digitalized and an increasing number of people are able to access and perform traditional library services online from their home computers, public libraries are challenged both physically and digitally. This development even questions the building that houses the library. The public library has a long history and is unique in that it is open to all, free of charge. This is also a place where people go to find assistance regarding different forms of services, such as municipal services and citizen services; it is a place where people hang out or learn to use new technology, e.g. computer aid courses for the elderly, as well as play games on popular game consoles. It is a place where people from different cultural and economic backgrounds meet, across age and gender. It is a unique public place and also one of the most visited public institutions.

In a sense, the public library and its visions about its own future identity may be said to pose a threat to itself. The leader behind the development of the new library in Birmingham states that they are not building a library for the city, but are rather building the city (Next Library, 2012). In an ever-changing cultural and media society, the library puts its identity at risk when taking this position while at the same time entertaining a wish to offer experiences such as those offered by

e.g. science centers. According to certain research on libraries, the objective of the public library becomes to support Experience, Involvement, Empowerment and Innovation (Jochumsen et al., 2010). Supporting experience and involvement is about supporting the perception of the individual, i.e. his/her quest for meaning and identity in a complex society. The last two objectives underpin societal goals to a greater extent: Empowerment has to do with the development of strong and independent citizens who are able to solve everyday problems, while innovation has to do with finding new answers to practical problems or developing completely new concepts, methods or artistic expressions. Also, one of the major future challenges will be to open up for activities that can inspire to creativity and innovation and the task is to make all four objectives interact by incorporating them in the architecture, design, services, programs and choice of partnerships of the library (Jochumsen et al., 2010). I would add technology to this list and as media and technologies change rapidly, it is necessary to look ahead and create flexible structures that can support visitors and staff at the library in the long run. Physical classification systems should e.g. be combined with digital search habits, supporting personalized recommendations and collaborative filtering, new searching systems for children, community informed services, to mention a few of the ideas which have been raised previously. One main question designers working with public libraries have to deal with is how we create environments that promote ownership, innovation, relaxation, openness and capacity building – and provide the users with an experience that makes it worthwhile for them to visit the library?

Today, there is a greater awareness of and acceptance for noisy elements, such as playing games and hanging out for social reasons is considered an important element of what a public library ought to offer its users. However, little has been done in order to explore and intertwine the existing physical information materials with digital technology in new ways, while at the same time emphasizing the social qualities of being co-located, which promotes the sharing of views and ideas. The library should support explorations across materials, media and genres and mediation and communication of these materials should be based on participation and exiting physical and digital frames (Dalsgaard Dindler & Eriksson 2008, BS 2008). Extensive research has been performed on various digital services for libraries, e.g. web sites, search engines, sociable web-based chat rooms connected to the library web site, and digital comments on books; services and development supporting future visions of the library as digital, virtual and distributed (Mackenzie, 1998; Kaplan et al., 2004; Reuter & Druin, 2004; TPDL, 2012; JCDL, 2012).

On the other hand, research reveals that children desire physical spaces in the libraries which are meant for them, spaces supporting them in living out their social life among friends and peers (McIntyre, 2002), and that they wish to hold on to the libraries (Meyer, 1999). Although Kaplan et al. (2004) present findings from studies on digital libraries, some of them are directly valid also for physical libraries. For instance, children will not use libraries that are uninviting or do not support their search and retrieval strategies. In order for the users to familiarize themselves with the services and the many facets of the library, initiatives such as web-based services have been introduced such as e.g. forums for Q&A, chat, reviewing, and recommending material. One

example of this is Palles Gavebod (Palle's Gift Shop, 2012), a common web-based platform for all Danish Children's Libraries. Here, children can search the databases of all libraries in the country and are able to share tips and links with others. The site also provides information on activities and entertainment such as games and YouTube links. Another approach is the Library 2.0 initiative around the globe, which gives library users a participatory role in the services offered by the libraries (Casey & Savastinuk, 2006).

Mixing Media in Public Libraries

Digital resources in public libraries are growing rapidly. Still, public libraries are a fairly new domain for pervasive computing installations: there are only few examples reaching beyond the desktop computer. One early example is iFloor, developed in a one-year Danish research project called The Hybrid Library. The vision of the project was to create aesthetic and engaging Augmented Reality Environments and spaces in the library of the future. In contrast to pure web-based services such as Library 2.0, iFloor is a project focusing on the social and physical aspects of the library. iFloor is an interactive Q&A floor that supports and stimulates community participation and interaction between co-located people at a municipality library through shared interaction (Krogh et al., 2004). Questions and answers are sent through sms-messages and visualized on the floor. The digital cursor used to enlarge messages is navigated by several people co-operating by positioning themselves on the floor.

One of the categories of pervasive computing projects developed through research support the search for physical material in the public library and visualize it digitally. One example of this is SearchLight, which uses a steerable camera scanning AR toolkit or RFID to locate a book on the shelf or elsewhere in the library (Butz et al., 2004). Another example is ARLib, which aims to aid the user in searching for a book and in returning a book to the right shelf through an augmented library environment and a head-mounted display (Reitmayr & Schmalstieg, 2003). In AudioIndex, the materials of the library are instead presented through audio. It allows visually impaired users to point at objects in the library environment through a mobile system based on RFID, supplying audio feedback about the nature of the book, the author, the title, and a summary of its contents (Fällman et al., 2007).

A category of projects in which physical and digital materials are mixed strives to make the digital material act as the same way the physical book does. An example of this is Turning the pages from British Library, which created digital three-dimensional versions of precious items in order for people to be able to interact with them and look through entire manuscripts, as opposed to the precious manuscript being open only at one page when viewed in a display case (British Library, 2012). Librovision is another example: a gesture controlled virtual book (Hörtner et al., 2003). In Tangible Books, this is taken one step further and into the physical world through a tangible interface for virtual libraries using physical books in real space to interact with digital books in the

virtual space, using RFID sensors, cameras and OCR technology to realize a smart interactive workspace for library users (Beck & Schrader, 2006).

Ramasjang is an example of a project where more traditional media meets the traditional public library, thereby providing new meeting places physically as well as virtually. Ramasjang is a full day children's television channel and website provided by the Danish Broadcasting Cooperation (DR). In 2010, a live half hour show called Ramasjang Live was broadcasted daily from the children's library in the city of Aalborg in Denmark. From 2011, the show continues on the road, where a Ramasjang bus visits libraries all over the country. Ramasjang Live attracts a large audience every day, both meeting up physically and watching the show on TV.

Another approach is to foster the library as a place for creativity and not just to change ideas, but to actually make them come alive. At the Westport public library in Connecticut, a new "Makerspace" has just opened, where people are able to attend participatory workshops and come and use different prototyping tools for free, such as e.g. 3D-printers (Enis, 2012). In the Edge, a digital culture center prototype from the state library in Queensland, Australia, new engagement spaces for libraries are explored (Foth et al., 2012). Here, the need for de-institutionalized, publicly accessible learning environments with a focus on digital technology and a social-cultural environment that embraces participation, collaboration, peer-to-peer learning, teaching and sharing of information, knowledge, and do-it-yourself skills is acknowledged. The traditional values of the public library are intact, although without books and archives and more as a place for collaboration. The center is open to all, but is designed for young people who are creative in digital technology and arts. The preliminary results show that visitors lack a perceived "sense of place" and that they have a weak sense of what the Edge is and what it provides. A lot of resources have been invested in the physical architecture, interior design and infrastructure, but it still remains a challenge for the Edge to shape the socio-cultural space envisioned by the architects. A proposed design intervention in order to change this is an ambient information system that aims to facilitate shared encounters and a better sense of co-located visitors currently at the Edge (Bilandzic et al., 2011). The system enables visitors to virtually "check-in" at the Edge and as the digital footprints that the visitors leave there are being stored, the system will display a visual patchwork of aggregated information, so that new visitors entering the Edge may have a glimpse of the profiles and knowledge of other visitors who are there or who have recently been there. This work is interesting because it recognizes the significance and importance of studying the interplay between people's spatial practice and the embodiment and ubiquitous integration of computing devices in everyday environments.

In 2017, the new Deichmanske Main Public Library will open in Oslo, Norway (Deichman, 2012). Here, one guiding approach is to raise the focus of how valuable the library is through new types of services. Participatory design and user involvement have been used to understand the user experience and the results play an important role in the building process. A workshop with all the employees at the main public library aimed to come up with new ideas and concepts (Deichman,

2012). The outcome was about 200 ideas and four prototypes. The first concept was a web service based on tags to visualize Deichman in the city and the city in the Deichman collection. The second concept was prototyping of the roles of the employees, both regarding services and alterations to the interior design. The third concept was a new type of social user profile web service, were the user may be recommended happenings, books and music based on his/her previous lending history. The fourth concept concerns active shelves, where digital information from different sources concerning a certain book is presented next to it. What was common for all prototypes was that they were tested by very few people and for a short period of time. However, they have provided some important lessons concerning e.g. the importance of involving the employees in the project tasks, as it provides the project with more ownership and meaning. It also pointed out that the physical collections and the room forms the base, but that it is important to make use of the digital tools and materials in different ways and to a greater extent than today. Finally, it showed that it is important to visualize the different competences of the employees, both internally and externally, to communicate that change is coming and to see that they have been prepared to cope with that change. The design activities performed in the Deichman Library focus on services, while a wider focus is missing, e.g. having the outcome inform the design process and the actual layout of the building and not just the services as such.

In Aarhus in Denmark, the main public library has long needed more modern housing than the 1930's building in which it currently resides. After several years of political discussions, both funding and site was decided on and an architectural competition was set out. During this process, a longer discussion took place concerning what this new library would be used for and how, what needs will exist and what materials will be available in ten to fifteen years' time and so on. So far, the architectural competition is set and the first stone has been put in place for the new building, which will be completed by the beginning of 2015. The project, named the Urban Mediaspace Aarhus, the UMS, is supposed to belong to the people of the city and to become a place for experiences, production and recreation. In order to reach these goals, a long and remarkable process has been initiated at several levels and at different scales. In this thesis, three different smaller projects related to the UMS will be presented as examples of how different types of methods, materials and experiments are able to inform the large-scale process on developing the future public library and its many services.

Staging Interaction Design

In most of the work I have taken part in, there has been a great influence from architecture due to the constellation of the design team and the working environment. This has also come to affect my definition of what interaction design is. Based on that architecture is understood as organizing social relations by means of spatial layout (Eriksson, Krogh, Lykke-Olesen, 2007), I would say that *interaction design is about organizing (intentions for) social relations and interactions by means of spatial and digital layout. It is about constructing interspaces, a context within which communication and experience takes place.* The term interspace, once defined by Winograd (1997) as a construction in which people live their lives rather than an interface with which they interact, fits the work presented in this thesis well. In order to stage my concept of interaction design in relation to the field, however, some background is needed.

Background to Interaction Design

When computers started to become ubiquitous and used for leisure, play and work, new methods and objectives were needed and the field of interaction design emerged, based on among other fields Human-Computer Interaction, HCI, and Ubiquitous computing.

> *Human-computer interaction is by necessity a field with interdisciplinary concerns, since its essence is interaction that includes people and machines, virtual worlds and computer networks, and a diverse array of objects and behaviors. In the midst of this interdisciplinary collision, we can see the beginning of a new profession, which might be called "interaction design". While drawing from many of the older disciplines, it has a distinct set of concerns and methods. It draws on elements of graphic design, information design, and concepts of human-computer interaction as a basis for designing interaction with (and habitation within) computer-based systems.* (Winograd, 1997)

HCI developed when computers became common in working environments and is an attempt at changing the engineering design approach of "getting the job done" into "getting the job done with respect to its users". The development of HCI has been highly influenced by engineering and cognitive psychology applying cognitive and physical ergonomics to systems development. Ubiquitous computing is basically about moving HCI from the virtual world of the desktop into the physical real world, acknowledging that computers convey physical expressions in addition to information, extending the design space, which enables new forms of interaction and incorporates the whole body and the context around us. This field also has several other names, e.g. physical computing (O'Sullivan & Igoe, 2004) or pervasive computing (IBM, 1996), but the term ubiquitous computing, coined by Mark Weiser, will be used here, as Weiser can be considered the father of this field. Ubiquitous computing can briefly be described by the two words ubiquity and seamlessness (Weiser, 1991). Ubiquity means that each user will have several computers of varying sizes, each designed for its purpose or task and all of them connected wirelessly. Seamlessness means that the

technology is incorporated into our everyday working environment, living environment, and play environment, so that its presence is transparent and reduces the intrusion it presents into the environment or our activities. Ubiquitous computing acknowledges that people interact socially and is the opposite of virtual reality and desktop computing: instead of placing people inside a computer-generated world, the technology comes to life in a real context with people.

There are many definitions of interaction design, but there are two which have inspired me the most. "*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). Furthermore, Hallnäs & Redström (2006, p. 23) state that: "*Interaction design is design of the acts that define intended use of things*". The definition by Buchanan is interesting as it points to the human perspective and beyond the designed object itself, whereas the definition by Hallnäs & Redström is interesting as it highlights the interaction potentials made possible through design, not only through actual use.

The (leading) text book example state: "*By interaction design we mean designing interactive products to support people in their everyday and working lives. In particular, it is about creating user experiences that enhance and extend the way people work, communicate and interact*" (Preece et al., 2002, p. 6). In this example, there is still a strong influence of HCI as it points to "support" people and "work". Interaction design is not only about supporting people: it is just as much about e.g. taking a critical stance and making people reflect through interaction. "Work" is of course included in interaction design, but to reflect the breadth of the field it should be weighed with more leisure based alternatives and other intentions. As Gillian Crampton Smith, who founded the world's first MA program in interaction design in 1990 at the Royal College of Art, stated: "*it's about shaping our everyday life through digital artefacts – for work, for play, and for entertainment*" (Moggridge 2007, p. xi). This definition broadens the field and the work based focus.

An aspect shared by both ubiquitous computing and interaction design is that they are not to be designed in the Henry Ford model for design: you can have it in any color you want as long as it is black (Buxton, 1996). This means that design for computing does not have to maintain uniformity with the traditional computer form, i.e. consisting of mouse, keyboard, display and WIMP interfaces. Traditional HCI made a great contribution to interface design by introducing the user-friendly paradigm and opening up a new field of research. Later, with the growing field of interaction design, this paradigm became a prison (Mead & Pacione, 1996). Interaction design should not only aim to make the interface as recognizable as possible, but rather to challenge the interface givens and support the ability of a user to synthesize new experiences and evolve by using past experience. "As technology matures we become more and more concerned about meaningful design, which refers not only to usability in the sense of cognitive ergonomics, but also to aesthetical issues" (Hallnäs &Redström, 2006, p. 22).

Interaction design has strong roots in HCI and also among other fields of research such as design, graphic and industrial design, engineering, architecture, etc. While HCI has traditionally been oriented towards task completion (Winograd, 1997), interaction design has a focus on ongoing activities and the experience of interacting with the system (Preece et al., 2002), as a form of design practice (Hallnäs & Redström, 2006). In HCI, there is a strong focus on empirical usability studies where design is seen as a mere derivative of analysis. However, the problem of turning analysis into design remains in HCI. According to Löwgren, there is a distinction between engineering design and creative design (Löwgren, 1995). Here, engineering is construed as problem solving in a linear way, which displays many similarities with research within HCI. In contrast, creative design, the category of design into which interaction design falls, develops its understanding of the problem in parallel to the solution and makes the designer play a personal role in the process. Interaction design investigates some focuses by interventions with prototypes and design is used as a tool for gaining insights. In HCI, where the leading design process is theory grounding, fieldwork data, user testing and evaluations, there is a strong focus on usability studies, while interaction design instead investigates how to turn the analysis into design. Fällmans asks, where design is in HCI (Fällman 2003) and Wolf states that design is the black box art of HCI (Wolf, 2006), defending that creative design and design rigor is as critical as scientific rigor. In interaction design, experimental design is more common practice and the research questions rise from design practice.

An interaction designer designs what Winograd (1997) dubbed interspaces, assemblages of interfaces, actors and environments. The challenge of interaction design is to design spaces for human communication and interaction. To indicate both the skills of the interaction designer as well as the interdisciplinary nature of the interaction design field, Gillian Crampton Smith stated: "We must collaborate with those who have other skills and experience. An interaction design can never be a hermit" (Moggridge, 2007). Fällman argues further that: "The interaction designer has to be able to deal with user experience - including physical, sensual, cognitive, emotional, and aesthetical issues; the relationship between form, function, and content; as well as fuzzy concepts such as fun and playability" (Fällman 2008). Further, seeing the users is not enough: the interaction designer must see the bigger picture, must see the lives of the users. "Successful interaction design requires a shift from seeing the machinery to seeing the lives of the people using it" (Winograd, 1997). The shift from the traditional approach of engineering to that of interaction design includes, among other things, a shift from viewing technology as the center of interest, i.e. technology-driven development, to a view in line with e.g. the Scandinavian tradition of participatory design (Ehn & Kyng 1992), in which the user is acknowledged as an expert in his own work-practice and invited into the actual design process.

However, the user is quite tricky in design or even fuzzy, as described by Lykke-Olesen (2007). Hallnäs & Redström discuss the intended user, how the user is intended to be, interact and live both during design and after design interventions and open up for the possibility that it may be impossible to predict how the user is going to use the system (Hallnäs & Redström 2006). The user

is the designer's interpretation and definition of the user: the empirical user, the user as defined by design, and the actual user. During the design process, the designer goes back and forth between these three types of users and the user will perhaps even disappear in this process, leaving only the intended user, the design, and the intended use of things. Still, the user and, especially, the use will always be central to consider in interaction design, although it is important for the designer to be aware that the user is an interpretation made by the designer, the design process, and the design.

Inspiration

The work in this dissertation is inspired by *design thinking*, which constitutes design in a broader context, such as e.g. service design and architecture (Cross 2007; Stolterman, 2008). Fällman suggests that the core of interaction design "can be found in an orientation towards shaping digital artifacts - products, services, and spaces - with particular attention paid to the qualities of the user experience" (Fällman, 2008, p. 4). Some inspiration to shape digital artifacts from related fields will be presented in this chapter, while design in a broader context will be further discussed in chapter 4, which presents the research approach.

Architecture

Architecture concerns the organization of activities and social relations by means of spatial layout and is a relevant source of inspiration for interaction designers (Eriksson et al. 2007). The primary interaction design material is IT, but when designing spatial interfaces, physical materials come into play and designers should understand how the properties of IT relate to spatial properties and boundaries. The combination of architecture and interaction design may help to open up the traditional understanding of space when it becomes a dynamic set of potential functionalities that are open to augmentation.

A concrete way of seeking inspiration from architecture in the interaction design process is to work with various spatial design representations throughout the design process. Architectural models are an embodiment of the design process, where alternative designs and design decisions are represented in different forms. Prototypes in interaction design traditionally demonstrate and explore interaction with a focus on functionality, whereas models in architecture often serve to provide visual overviews and understanding of the entire space in which spatial forms and users will co-exist. Architecturally inspired design representations can take on a number of forms, e.g. virtual and physical models, paper sketches, statistically informed renderings of user behavior, graphics, etc., and may capture and represent structural aspects as well as aesthetic and affective ones. Architectural design representations may expand the functional focus of traditional prototypes and support communication, exploration and understanding.

Architects imagine alternative futures by models based on political and economic strategies, they calculate, describe and represent, but when realizing projects they are dependent on the variety of experts from many different fields who are involved in the building process. This means that they do not have direct contact with their material, although they still command a great amount of knowledge about construction effects and qualities of different materials. Interaction designers are also often dependent on co-operations with many different kinds of professionals to access competencies to enable them to realize their projects, but still have the possibility to have firsthand experience with the basic material, IT. Interaction designers have the opportunity to

make changes later in the development process to greater extent than architects do, who constantly have to work and push for decisions to be made in order to be able to continue the building process. Once the concrete is molded, it is much more difficult and often impossible to make changes to the design, although use will continue to change. Architecture both accommodates and affects certain behavior, use and ritual, but use also shapes architecture.

Architecture is the design of objects and relations in space and time, as objects of all sizes are related, and that there is life between buildings and objects, and that meaning is created in use. Architectural objects evolve over time as they have no fixed meaning and, thus, are open for reinterpretation, characterization, personalization and remaking by people, time and surroundings. Use and misuse reprogram found space with new functions and meanings (Mazé, 2007) such as e.g. when churches are turned into nightclubs. In architecture, focus is placed on atoms, in computation focus is placed on bits, and although they are profoundly different, they must be made to work together in interaction design.

Service design

Homlid (2007) argues that while interaction design focuses on the design of the interactive artifact, service design focuses on the services provided by the interactive artifact. I would rather argue that the design of the service is just as much a part of the interactive artifact as the artifact itself and cannot be separated into different sub-disciplines. However, service design is an important source of inspiration to interaction design as it opens up for the equal importance of designing both artifact and service. This relates to the discussion about scale in design, as the object of design is not a self-contained artifact, but is made up of and is bound up with a more complex set of relations or even ecologies (Maze & Redström, 2008). Forlizzi describes service design as a sub-discipline to interaction design and as being influenced by consumer psychology and cognitive psychology and even presenting some studies of organizations and marketing (Folizzi, 2010). It is a human-centered approach and an outside in perspective, concerned with a systematic appliance of design methodology to the design of services (Holmlid, 2007). The approach in service design is mainly focused on transactions and the key concepts are serving, character of service, co-production, and co-experience. The methods used in service design are qualitative, user-centered design methods, simulation, storytelling, blueprinting, mapping and modeling and are greatly inspired by participatory design methods (Forlizzi, 2010). The blueprint is central to service design, as it is a process diagram for all of the components of a service.

Interaction design and service design have some touch points, but will probably develop individually. The challenge, however, lies in serving: to explore how people experience services, both emotionally and socially, and also how the service and the design can adapt to use over time. While the service perspective can be a challenge in interaction design, technology can be a challenge to service design. This is why designers need to have an understanding for each other's disciplines (Holmlid, 2007). Interaction design makes use of information technology as its main

design material, while service design transcends many different material borders. Service design cannot operate on its own, as it depends on competences from interaction design and industrial design (Holmlid, 2007). Interaction design and service design have the material aspects of dynamicity and temporality in common and also shares similarities in the design methods they use.

Participatory design

Participatory design is interesting in relation to this thesis as methods from this field have been heavily used in many of the projects and also because participatory design is suitable to use when designing for public libraries. It is particularly interesting in the previously mentioned UMS project, as this is an example of a project where the values and methods from participatory design set the agenda for a large-scale development process.

Participatory design is a collection of tools and practices that focus on making technologies and environments more responsive to human needs. Central to participatory design is the direct involvement of people as co-designers, e.g. involving people in the introduction of technology in their place of work. Participatory design has its roots in both Scandinavian and North American traditions. The Scandinavian tradition of system development derived from a range of research projects dealing with the introduction of technology into work practices in the 1970s and 1980s, such as UTOPIA (Ehn & Kyng 1992). The initial focus on trade unions and blue collar workers has since moved on to other fields, such as museums (Dindler, 2010), schools, (Iversen, 2005) and health-care institutions (Grönvall & Kyng, 2011). Traditionally, participatory design has a strong place in academic environments, but has not really made any break-through in the practices of the design industry.

Due to societal changes, the challenges for participatory design are e.g. coping with the shift from designing for work places to designing for everyday life and also the transition from designing with participation to designing also for participation. In addition, as new technologies and open source hardware such as e.g. Arduino (2012) emerges, the end users become designers to a much higher degree, producing their own installations and applications. The development that turns former end-users into designers challenges the traditional understanding of users as participants in the design process.

3. Space, Scale and Context

Issues of scale are implicit in the definition of ubiquitous computing and Weiser's vision of the future describes devices at varying scales, ranging in size from hand-held "inch-scale" personal devices to "yard-scale" shared devices. Weiser defined the notion of scale as a broad space of computational devices (Weiser, 1991). Also, scaling systems and distributing computation into physical space aim to break the traditional desktop-bound interaction. Abowd et al. state that research in ubiquitous computing implicitly requires addressing some notion of scale, whether in the number and type of devices, the physical space of distributed computing, or the number of people using a system (Abowed & Mynatt, 2000). They propose everyday computing as an area of applications research, focused on scaling interaction with respect to time. Scale is further discussed by Ullmer and Ishii (2000) in a conceptual framework for the characteristics of tangible user interfaces. Tangible interfaces are divided into groups labeled spatial, constructive, relational, and associative and the framework states that concepts such as physical scale and distance need to be explored further. The aim of this chapter is to continue some of these discussions by focusing on e.g. the aspects of space, scale and context.

Space in Interaction Design

The traditional computer forms change and become part of our physical space, why interaction designers have increasingly come to work with spatial IT-artifacts. However, physical space has not been a major topic in traditional HCI. An early claim for the need to consider physical space in designing pervasive and ubiquitous computing systems is: "*Physical space rarely matters in current human-computer interaction; but as computational devices becomes part of the furniture, walls, and clothing, physical space becomes a necessary consideration*" (Mark, 1999). The embedding of IT into physical surroundings makes an understanding of space in relation to computer mediated activities pertinent for interaction designers. Lykke-Olesen investigates space as an interface and concludes that space is an unavoidable aspect that needs to be designed and not just as a natural consequence of being situated and embodied in the physical world (2007). We design interspaces; assemblages of interfaces, actors and environments (Winograd, 1997), where the challenge is to design spaces for human communication and interaction.

To add spatial aspects to interaction design brings the interface out into the room and expands the role of the interaction designer to develop structures and forms as well as composing situations for its users. Architects are faced with problems of creating meaningful situations beyond stones and windows, interaction designers are faced with creating meaningful situations in both physical and digital space using IT as a design material. Although IT can be considered non-physical and non-spatial, however, when designing spatial interfaces, physical materials come into play and designers should understand how the properties of IT relate to spatial properties and boundaries. With ubiquitous computing, the number of IT-artifacts taking up room in physical space increases.

Physical space is important in interaction design, as it grounds the most basic experiences upon which we create understanding. Spatial literacy, i.e. concepts and understandings of the relation of human beings to their physico-spatial surroundings (McCullough, 1996), is more or less highly developed in different people. Human reasoning is based on our perception of the physical space and its objects (Grivas 2008). We understand and navigate in physical space more quickly than anywhere else, e.g. in a text. We also communicate through physical space and the way in which we position our bodies and the fine conscious or unconscious gestures we make provide meaning and are a part of our language.

Findings from projects presented in this thesis indicate that a strong focus on the physical and spatial aspects in interaction design can be fruitful. In my work, spatial aspects have been investigated in different ways, both in practical projects, theory and methodology (Eriksson, 2011; Eriksson, Hansen & Lykke-olesen, 2007; Dalsgaard & Eriksson, 2007). Adding spatiality to interaction is of importance, as "our physical bodies play a central role in shaping human experience in the world, understanding of the world, and interactions in the world". (Klemmer et al., 2006). Price et al. (2004) describe an approach for developing digitally augmented physical spaces to facilitate active learning. In Fails et al. (2005), the merits of desktop and physical environments for young children are considered by comparing the same content infused game in both contexts. The findings point toward the overall advantages for physical environments over desktop environments. Inspired by this, digital environments with full body interaction in physical space have appeared, such as e.g. StorySurfer (Eriksson & Lykke-Olesen, 2007), Knowledge Well (Grönbaek et al., 2007) and iFloor (Krogh et al., 2006).

So, how to define or even talk about space and spatial perspectives in relation to interaction design? When Brunelleschi invented linear perspective in 1425 (Cooper, 2007) as a geometrical technique to illustrate depth in representations of our world, no digital space existed yet and concepts such as "under", "distant", "outside" and so on were used to provide meaning. Linear perspectives create a space through a "window" where the center of attention is pre-decided for the viewer. This representational space relies heavily on strict laws, reason and hierarchy and illustrates how we perceive the world around us. In contrast to this, abstract space can be one-dimensional or multi-dimensional and is more a representation of how we experience the world rather than how we perceive it. Traditional work-based HCI and WIMP interfaces are leaning more towards the

representational space, with strict hierarchies and where the shortest path between point A and point B is the goal. Interaction design is moving away from this efficiency focus toward abstract space, just as twentieth century artists such as the cubists tried to move away from strict perspectives and coherent depth. In the art-work of the cubists, the objects are broken up and re-assembled in abstract forms, depicted from several viewpoints to represent the subject in a larger context. Just like cubism, the goal for interaction design is not to represent the world as we see it with our eyes, but as we perceive it with all our senses and from different angles and perspectives, to provide a more multi-facetted experience.

Before Bauhaus, space was understood and defined as a container that could contain other containers (Forty, 2000), but later changed to a continuum where spaces dynamically would intertwine and flow among one another. This continuous space was changed by the observer moving in space. Ubiquitous computing and virtual augmentations further expand the understanding of space. With the dynamic nature of digital systems and interfaces, the perception of space is not only changed by the observer's moving point of view, but the space itself is dynamic, both regarding appearance and functionality. Space becomes defined by the potential functionalities afforded by areas or spaces within a continuous space and not only as a container defined by a three-dimensional set of physical and virtual boundaries. Space and the physical environment is a design resource open to virtual and interactive augmentation, which is why we should accept and play with the properties of physical space and the influence of those properties on different types of interaction.

There is an ongoing discussion on how to separate space and place in design, once set forward by Yi-Fu Tuan (1977). Harrison and Dourish make the following distinction: "Space is the opportunity; place is the understood reality" (1996). A space, as a pure physical structure, becomes a place when it is invested with meaning, e.g. when a house becomes a home. Space can be both physical and digital and is formable by the designer, whereas place is created by humans investing feelings into it regardless of the form in which it exists. Tuan divides the notion of place into four dimensions: physical, personal, social and cultural. The physical dimension is grounded in physical materials, the personal in emotions, the social in communication, and the cultural in conventions and rules. However, the physical dimension is the only one possible for the interaction designer to form: the other three dimensions should be supported, analyzed and become parts of the design process as well as of the final outcome and its intended use.

In interaction design, there is a need for understandings of how both the augmented and the physical spatial layout affect the users' experiences and the users' behaviors and social relations. Ciolfi (2004) claims that current design methodologies and techniques do not explicitly consider the importance of gaining a full understanding of the human experience of space when designing technologies that will pervade and become an integral part of our physical environment. Dalsgaard and Eriksson consequently identify a gap in that the role of space is not recognized in the design process (2007). Adapting understandings of physical space into interaction design, both in the

design process and in the designed artifact, may yield new ways of understanding activities and use. This may lead not only to a better understanding of spatial issues in the design phase, but may also come to inform the analytical phases before and after the design phase. Design experiments are important to gain insight into spatial design issues. Architectural models are examples of spatial representations that can provide visual overviews and understandings of the entire space and may supplement the functional focus of prototypes in interaction design. Another approach to incorporating all aspects of the context into the design process is to carry it out in situ. The advantages of performing design sessions or even the entire design process in the right context is further described by Eriksson et al. (2006).

Scale

In the 1970s, architect Christopher Alexander developed a number of design patterns that reoccur in urban architecture. Similar to the ideas behind participatory design, the intention behind the patterns was to create a common language supporting the participation of all involved parties and especially to allow citizens to discuss with professionals. The patterns range from large-scale designs, such as a neighborhood, via smaller-scale ones, e.g. a promenade, to the designs of single buildings and intimacy gradient (Alexander, 1977, 2003). While Alexander developed the design patterns, John Chris Jones further developed design methodology with respect to modern design problems and different scales (Jones, 1992). Jones suggests four levels or scales of design: the community level, which is the political and social aspects of user behavior, the systems level, which is the relationship between products, a level comprising the products themselves, and finally a level for the components which make up the products.

Jones states that modern design problems are so difficult to solve due to the search space in which possible new systems can be found is too large for rational search and too unfamiliar to be simplified by those who have experiences limited to the existing design and planning professions. He claims for the need of new methods at each of these levels and for what he calls "multi-professional" designers, whose intuitive leaps are informed by experience of change at all levels, from community activities to component design (Jones, 1992).

What the two have in common are their conceptions of the whole (Alexander 2003) and of the total situation (Jones 1992) as the scale of design today. This involves functions and uses of things, systems, communication and environments. Intangible designs or operating wholes of which modern life is being formed and made. Alexander's pattern thinking has been an influential source of inspiration to the development of programming methodology, an area which is typical as it considers the only way to solve large problems is to find subsets of problems and in which repetitive solutions create a pattern. Jones's methods can be applied to both large-scale and small-scale design problems.

Small-scale and large-scale in design

In order to understand what different scales are in this dissertation, some definitions of small-scale and large-scale design projects will be presented in short here. In this dissertation, small-scale refers to projects aiming to investigate and explore certain aspects in order to develop a set of prototypes. Small-scale projects are characterized by one or several of the following factors; short time-span, small or homogenous groups of users, and result in products or systems that are not very complex or extensive in scope. The small-scale projects may run for a couple of years, belong to any domain, and have an unlimited number of partners and levels of participation. The challenge for this type of interaction design project is to design the design process, managing the project team, and to try to meet the needs of the users while sticking to a focus investigating certain issues rather than considering the whole. In related works, this type of projects can be defined as near-field space design, such as e.g. interior and textile design (ArcInTex, 2012). In chapter 5 in this dissertation, two examples of small-scale projects in the public library domain will be presented in more detail. These are two-year projects and are named the Interactive Children's Library and Families at Play in the Library and there are also descriptions for the three prototypes StorySurfer, U.F.O.scope, and BibPhone.

In large-scale projects, the timeframe is likely to be more than five years. The project is highly complex as it involves both small-scale projects and organizational and perhaps even political issues. Large-scale projects are typically characterized by one or more of the following factors; long time-spans, large or diverse groups of users, and results in products or systems that are complex or extensive in scope. The challenge for large-scale projects in interaction design is to keep the organizational overview at the macro level, while also investigating and making explorations at the micro level. Also, during the long project time, resources and attitudes will have changed, partly in response to the new design project (Jones, 1992). It is necessary for the project as a whole to be informed by small-scale projects, because this is the foundation for everything. Use of designed artifacts can only come out of small-scale behavior and interaction is based on use. In related work, this type of projects can be defined as far-field space design, involving areas such as architecture (ArcInTex, 2012). The large-scale example presented in more detail in chapter 5 in this thesis, the Urban Mediaspace Aarhus, concerns the development of a new public library, including buildings, services and identity. The timeframe spans approximately fifteen years and examples of people and partners involved are library employees, architects, citizens, engineers, developers, politicians, and different communities (Aarhus Municipality, 2012).

Discussions concerning large-scale design are found in different areas. Previously, it was touched upon in architecture by Alexander (2005) and in design methods (Jones, 1992), but it can also be found in e.g. participatory design (Dalsgaard, 2010, Simonsen & Hertzum, 2008, Oostveen & Besselaar, Dalsgaard & Eriksson, 2012), in design (Redström & Maze, 2008), and software design (Lakos, 1996). As mentioned in the introduction, Alexander once said that the perhaps most

difficult aspect of large public buildings is that people should be the core of the building, and that inspiration comes from the deep feeling of the users (Alexander, 2005). In other words, user-centered design and participatory design are some of the approaches that could be used for designing large public buildings, such as when Alexander designed and built the homeless shelter in San Jose in 1987 with the homeless people as co-designers, although what he did is rare indeed. Participatory design projects have a history of being small-scale and stand-alone, as examined by e.g. Oostven & van den Besselaar (2004) and Simonsen & Hertzum (2008). However, voices such as Shapiro (2005) are raised for the community to change and engage in the development of large-scale systems. Still, only a few have taken up the mantle and Alexander's approach to the homeless shelter is far from commonplace. In order to further address different scales in design, a discussion on context will be presented below.

Context

"Designers need to not only perceive a product but to see the diverse ways it relates to the texture of everyday life surrounding it." (Ylirisku & Buur, 2007, p. 10)

Within interaction design, the physical world is used as part of the system or interaction, both directly or indirectly. Design of context-aware systems aims to create systems providing performances which are reliable in the sense that they respond to what state the real world is in and what users really want to happen (Pederson, 2003). The challenge, however, lies not only in making the system aware of the real world state, but also to make the context aware of the system and the implications of one's actions (Bellotti & Edwards, 2001). As pointed out in Pederson (2003), the real world context is, however, something very complex, why the tendency is to focus design on simple physical measures such as temperature, location and time of the day, while it seems to be more difficult to interpret e.g. the social domain. To avoid systems which become superficial and insensitive to reality, context has come to play a more important role in interaction design. Rodden et al. state that, "In considering context as a starting point for the design of interaction within we need to unpack what we actually mean by the term context and how we may exploit to determine different interaction possibilities" (1998), why context will be further discussed here.

There are many different types of definitions of what the context of a computational object really is, as it can be applied in many fields. Dey, Abowd and Salber (2001) present a list of context definitions, including items such as: "location, identities of nearby people and objects and changes to those objects" (Schilit et al., 1994), "the elements of the user's environment that the computer knows about" (Brown, 1996), "the situation of the user" (Franklin & Flaschbart, 1998), "the application's setting" (Rodden et al., 1998), "aspects of the current situation" (Hull et al., 1997). Dey et al. interpret context as "any information that can be used to characterize the situation of entities (i.e., whether a person, place, or object) that are considered relevant to the interaction between a user and an application, including the user and the application themselves. Context is typically the location, identity, and state of people, groups, and computational and physical objects" (Dey et al. 2001). In Brynskov et al. (2003), the context of context-aware systems is defined as three perspectives that focus on different aspects of the design space. They divide context into physical context, digital context, and conceptual context as most entities both have a physical and digital representation and the user's conceptual model is the link between them. One of the benefits of this model is that there are known design methods related to each perspective in architecture, mathematics and psychology.

In my work, we have worked with different definitions such as the combination of the social fabric and the physical location where the object will be placed (Eriksson et al., 2007). The different definitions have something in common, but the definition of context is of course context-dependent in itself. The definition of context differs between designers coming from different fields, e.g. between robotics and ethnography, and if the designer is involved in the initial or final phases of the

design process. In this thesis, the guiding design program leans more upon Jones's notion of "the total situation" (Jones, 1992). In Jones (1992), this is not used to describe contexts, but instead describes the intentions of his design methods, that it is about the design of "all-things-together", the "total situation", meaning the functions and uses of things, the "systems" into which they are organized or the "environments" in which they operate (Jones, 1992). The scale of design today has expanded from things to "intangible designs", the operating wholes of which modern life is being formed and made, such as systems, software, programs, flows, communications, communities, etc. The change in scale is also a change from designing-in-space to designing-in-space-and-time and, thereby, the way things are used or are intended to be used is as much designed as are their shapes (Jones, 1992).

So why is context important in interaction design? The move to consider context of use builds upon previous trends such as developing media spaces at PARC and the notion of ubiquitous computing (Weiser, 1991) and small-scale devices exploiting context to provide ambient awareness (Ishi & Ulmer, 1997). The central design material in interaction design is information technology, which is both abstract and concrete, software and hardware. It can adapt and take any form, be precisely controlled, and is expressed physically, although it is primarily temporal as its essence is found in executing program code. However, information technology is not sufficient on its own as it is dependent on other materials such as plastic, metal, wood, organizations, economy, etc. These artifacts are made up of several materials, where information technology is central, and, thus, have a dual nature as they are both physical and digital. Existing approaches to design often tend to focus on only one of these aspects or on one after the other in the design cycle. It is rarer to consider both physical design and digital design simultaneously and as being equally important, feeding into and depending on one another. When designing dual-natured artifacts, there is a tendency to focus on isolated objects, not respecting their dependencies to their context. The context is therefore not involved as it is not a vital part of its design and expression.

Dourish suggests that context is continually renegotiated and defined in the course of action (Dourish, 2004). Context construction is dynamic and space and place are distributed and depends on the perspective of the viewer. This may seem impossible to design for, but it points to the importance of involving context in all parts of the design process. Framing context is about exploring and discussing what exists right now and the importance of it. Context can trigger new ideas or improve existing products, but it can also affect the design. According to Ylirisku & Buur, "everything that a design affects, or that the design is affected by, forms the relevant context" (2007), which is in line with the notions this work is based on. As pointed out in Brynskov et al. (2003), all real world problems involve several perspectives and should at some stage be addressed as an integrated part of the design work. Methods and models such as e.g. the Four Space Model proposed in chapter 5 in this thesis are necessary tools when considering the complexity of the multi-faceted context matrix.

From Objects to Ecologies

Several sources mention how design has changed from object to ecologies, e.g. energy ecology (Maze & Redström, 2008), product ecology (Forlizzi, 2008), and service ecology (Mager, 2009). "Ecologies" describe the complexity of relations among living organisms and their physical surroundings and has traditionally been applied within the natural sciences. Product ecology provides a way of understanding the complex physical and social context of use around a product and a means for suggesting change within the current state of the world. It is focused on real world contexts and aims to play a role in developing future products. Service ecology is the system in which the service is integrated, a more holistic visualization of the service system. All the factors are gathered, analyzed and visualized, such as politics, economy, employees, law, societal trends, and technological development (Mager 2009).

In Maze & Redström (2008) design is considered an intervention into multiple and interpenetrating technical, material, and social systems - or ecologies. In the California High Speed Rail project, CHSR, infrastructure is not considered to consist of a single fixed machine, but an artificially-developed ecological system (CHSR, 2012). The design problems it poses relate to interfaces operating at multiple scales, at the scale of a city and the scale of a person, of a data-object and a track grid, some fixed and some in motion, some singular and some collective. By analyzing ecologies, it is possible to reveal opportunities for new actors to join the ecology and for forming new relationships among the actors. What the different ecologies have in common is that it is the interactions within, around, and through many things within a particular setting that should come into focus rather than the object itself. The question to pose then is: can solving large-scale problems still be considered design? Maze & Redström (2008) suggest that we can use design as a vehicle for exposing and debating values within these complex ecologies and also intervening in them, thereby introducing new openings for awareness and change. Thus, it may not fall to design research to have the power to control or to design and implement new systems and structures at such a scale. In this thesis, I will take a different stance and say that interaction design research can take on such a large-scale perspective.

In interaction design, it is important to be able to cooperate, admire and respect solutions that constrain your own design in certain ways. Space, context and physicality have become major issues in interaction design and have traditionally been issues in fields such as architecture and biology. In architecture, Alexander talks about "wholeness", something he describes as a cousin-like structure to topology, and defines it as "that global structure which pays attention to, and captures, the relative strength of different parts of the system, paying attention both to the way they are nested in one another, and how the pattern of strength varies with the nesting" (Alexander, 2003). The cell has the ability to determine its place in the overall, a process called topobiology, from the Greek word for place, *topo*. Cells rely heavily on the DNA code for development, but they also need a sense of place to do their part for organism, a feature that is accomplished by paying attention to one's neighbors (Johnson, 2002). In the human body, a single

cell contains a set of tools for detecting and communicating with surrounding cells and even if cells are not very smart, complexity grows when they come together in groups. Each cell has to figure out where it is in the larger scheme of things, even though cells have no way of seeing the whole (topology) (Johnson, 2002). In a sense, components in computational objects are very much like cells as they lack the bird's-eye view of the organism in which they are one part, although they can still perform street-level assessments via their signals, every cell looking to its neighbors for clues on how to behave.

In interaction design, the designer has to pay attention to all the layers of the context surrounding the computational object, to have it pay attention to its neighbors at many different levels, and to determine its place in the overall system. Objects should contain mechanisms allowing them to consider and to be able to take advantage of other nearby objects in their context to a great extent. This is similar to large-scale software systems, such as e.g. designing a user interface for critical alarm handling in a large so-called umbrella system for air traffic controllers (Eriksson & Lindros, 2003). The system has inputs from all other actors at airports and in the air around the world. The information is based on everything from airplanes and luggage handlers to crew, passengers and even the weather. In such a system, it is obvious how every small and local operation produces effects worldwide which influence the overall system, just as the airport itself does. This bottom-up understanding should also guide the design process, starting from the ground (controllers) and working its way up (system).

Examples of bottom-up organizations are e.g. social media, Web 2.0 technologies, and people recommending one another material. This is a powerful tool to use for citizen involvement, community building, and the design of services, but should also be used to shape the use of the physical public library and for user involvement methods. This is also in line with Alexander's work in the field of architecture (2004) and the emergence of life in a city. Naturally, there has to be an overall plan or organization to guide the result of the whole, whether it refers to DNA, project organization, or politicians. During their education, interaction designers develop projects from concepts to implemented prototypes, most often with low constrains and as standalone systems. To deal with this, we organized a hands-on workshop, "Missing link – designing for dependency" with students in interaction design (Eriksson et al., 2010). The students designed and developed a component that works within the rules of an overall system interface, in this case an interactive light installation (see Fig 3.1). Each component works on its own while at the same time being a part of a full-scale system, in which it reacts to and depends on the other components of the system, which are all different. When the components are connected, they are no longer in control but must obey the rules of the system as a whole. This confronts the questions on how to give up control of your design and at the same time exploit the available rules of the system context in a creative way (Missing Link 2004).

Figure 3.1. Missing Link result (a) and concept (b)

Today, as Weiser's future scenario of ubiquitous computing has become a reality, it is vital to respect the dual nature of the objects we design and their dependency on their context. Our design objects are a part of a system they must relate to, our devices are dependent on the existence of other users and infrastructures interacting at the same level and with the same tool: they must be intertwined. The final design is larger than each component, both within the object and for the object in its context. The objects contain input from the users and output to the world, input from other systems/infrastructures and output to those same systems/infrastructures. Even though they consist of simple basic rules, computational objects are complex systems: e.g. computer chips use the language of ones and zeroes. Just as the human body or an airport, the computational object is much larger than the sum of its parts and completely dependent on the individual parts working together in parallel. In a computational object, the ALU (Arithmetic-Logical Unit) and the BUS (the transmission line) must cooperate within the CPU (Central Processing Unit). In an airport, the bus driver waits for a command before he goes out into the landing area to look for the passengers from a certain flight; his work is independent from the one done by the luggage carrier, but both are equally relevant for the task of bringing the passenger and his/her goods to his/her destination. In airports, there are many simultaneous processes happening in parallel that cannot be controlled by a single person. The success of the different operations performed in such an environment is the result of endless actions performed by the distributed intelligence of hundreds of people, collaborating at the same time at many different levels.

This kind of activity requires the realization of a strong abstraction process where the designers start by looking at the objects as if they were a magician's collection of black-boxes. The design activity is then reduced to a small portion of the whole system. The design of a complex system is based on the assumption that all the other parts will do what they are expected and will provide whatever is expected of them when a certain request is made. Complex systems consist of very simple basic rules that produce complex behavior and their beauty exists in the unforeseen behavior. Working with large scales, whether for ecologies or development projects, it is important to design from the ground up, so that the larger perspectives and adaptability stems from local knowledge. This is e.g. how the specifications for the UMS were drawn up and this is also the reason I was able to contribute to the design process. Through the experiences gained as an active

participant and by introducing design interventions at the ground level, I was also able to participate in discussions at the macro level. Johnson (2002) introduces five fundamental principles necessary to achieve a complex system developed from the bottom up: More is different, Ignorance is useful, Encourage random encounters, Look for patterns in the signs, and Pay attention to your neighbors. I consider them relevant for interaction design, where large-scale design is informed by small-scale design. Inspired by the five principles for bottom-up shaping of complex systems, I have created some design considerations for public libraries which are relevant for interaction design. These are: Use the masses, Simplicity, Encourage random encounters, Follow the drift, and Go local to aim global and they are all presented in the toolbox in Chapter 6.

4. Research Approach

While working on this PhD, I have been a part of both the Division of Interaction Design at Chalmers University of Technology in Gothenburg and of the Center for Interactive Spaces at Aarhus University in Denmark, why my work is highly affected by both institutions. My work leans on recent dissertations in interaction design from these institutions such as e.g. Ludvigsen (2006) and Lykke-Olesen (2007) at the Aarhus School of Architecture, Dindler (2010) and Kortbaek (2011) at Aarhus University, and Landin (2009) at Chalmers. My reason for pointing out these dissertations in particular is that they resemble my work both regarding methodology and because we developed several of the prototypes and methods together. The thesis by Ludvigsen thoroughly discusses the methods of design research, while the thesis by Dindler discusses the use of participatory design. Lykke-Olesen's thesis is mentioned due to its high emphasis on prototyping, Kortbaek presents an interesting take on space from the perspective of interaction design, and Landin discusses the language used in interaction design.

My research method is research through design (Zimmerman et al, 2007; Gaver, 2012), where design is used to creatively and constructively inquire and explore the potential and relation between human beings and technology within the field of interaction design. Using design as a method for research inquiries produce results that expand our knowledge, and the results will here be presented in the form of reflections, techniques and tools. My research contribution has a focus on means, focusing on process and interventions with the area being studied.

A design program has been used to guide research, which implies that there are still questions to ask and issues to investigate after the PhD project has been concluded. The design explorations described in the published papers partly answer some issues and the overview of this dissertation aims to strengthen these arguments through further discussion and clarification. The results will be useable to the communities of both interaction design and public libraries.

Design Approach

Buchanan states that, one of the great strengths of design is that there is no settled single definition (Buchanan, 2001), but as design is central in this work, there is a need to clarify how this thesis defines the concept of design. There are many definitions of design and designer, some of which will be presented here, but my idea of design is rooted in Jones's definition: "design is a change in manmade things" (Jones 1992). Whatever it is we design, it will always constitute a change compared to the conditions existing before the design intervention. Ehn states that design is, "a concerned social and historical activity in which artefacts and their use are anticipated; an activity and form of knowledge that is both planned and creative, and that deals with the contradiction between tradition and transcendence" (Ehn 1988, p. 161).

In design, there is no clearly defined problem to begin with. Design problems have been defined as wicked problems, a definition that separates design from engineering. Wicked problems can be characterized by e.g. that the understanding of the problem appears only after having developed a solution, that solutions are not right or wrong, that there is no stopping rule, and that every wicked problem is unique and novel (Rittel et al., 1973). Solutions related to problems posed by natural science and engineering can typically be evaluated in terms of true or false and it is, in principle, possible to tell which solution is the best one. Regarding wicked problems, there is no optimal solution and, instead, the design project ends and its results are called "solutions" because they are believed to be good enough, although the success of these "solutions" is revealed in their locations, in real use and over time (Stolterman, 2008).

My basic understanding of design is inspired by the work of Schön (1983), who describes design as a conversation with the design materials, wherein the reflective practitioner works with different media or materials, experimenting with various aspects of the design. This means that the core competence of the designer is to set up the mutual learning process among the design practitioners and the design material during the design process. This is a contradiction to the more problem solving approach proposed by Simon that states: "everyone designs who devises courses of action aimed at changing existing situations into preferred ones" (Simon, 1969, p.111), and that design may be understood as a science of the artificial where the design problem delimits a problem space in which the designer, through rational processes, search for a design solution. Simon's problem solving approach says that design is the design of the process that leads to the actual design, while Schön's approach underlines the importance of the conversation and understanding appearing when involving in hands-on work.

The designer plays a major part in every design and design process. It is the designer who interprets, makes design choices, and decides upon methodology. There are many obstacles during the way and never a clear path, which is in line with the nature of design problems. Löwgren and Stolterman state that, "...design is about uncertainty. To participate in design works means that you, as a designer, play a part in a venture that involves great risks. Design involves chance; it

forces you to challenge the unknown and to create the not-yet-existing" (Löwgren and Stolterman, 2004, p. 9). Design is about challenging the unknown, but it is also colored by the designer's intentions and understanding of the world and is therefore the design of something given. Hallnäs & Redström state that: "Design is always design of something given; we express function, materialize ideas, try to meet user requirements, provide solutions that conform to given specifications, solve problems, turn given abstractions into concrete expressions" (Hallnäs & Redström, 2006, p. 32). However, what is initially given is changed through the designer's interpreting acts of design, which in turn changes our perception of what is given. This is in line with Schön in that the problem setting is inseparable from the problem solving (1987).

> The fundamental problem is that designers are obliged to use current information to predict a future state that will not come about unless their predictions are correct. The final outcome of designing has to be assumed before the means of achieving it can be explored: the designers have to work backwards in time from an assumed effect upon the world to the beginning of a chain of events that will bring the effect about. (Jones, 1992, p. 9)

The statement by Jones relates to the assumption that design is always the design of something given (Hallnäs & Redström, 2006). In going from the abstract to the concrete, the "something" is interpreted in the design process into "something" as a definition of design. This introduces what Hallnäs & Redström terms "the hermeneutical gap" – a gap between what is actually given and what we actually design. The hermeneutical gap can be applied to the actual design, to the users, to the gap between the actual user from empirical studies and the described user in the design process; the hermeneutical gap appears also at the end of the design process, in the intended and actual use of the interaction design. The hermeneutical gap is, "between what in fact is given here and now and the change of meaning that the design will bring about" (Hallnäs & Redström, 2006, p.71).

The researcher can both discover new knowledge through systematic investigations and empirical experiments and by using imagination and creativity. An understanding of the bigger picture as well as a desire to explore and the creativity and imagination to think outside of traditional boundaries is needed. Someone may be able to mathematically calculate the power of an atomic bomb, but it takes imagination to understand the human perspective of being bombed. A researcher can be a specialist in a subject or have knowledge in several. In design research, it is more common to have knowledge in several fields, to be able to overview the big picture and discover relationships between details. The design methods movement has developed a great deal over the years, but there is generally a move away from the systematic, optimized and rational toward satisfactory solutions and participatory processes (Cross, 2007). Design is a constantly expanding discipline, based on reflective practice.

Research in Interaction Design

Interaction design research is an intellectual as well as an applied discipline that uses design practice to perform experiments in order to develop theory. It opens up for new possibilities, using varying methods, and its results expand our knowledge and ability to act. There are different ways of performing research within interaction design.

Fällman presents the interaction design triangle, where interaction design research can be divided into design studies, design practice and design explorations (Fällman, 2008). Design studies involve analytical work in design theory, design methodology, design history and design philosophy, contributing to the body of knowledge while building an intellectual tradition. Design studies have a more general focus and aims to describe and understand rather than create and change (Fällman, 2008). In design practice, the activities are closer to the type of activities one would perform if practicing outside of academia, however, with a research question in mind. The third way, design exploration, is more explorative than design practice and shows alternatives, examples, of what is possible outside of current paradigms. This is perhaps what makes this triangle differ the most from the classic triangulation of research problems from the three perspectives theory, design and empirical work. Design explorations seek to test ideas, find alternatives; they are provocative and driven by ideals or theory. To sum up, design studies seek to explain and understand, design practice to create and change, and design explorations to suggest and provoke. Fällman argues, and I agree, that it is necessary for interesting interaction design research to move between these three approaches and to deal with the tension between them.

There are many other perspectives and models describing design research. Buchanan (1996), for instance, uses three categories to describe design research: clinical, basic and applied design research. Clinical design research includes design activities that solve a problem by designing something and where the designer is able to collect relevant information and understand the circumstances. Applied research makes generalizations based on many cases and basic research is more concerned with design theory. A second example is Cross's model of the activities that take place in design research, which also includes three categories: epistemology or the study of how people design; praxiology or the study of methods, techniques and processes; and phenemelogy or the study of artifacts (Cross, 1999).

All three models recognize that here is a division between design practice and design theory, but the explorative approach appear only in Fällman's model. The design explorations are important in interaction design, transcending both practice and theory. In line with Jones, Fällman's model allows and actually pushes the design researcher to change role and perspective in order to improve and expand the scope and relevance of the interaction design, discouraging from staying to become a specialist in one of the fields. With this thesis, I aim to demonstrate that my work in interaction design within a large-scale project has expanded the scope and relevance of the field.

Research Method

The research method used in this thesis is research through design (Zimmerman et al, 2007; Gaver, 2012), where constructive and creative inquiry is posed into the research field of interaction design. In this perspective, design is used as a method of investigation in other fields and one in which the design process itself becomes a scientific method of inquiry (Ludvigsen, 2006). This resembles action research in the sense that action researchers investigate social systems by applying changes to these systems and observing the effects; however, research through design, also pays a great deal of attention to the design of the intervening prototype itself. In this sense, the knowledge that stems from observing the artifact in use or from the design process is the contribution, while the artifact is the mean. (Fällman, 2003). Research through design experiments are based on many different types of methods and these methods change and modify depending on the situation and context. The researcher is in dialog with the situation, material and context (Schön, 1983), making the design choices regarding methods an essential part of the result.

There is so far no set standard for what research through design is, but there seems to be a general consensus among design researchers on four common values (Gaver, 2012). These are: some variation of user-centred design, exploration of a wide set of potential designs such as sketches or prototypes, the value of craft, and finally that the practice of making is how to make discovery (Gaver, 2012).

Design Methods

The design methods used in the different projects have varied due to the complexity of the wicked problems, and the materials chosen. Though, there are some fundamental methods that have been used throughout the different project, see diagram of the general design process in Figure 4.1. The diagram is to be read as an iterative process in different variations, not linear as presented here.

Figure 4.1. General diagram of the different phases of the design process.

Initially, there have been some literature studies in order to explore the problem space and the area of study. Secondly, ethnographic studies and interventions have been performed in the context of study, such as observations, interviews, participatory sketching, role playing, Four space model, and so on. Thirdly, there have been participatory design workshops of different kinds with different stakeholders, aiming to ideate and settle expectations and resources. After this, there is usually a longer iterative period of prototyping and testing, ending up in full-scale test intervention in the context of study. Both the early as well as the full-scale test is documented by video, pictures, interviews, and observations. The last step in the research process is to reflect and pass on knowledge from the project, by publishing research papers and giving presentations. All steps in the process inform each other, and are the base for following projects.

On Design Programs

In this thesis, a design program based on experiences with design explorations, design theory and design methods, has been formulated to guide the research endeavor. Research has been performed through design, i.e. the design processes have formed the base for research. All research has developed from one initial design program, 'Spatial Multi-User Interaction' – SMUI (Eriksson, 2006) which, during the course of research, was re-defined into a new program: 'Intertwine and Play! – Multi-scaled Interaction Design' - MSID. Practical design experiments have generated new theory and methods in both programs.

Hallnäs & Redström highlight the need for new design programs to guide and develop practice by opening up new design spaces (2006). The design program both defines the limits for what should be investigated, a space spanned by the experiments, and guides the experiments as they expand into that space. Hallnäs & Redström (2006) define a design program as a description of the design intention at a general level, where a position regarding the basic approach is stated. Binder & Redström propose a possible metaphor for a design program, namely that it works as a lens through which some things are enlarged and thereby better seen, while some things are hidden (Binder & Redström, 2006). It is characteristic of a design program to claim something and then ask what would happen, a question to which the experiments will provide answers (Redström in Ilstedt, 2007). The experiment does not ask the questions, which is a more common approach to experiments.

A design program seeks to make a difference, to change something. It is not as much coming up with an answer as it is to find alternatives and possibilities for a different future and design practice; to make concrete what is possible. The experiments expand and express the possibilities of the design program in different ways and for the program to answer both the questions "what" and "how", it is then important to also describe the process in which the alternatives develop. Examples of design programs are Things-that-think (MIT, 2012), Switch! (Maze & Redström, 2008), Slow technology (Hallnäs & Redström, 2006), and Augmenting places (Binder & Hellström, 2005).

Doing research guided by a design program is comparable to how core values have been guiding the process for the large-scale UMS project, which I have taken part in and will be presented in chapter 5. The core values do not set any clear limits, but guides both process and explorations as they move forward. The seven core values in UMS were developed in the initial project phase and integrated into the process, subsequently becoming parts of the architectural program, which in turn will be manifested in the final building.

Formulating and using a design program as a guide to research has been fruitful in many ways. It has been a supporting foundation for choosing values the work should be based on, but also a pointer helping to decide the direction of the process. However, a somewhat complicated aspect of the design program is that the initial program description was so wide and so general in character, that it has been difficult to focus on specific issues. However, it has been great to have it as a starting point and development has taken place in the values and methods rather than for the program as such. The inspiration from architecture and ubiquitous computing is still recognizable in the program theme, two fields which in many ways have formed the foundation of several of the values which are still important in my research.

A design program reaches its end when the experiments begin to repeat themselves or fail to generate new output. The program should either be evaluated against the borders proposed by the program itself or in comparison with other programs (Redström, 2011). In this type of research, it is not the design program or the evaluation of the design program as such that is of the greatest importance, rather the creative work it supports (Binder & Redström, 2006). Regarding the first program, SMUI, it is probably not possible to say that it is finished yet, as it still works to fulfill the purpose stated when it was initiated. Rather, what happened was that the design process initiated by the program and the experiments got focused. In this sense, the design program may be somewhat time-sensitive and should not be considered a static creation. While I was still working on this research, the need for a more specific program arose. The initial Spatial Multi-User Interaction design research program was re-written in order to better suit the findings and explorations. The second program, MSID, is more focused on spatial explorations with technology in the public library domain. The examples do not completely span the space of possible design alternatives in line with the program, as there will almost always be questions and experiments left when the design program is has come to an end.

Working with a PhD dissertation for as long as seven years may give rise to many different issues. In relation to a design program, it is interesting to see its progress and development: how the program has developed along the way and how it, slowly, developed at the same speed new experiences presented themselves. It is vital for the program to be dynamic, although it is important that some values remain as a foundation, as they will guide both the research and the development of the program. The new program, MSID, is still rather general in character, but is more focused regarding domain and it also introduces the concept of different scales in interaction design. The values and norms from the SMUI program remain, but the focus is sharper. When some values are stuck in the back of your bones it is time for progress and, in this case, daring to set a focus. The program theme can certainly be more focused, but that task is left for future work to deal with.

5. Cases

This chapter will provide an overview of some of the results from the research behind this thesis. Firstly, the different design experiments will be presented shortly. Since entering the world of interaction design for public libraries, the aim has been to inform the large-scale project UMS. The different smaller projects, the Interactive Children's Library, Transformation Lab II, and Families at Play in the Library, are though projects with their own rights. Further descriptions of the different projects can be found in the referenced and appended papers. The Four space model that is presented has been used in the design processes of the explorations. Figure 5.1 is a visualization of the timeline of the PhD.

Figure 5.1. Model of a Phd thesis (next page). The timeline runs from 2004 to 2013, though the actual PhD-position started in Sept 2005.

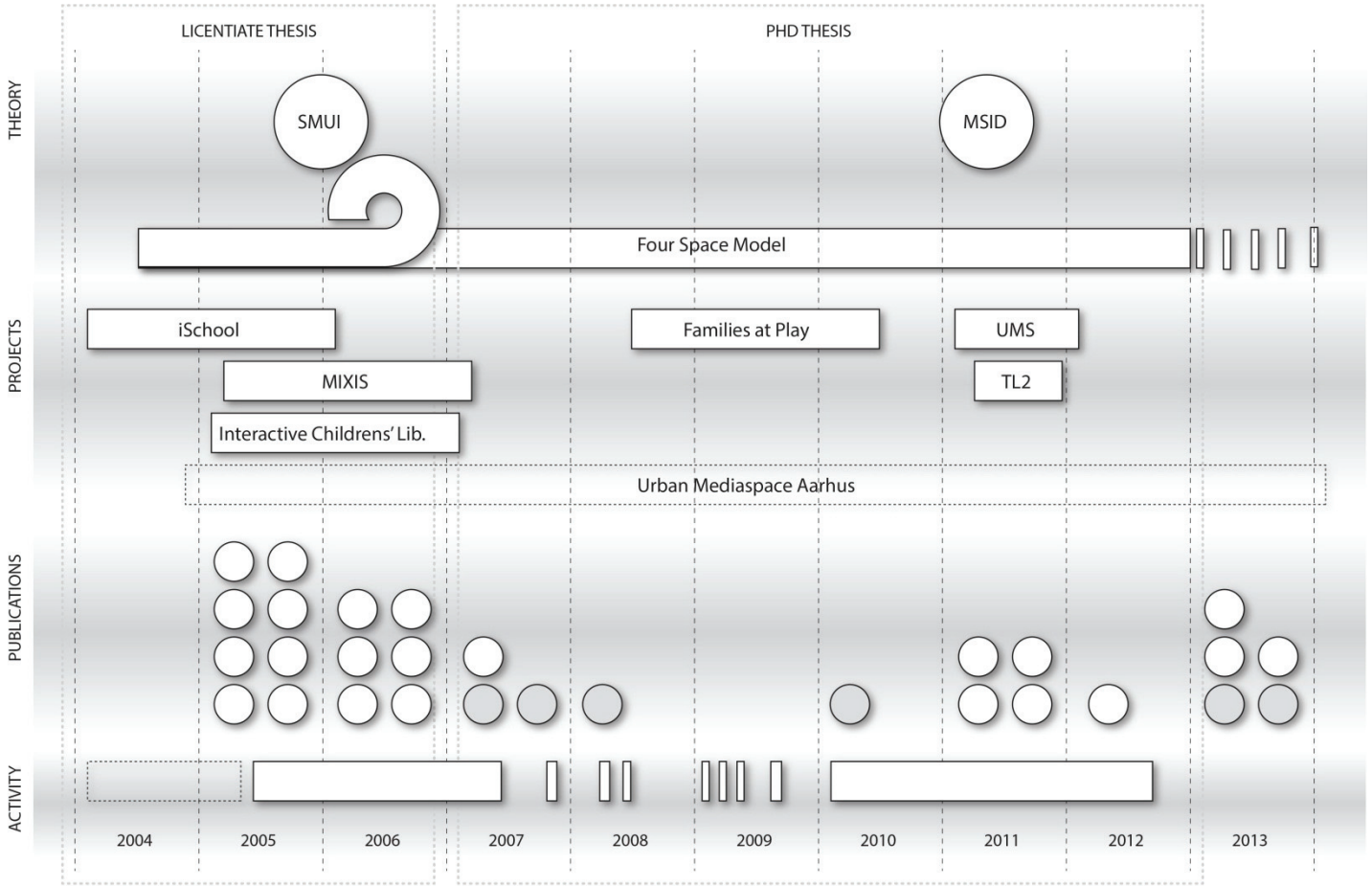
Activity: The level of activity of the PhD position is shown in the lowest section. Before September 2005, some research was performed as research assistant at Center for Interactive spaces at Aarhus University in Denmark, and teaching assistant at Chalmers University of Technology. This work was the grounding for my licentiate thesis, which was handed in after one year as PhD, and defended in January 2007

Projects: The projects section show when the different projects ran.

Publications: The publication section show when most publications took or will take place. The publications filled with color are the six papers appended in this thesis.

Theory: In theory section, it is shown when the two different design research programs were formulated. For the licentiate thesis, the program was named Spatial Multi-User Interaction (SMUI), which for the PhD thesis developed into Intertwine and Play! - Multi-Scaled Interaction Design (MSID). The results from these programs are the program descriptions themselves, the published papers, the prototypes, the methods and models, and the materializations described in chapter 6 in this thesis.

In the theory section, the origin and development of the Four space model is placed below the programs. The initial try outs for developing a model with dividing the context into different layers started during a workshop, Bthere, in 2004, and developed into the model during 2006. The model has been used as method in almost all the projects, and has been tested more focused in another workshop in 2010.


LICENTIATE THESIS
PHD THESIS
THEORY
PROJECTS
PUBLICATIONS
ACTIVITY
SMUI
MSID
Four Space Model
iSchool
Families at Play
UMS
MIXIS
TL2
Interactive Childrens' Lib.
Urban Mediaspace Aarhus
2004
2005
2006
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2013

UMS - Urban Mediaspace Aarhus

My participation in various library projects has aimed to inform the development of the libraries of the future, particularly a new public library in Aarhus, Denmark, called Urban Mediaspace Aarhus, UMS. The project involves a new urban space and a public building, see Figure 5.2. The project runs from 2001 to 2015. The project has a budget of about 200 million euro and is one of the largest construction projects the Aarhus area ever (Aarhus Municipality, 2012). The project aim to expand the city and to be an inspiration internationally, while at the same time also creating a flexible, dynamic refuge, providing the setting for an open, easily accessible environment for learning and experiences and a unique place for people's self-expression and collaboration. The public building will be large, about 23.000 m^2, and will in the future house the main library and citizens' services as well as the largest automated parking place in Europe.

Figure 5.2. Urban Mediaspace Aarhus seen from the north.

I have been involved as an interaction designer in the public library domain and with the direction of future library services for the UMS more or less since 2004. Knowledge about the project stems from various sources: first and foremost from the extensive web-based documentation of the project available to the public (Aarhus Municipality, 2012). Secondly, it stems from different research projects in which the public libraries in Aarhus are partners: the Interactive Children's Library and Families at Play at the Library (Aarhus Municipality, 2012), from interviews conducted with different project partners, and also from the overall development process of the UMS and participation in the ongoing Transformation Lab II project. The appended paper "Large–Scale Participation: A Case Study of a Participatory Approach to Developing a New Public Library" is a result of my involvement in the development of the UMS (Dalsgaard & Eriksson, 2013). In the process of writing papers, a series of structured interviews have been performed with key project participants and stakeholders, the principal architect, the main project manager, and a project consultant and also a series of informal interviews with library staff. For the formal interviews, a comprehensive interview guide was developed and the responses were codified and analyzed.

Process

From the start, it has been important to incorporate the ideas and wishes of citizens, partners and staff into the process. To ensure community involvement, seven core values were developed to guide the entire development process. The core values are (in short): *The citizen as key factor, Lifelong learning and community, Diversity, Cooperation and network, Culture and experiences, Bridging citizens, Technology and knowledge, Flexible and professional organization*, and *Sustainable icon for Aarhus (Aarhus Municipality, 2012)*. The architectural competition brief even state that the proposals are judged on the basis of how these values are addressed in the architectural process. The seven core values have worked as an ambition, an inspiration and as a guide for all projects.

The user involvement activities have performed a guiding function for the development process, see Figure 5.3 & 5.4, and have changed in character as the project has proceeded. From the initiation of the project in 2001, when the municipality made the decision to build a new library, until 2004, when the process took its first steps, several experiments took place, both to establish new collaborations with potential partners and also by playing with what is possible with new materials, such as e.g. IT. New projects were initiated, such as e.g. the Interactive Children's Library (Eriksson et al., 2007) and Transformation Lab (Aarhus Municipality, 2012). The attitude to designing with technology changed: the library employees became involved as designers of new settings, materials and services and users were also invited as designers, not only as visitors and testers.

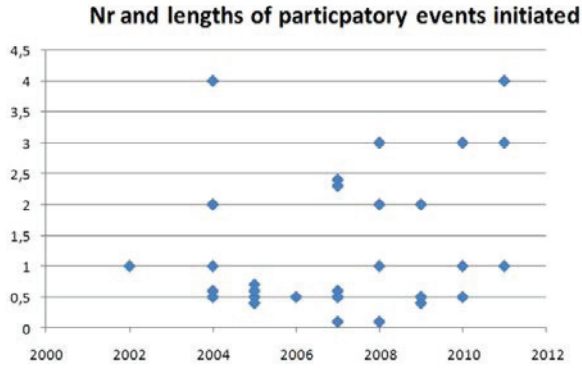


Figure 5.3. Visualization of the number of user involvement activities initiated and the length of the projects in years.

Between 2005 and 2007, the core values and the program for the competition were established, based on the experiences from the ongoing projects, and the entire process was still under preparation. Visitors and employees were involved as designers at different levels and new networks and collaborations were developed. Examples are design labs set up to allow children to design the library of the future (Aarhus Municipality, 2012), user involvement methods being tried out and grounded in the organization through Unleash the users (Aarhus Municipality, 2012), IT

artifacts were developed to e.g. gather data in new ways about visitors' use of the library and the city (Aarhus Municipality, 2012) and employees worked for six weeks with developing activities and ideas. During 2008, the project competition was finally initiated and public information meetings were held (Aarhus Municipality, 2012). During the course of 2008 there were further development of services and activities in the new house, but also of the layout for strategies to e.g. involve the user in development processes of the library (Aarhus Municipality, 2012) and methods to open up the organization. In 2009-2010, the winner of the competition was selected and development of the architecture and functions were able to begin to take form. Once again, new projects were initiated such as Families at Play in the Library (Aarhus Municipality, 2012), which came into being as a consequence of the decision that children and families were to be a prioritized user group in the new library, but also in order to try out new roles for the librarians. New tools for user involvement were developed and experiments performed together with new partners and networks also took place to make the library break out of the box (Aarhus Municipality, 2012).

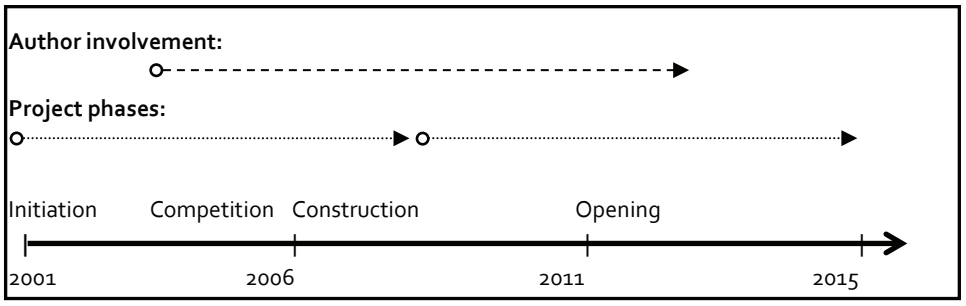


Figure 5.4. The projects can be divided into two phases, where the first phase consists of the projects informing the architectural competition program in 2007. The second group of projects informs the building of the UMS after the competition was set.

From 2011 until the project is completed in 2015, there will be continuous experimentation and also refinement of the main project design. Citizens, partners and employees will all be involved as active designers in the design of details such as accessibility, new services, networks, the interiors, methods, competences, roles and activities. Transformation Lab II has been initiated, aiming to conclude as the move to the new building commences, and there is more weight on analyzing the digital needs of the citizens and digital support of communication in physical space, see Figure 5.5.

Figure 5.5. Collaborative workshops on the future library: a) in 2004 in "the Interactive Children's Library" and b) in 2012 in "Transformation Lab II"

Transformation Lab II

The project called Transformation Lab is one of the projects which have contributed the most to involving citizens and staff in the process of forming the future library, both regarding the identity of the library and its physical shape. The Transformation Lab project recognizes the digital revolution taking place and views the library as an interactive interface for access both to digital resources and to physical ones. The project establishes an interactive exhibition space and experiments with this new place by exploring the interaction between user, space and material. Public experiments have been performed in the foyer of the main library in Aarhus. This space is flexible enough to house very different types of activities and dialogs, why a few tangible experiments in close collaboration with users and staff have been conducted. Some of the results and insights from the first round of the Transformation Lab project include that flexible spaces are necessary, that open events are a good idea and are well received, that the physical library needs to be augmented with interactive technology, that networking is critical among users, IT specialists, library staff, architects, etc., and, finally, that users need to have a more visible role inside the library (Aarhus Municipality, 2012).

Figure 5.6. Activities for children in Transformation Lab II.

The Transformation Lab project was considered to provide so much experience and useful results that it was decided to continue working in this manner. In the second round of Transformation Lab, initiated in 2011, focus has been placed on prototyping library services for the UMS. The project aims at trying out services to investigate user needs, but also to develop competences among the staff. The project will develop services iteratively in cooperation with staff and external partners and it will be staged in the main entrance hall of the Main Public Library in Aarhus. Some examples of services are installations and milieus for families playing together, a welcome and hostess service for the library, new types of librarian services, e-book merchandise, and a digital café. The project is still ongoing and so far all results are preliminary, although there have been some successful participatory design events where the employees have been inspired to form their own workplace and roles. My role has been to find out more about the needs of the library users, employing different types of methods, as well as leading workshops with employees who are designing new services and are actually changing their workplace and roles, see Figure 5.5 & 5.6.

The Interactive Children's Library

The vision of the two year Interactive Children's Library project was to develop prototypes of new IT services and physical installations embedded in the physical spaces of the library that challenge, support and promote curiosity in the play and learning activities of children. I was involved in all parts of the project. The project generated new design thinking in the public library, a series of new design concepts, and two computational prototypes, StorySurfer and BibPhone. StorySurfer is a spatial book browsing installation for children, and the BibPhone enables children to annotate physical material with digital recordings. The papers "Inquiry into Libraries – A Design Approach to Children's Interactive Library" (Eriksson et al., 2007) and "StorySurfer – a playful book browsing installation for children's libraries" (Eriksson & Lykke-Olesen, 2007) are results of this project.

Background

There are many challenges and opportunities to consider when designing for the children's library domain: the behaviors, skills and needs of the children, the decreasing number of visitors, the massive free information potential, the need of a meeting place, and the existing technologies. The project aimed to investigate potential in seeing such factors as material for design and to join them in design proposals. The research consortium was comprised of various competences from the Interactive Spaces Research Centre (2012), industrial partners, and representatives from five major children's libraries. The structure of the project facilitated several experimental periods involving children in the test drive of the installations and in different iterations. The ambition with the designs were e.g. that the children would be able to engage several senses and even their whole bodies when experiencing and dealing with information and for noisy activities to become accepted on equal basis with more silent ones, e.g. reading. The ambition was also to re-establish the importance of meeting in a physical room by emphasizing and staging the social qualities such meetings generate and also to work positively for children to view IT services as a natural and attractive part of a learning environment.

Design process

The design process led to a range of different concepts within the domain of children's libraries (Eriksson, Krogh & Lykke-Olesen, 2007). Ideas were informed and changed through design iterations and the entire process was highly research driven with respect to the other parties in the consortium. The prototypes evolved through numerous iterations by sketching out ideas and discussing these with the core group and also through user testing of prototypes at different stages. We performed field studies at three different public libraries early on in the design process to gain insight into children's libraries (See figure 5.7). Apart from observing the physical space and organization of different books and materials, we had informal talks, unstructured interviews and sketch sessions with children visiting the library. We asked the children to tell us about the library,

why they were there, and who they would meet. We asked the children to make short video films about the library, where they would film each other demonstrating and talking about the library. Furthermore, we asked the children to draw from one of two themes: either what the library is like in a hundred years or what a library on the planet Mars is like (Figure 5.7.).

Figure 5.7. A) Researcher studying children playing a computer game, B) researcher sketching with a child, and C) library drawing by a child.

Our findings from the user studies show e.g. that many children find it difficult to find a physical location to hang out. Also, shelves are not the preferred ordering and display of books seen from a child's perspective and the children expressed interest in having more information on the story to help them decide which book to read. New technologies do not stay strange to children for long, but are quickly adopted as an everyday element in the environment. Children do not use computers to search for books as the interface of search engines and browsers available at the library are perceivably more suitable for adults.

StorySurfer

StorySurfer is a multi-user spatial book browsing installation for children, 5 meters by 3.6 meters in size, comprised of a floor with pools of books related to keywords and a table where the books chosen by the children can be viewed in more detail (Eriksson & Lykke-Olesen, 2007). Aiming to put focus on the physical aspects of the library and inspired by technologies supporting potentially social or collaborative interaction, we focused on the floor and the table as two surfaces that relate to the body in different ways. By making this distinction, the search for books was divided into two activities: roughly browsing pools of books with your body on the floor and then more in detail with your hands on the shared table. The interaction on the floor and on the table both support multiple simultaneous users interacting through their own cursors (Figure 5.8).

Figure 5.8. StorySurfer prototype installed at the library and a diagram of the set-up.

Setup

The physical setup is 4 meters by 6 meters in size and has been designed as single plane folded into a waveform, creating a continuous surface between a floor and a table, see Figure 5.8. The edges of three sides of the floor hold nineteen buttons, evenly distributed and available for the children to step on in order to configure the application. The table surface is made up of translucent glass suitable for projection from beneath. The digital setup consists of two desktop computers, two web-cams, a reconstructed keyboard, four LED pens, and three projectors. The computers are in direct contact with the database of the library which prevents books from appearing in either of the projections if they are not present in the library at the moment.

Interaction

There is no specific order for interacting, but the initial idea is that users make a rough search on the floor, pick up some book covers by sending them to the table and then go on to further inspecting them there. On the floor, the interface is capable of displaying up to three sets of book covers that match a specific keyword, with overlaps visualized in a Venn diagram (Figure 5.9). Stepping on a button expands a new blob and displays a new set of book covers. Entering the floor surface, the user is provided with a magnifying lens that is projected in front of him/her and that follows him/her around on the floor (Figure 5.9). Multiple simultaneous users can interact individually through their projected magnifying lenses. When a lens rolls over a book cover the image expands and after keeping the lens over the book for a short while, a graphical timer will appear around the lens, counting down the seconds until a selection command is executed, meaning that the book is sent from the floor to the table: this is visualized as an animation of the book cover literally sliding up the waveform onto the table (Figure 5.9).

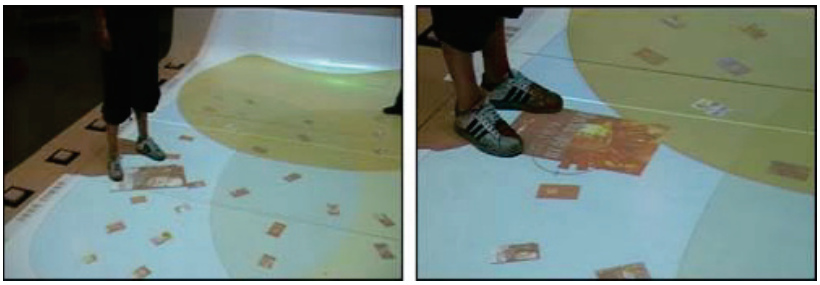


Figure 5.9. Using the floor: Expanding a book cover, and invoking the selection timer.

When books arrive on the table, they reveal new properties that are not visible on the floor, such as e.g. information on the author, a summary, related books, and access to a printer. The table interaction technique allows up to four individual users to interact simultaneously (Figure 5.10). To locate the physical book in the library, it is possible to print a slip of paper that contains directions to the shelf, related meta-information, and the cover image (Figure 5.10).

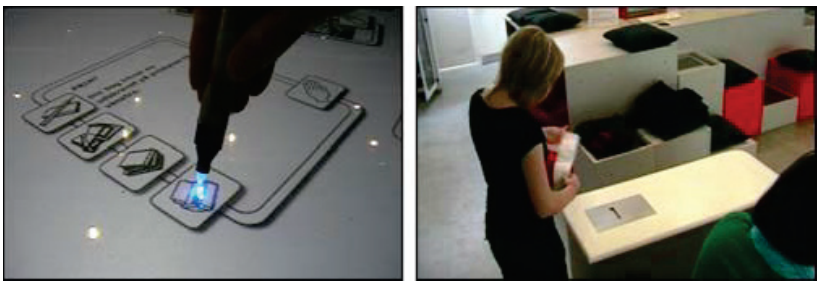


Figure 5.10. Using the table and printing a description of the book.

Evaluation - StorySurfer

Empirical analyses of StorySurfer lead to a more general discussion of interactive use of space and mediation of information in children's libraries of the future. StorySurfer is able to raise awareness of new routines around e.g. searching for information as it puts the user at the center of attention and makes searching for information become another form of (often social) activity. The children have to enter the floor and use their entire bodies in their search for information. StorySurfer supports the project ambition to have pervasive computing give new forms of (interactive) use of space and new forms for cultural experiences and learning processes. StorySurfer creates attention around searching for information that catches and involves children, in contrast to the traditional practice at the librarians table.

BibPhone

The BibPhone consists of a couple of devices for recording audio annotations onto books and other materials, functioning as the mediator for playing back annotations stored on books in the children's library. Hereby, the children's library becomes an invisible landscape of sound tightly connected to the physical materials which is open for the users to explore and contribute to. For more information, see (Lykke-Olesen & Nielsen, 2007).

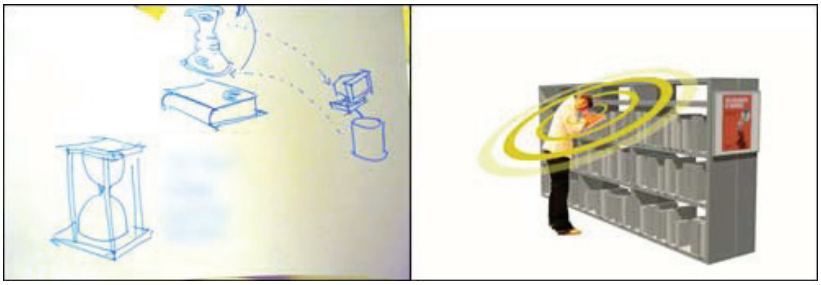


Figure 5.11. Early sketch and rendering of the BibPhone.

Setup

The BibPhone combines physical and digital properties and infrastructures of the existing library (see Figure 5.11 & 5.12). The BibPhone exploits RFID and Bluetooth technology to establish a wireless connection between the physical book and its metadata, which is stored in the central library database. The design is based on pushing a single button and providing sound feedback. To emphasize the connection between physical and digital layers, the RFID antenna is designed in such a manner that it needs to be in close contact with a book to read its ID. When the BibPhone detects a book, the ID is sent to the backend PC that queries the database for that specific book. If there are sound files connected to the book, the PC will start playing them and the sound is transmitted via the Bluetooth link to the BibPhone loudspeaker. If the book does not have any sound files connected to it, the BibPhone will respond with "this book is empty - press the button if you want to record a sound on this book".

Figure 5.12. The two BibPhones in action.

Interaction

The configuration is handled by the librarians, who decide whether the BibPhone can record new sounds or if it will only be used to listen to existing sounds and in what order. When a user has ended a recording, the BibPhone replies: "Your sound has been recorded on the book" and the sound will be played back for the user to hear. Two prototypes were developed that require slightly different kinds of use. The green vase prototype has its loudspeaker set at a low volume and is intended for a single user. The white oil can prototype offers higher sound volume and, thus, allows the investigation of books to become a social activity.

Evaluation – BibPhone

The prototypes have been tested at two different libraries and were also connected to the databases of the libraries. There are many additional possibilities embedded in the BibPhone infrastructure that could address and exploit the link between physically distributed materials of the library and digital information. For instance, content inside the books may be activated along with the BibPhone in storytelling games or treasure hunts in which prerecorded messages are linked to specific materials, telling the children to find e.g. certain passages in a book that will lead to the next clue or the next book. Another idea is to see the book as a physical link to real-time data. A book on the weather could e.g. link directly to the local weather forecast or a book on soccer could play back the 1970 World Cup semifinals. Hereby, the landscape of sound becomes much more dynamic and perhaps more interesting to revisit, turning the library into a place different from online services.

Families at Play in the Library

Families at Play in the Library is a two year project consisting of public libraries from three different cities in Denmark, Aalborg, Århus, and Randers, and two research centers, the Center for Playware and the Center for Interactive Spaces (Families at Play in the Library, 2012). The project investigates children playing, children playing with adults, and shared play culture through new innovative services and family activities at the library with focus on play, but also how the members of the family can use the library simultaneously while still involving in individual activities. The project strives to gain knowledge about families and play and to develop and test new play concepts at public libraries for families with children. The three different libraries develop concepts and installations individually and together, try them out and pour new knowledge and experiences into the project. Examples of concepts are a time music machine, a treasure hunt, a pirate world, a nostalgic playroom, and the U.F.O.scope installation (Playing families, 2012). I was involved in developing the U.F.O.scope installation, but also in the steering group and as a workshop leader and a workshop participant. The appended papers "U.F.O.scope! – Families Playing together at the Public Library" (Eriksson, 2010) and "Intertwine and Play – Explorations into the Future of Children's Library Services" (Eriksson & Johansen, 2012) are results of this project.

Most families experience a shortage of time and it is important for them to find a place where they are able to play and experience things together as a family, to increase the family bond and to have quality time together. Play is one of the most important ways in which children can express themselves culturally and create their cultural identity (BS, 2008). Play is a universal activity sought after by both children and parents and is particularly true for play activities in which both groups can engage in together, although it is a challenge to make the parents let go and dedicate to playing. The project originates in experiences from the previous Interactive Children's Library project (Eriksson et al., 2007) and aims to go beyond existing interaction modalities, acknowledging the social needs of the children and their families and to explore if new ways of navigating the physical library and discovering information will make the resources of the library more attractive to existing and new user groups.

The U.F.O.scope

The U.F.O.scope is an interactive installation aiming to evoke curiosity and engagement, both for the installation itself and for the physical library and its many resources. Inspired by Dindler et al. (2007), the prototype has been further developed through several design workshops with all project partners and also through physical tryouts and bodystorming at the library.

Figure 5.13. The U.F.O.scope and the Martian at play in the library.

Setup

The U.F.O.scope is basically a large horizontal tire tube on wheels filled with technology, protected by an acrylic and wooden top. It contains an RFID reader, an accelerometer, speakers and a screen. The hardware is well-protected and survives kicking, pushing and riding.

Interaction

By pushing and kicking the U.F.O.scope, the user is able to discover the library and its content through play. When crossing an RFID-tag, information connected to that tag is displayed on the screen and played through the speakers. The information is presented in the four media categories the library offers its users, i.e. text, film, sound and pictures, in order to stronger contextualize the content to the library and evoke curiosity for its different types of resources. The round shape of the installation supports collective play, as several people can be in control simultaneously (5.13).

Figure 5.14. A family playing with the U.F.O.scope at the library.

Evaluation of the U.F.O.scope

The evaluation consisted of user studies in four different iterations, at three different libraries in Denmark (Figure 5.14). The outcome of the project was that the shape immediately attracted children and the technology worked properly, but it also meant a great deal of input for the iterative and continued design process. Children were inspired and played together, even though they did not know each other. Families inspired each other, so that one family watched another and then gave the activity a try once the first family was done. The U.F.O.scope moved around in the library, making children venture into places in the library where they would not normally go and they also discovered material there they would not otherwise have found. Under normal circumstances, most children find the adult department boring, why parents leave their children behind in the children's department when going to search for their books. Herein lies a great potential for the U.F.O.scope, as it makes it possible for any department to be fun and mysterious and children have something to do when discovering the content and the setting in departments other than the children's library. The U.F.O.scope is attractive to all age groups within the family, which is one of the many challenges of this project. Traditionally, children are used to be in control of the toys, while parents often hesitate to devote themselves to play. Parents are used to be in control of the library functions, i.e. searching for materials and making contact with the librarian, while the children follow along. With the U.F.O.scope, both parents and children have an equal amount of control over the library visit, which is a difference compared to the usual library visit of the family. The content and the form of interaction support the three themes that have been investigated in this project: nostalgia, competition and physical movement.

Four Space Model – a Methodical Exploration

As an attempt to unfold and identify the context of the project, a model for insterspace design was developed, guided by the research program and informed by the design explorations. The Four Space Model is an analytical tool, an attempt to divide the findings and the prototypes into different design spaces (Eriksson, 2011; Eriksson, 2007). The term *design space* is often used for the space of opportunities and constraints in a design project. Working with information technology as a material for design means working with software, hardware, traditional physical materials and social aspects, spanning over the *interactional, digital, physical and social* design spaces. The model aims at making the resources of all four spaces more visible during the entire design process. The model can be used as a tool in the data collection phase, in the design phase, for definitions, and in discussions (Eriksson et al., 2006; Eriksson, 2011). The model is an attempt to mark out that all the four design spaces are equally important when designing computational things, which could be visualized e.g. in a Venn diagram as in Figure 5.15.

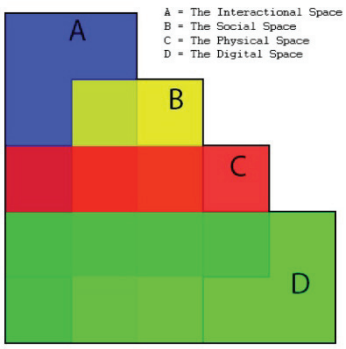


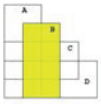
Figure 5.15. Illustration of the Four Space Model. The Venn diagram shows all logical relations between the sets of design spaces and the universe. Four potential design spaces have been identified to focus on and define the interspaces: *The interactional space* - the sensor reading space where movement, fixed points and input can be sensed; *The social space* – people's skills and everyday life, communication, co-operation, attention, activity, intention, understanding, place; *The physical space* - everything visible, meaning things, environment, personal gadgets, appearances, locations, physical interactions, physical time/space; *The digital space* - projections, communication protocols, computer models, infrastructures, relative time/space, augmented space, machine communication.

Below, definitions of the four spaces are presented and to further explore the model, an example is presented in which the model has been used in an actual design process, the development of StorySurfer. The focus here is on observations in the four different design spaces and, furthermore, how these observations have turned into explorations. Other uses of the model are of course possible, which will be discussed later.

The Interactional Space

The interactional design space spans between existing technology and the physical abilities of human beings. The interactional space is defined as the sensor reading space where movement, fixed points and input can be sensed. On the user side, input is inspired and constrained by the multiple intelligences and functions of the human body. On the technology side, a sensor reading space can e.g. be the ability of a microphone to record sound or the area where a camera is able to pick up physical input such as movement or appearances. By investigating the borders and possibilities of this space - static or non-static, aware or unaware - it is possible to use the full potential offered by the sensor and the interaction taking place. There are unlimited mapping combinations between the sensor and the interaction. This may be a huge inspiration to the design process: trying out different combinations to make computing become more similar to the everyday actions performed by people. The interactional space starts out with the technology and bodies at hand, but curious investigations vastly extend it, enlarging the possible design space.

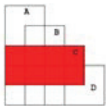
Interactional Space Observations	Interactional Space Explorations
The children's library contains traditional computers that the children use for internet access, to chat and to play games on. Typically, one child sits in front of the computer and controls the application, while other children watch, unable to interact. There is a need for forms of interaction where several children can be in control simultaneously.	StorySurfer is divided into a floor and a table which both support several simultaneous users. Different types of tracking technologies have been explored and a web-cam is used to track users on the floor. The floor tracks everyone who steps on it, an entire school class or a single individual. Each person is given control of an individual digital cursor that follows the body.
The children should be able to engage several senses, even their whole bodies, when experiencing and dealing with information, which opens up for several different types of interaction techniques and sensors. Interaction is inspired by Gaardner's multiple intelligences.	No extra gadgets are needed to interact with the floor and it responds to body movement. Different interaction techniques have been tried out, but the home-made pressure sensitive buttons on the edge of the floor were chosen and tried out for the task.
An increasing number of libraries use RFID-technology and robots to replace bar-codes in tracking books going in and out of the library.	RFID has been investigated as a design material, what type is in use, reachability, sensitivity, and so on. In the original idea, there was an RFID reader on the table of StorySurfer so that information about the book would appear when placing the book .



The Social Space

This is the space where people meet: the social design space includes technology but spans the distance between people. This is where space is given meaning and transforms into places (Harrison & Dourish 1996). The social space is defined as spaces where people act, live their everyday lives, and co-operate; it includes attention, activity, intention, understanding, communication and place. This is not a space for designing the user or the user's behavior, this is the space where designers start with the user as a reference point and support the user at the level of the user. In this space, people communicate with several others simultaneously: over long distances with the use of technology and over short distances through face-to-face communication and with body language and gestures. There are hidden rules, hidden messages, and value signs. Failure to address this design space means missing out on human behavior which can lead to designing the user, not just the system. This design space can be used as an inspiration, e.g. to reveal the potential in people's habits and behavior. The social space greatly impacts the way people live and communicate, i.e. the relationship they have to the computational thing and to each other using it. To investigate aspects of the social space, a deep and nuanced analysis is needed, as appearances are deceptive.

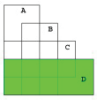
Social Space Observations	Social Space Explorations
The children's physical library is a highly social place, either for meeting with friends to play computer games or for other typical social encounters, e.g. children meeting other children with similar interests in a place where there are books that interest them both. The library is a third place, i.e. a place where regular people from all parts of society are able to meet in a playful mood.	Being on the floor of the StorySurfer, the children can choose among fifteen different categories. In this way, they are able to see who chooses which categories and thereby find out who they share an interest with. There is also a discussion going on among the children regarding if they wish to stay with their choice of category or move on to another one, which causes the children to engage and socialize with one another.
Alternative information such as e.g. which book is most popular at the moment is important to children.	It is possible to see information such as "others who borrowed this book also borrowed:"
There is an increasing awareness and acceptance of noisy elements such as game playing and hanging out is an important element in a children's library. The children's library should build upon values appreciated by children and not just be a miniature version of the adults' library comprised of material targeted at children.	StorySurfer provides an arena for hanging out or discovering information. The installation does not emit sounds, but the children using it do.



The Physical Space

This design space spans physical constraints and contains all types of visible things, such as human beings and computational things. The physical space is defined as things, context, personal gadgets, appearance, location, physical interaction, physical time/space or simply everything visible to the naked eye in the environment. This is where the system meets the user and the physical context in which the computational thing lives. See the potential in people's gadgets and behavior, use that as a base to find new ways of interaction, and design the technology, not the user. The embedding of information systems into our physical surroundings makes understanding of physical space in relation to computer mediated activities foundational for interaction designers. When designing spatial interfaces, physical materials come into play and designers should understand how the properties of IT relate to spatial properties and boundaries as design materials. Spatial and physical aspects are important in the final system and should therefore be carefully attended to in the overall design process. It is the responsibility of the interaction designer to care for the physical aspects as well as the interface aspects in design.

Physical Space Observations	**Physical Space Explorations**
Shelves are not the preferred ordering and display of books. Books placed together make the titles difficult to separate from one another and it is also difficult to assess which book may be interesting. Children perceive it as if the books turn their backs to them. In response, librarians pick out books for cover display on special stands. When the cover has been turned to face the child, the number of children borrowing the book increases dramatically.	StorySurfer provides the children with an opportunity to search for materials without staring at shelves or trying to use the computerized search system of the adults. In StorySurfer, children browse among the covers of books instead of among the backs of books, so that the pictures make it easier for them to separate the books from one another.
The extensive Internet-based services enable people to perform library services from their homes. The need to go to the library to collect information materials is decreasing.	The installation provides the library with a unique thing that has to be experienced in the physical library and is thus a means to attract visitors to the library.



The Digital Space

The digital design space is where different computational things communicate with each other and with the users. This design space spans the communication of the different computational things and their output. The digital space is defined as projections, communication protocols, computer models, infrastructure, relative time/space, augmented space, and machine communication. What is happening in this space can be communicated to the user through various kinds of feedback. For instance, an individual cursor on a shared display can contain information about the input previously provided through the interaction device.

Digital Space Observations	**Digital Space Explorations**
Children see IT services as natural and attractive parts of a learning environment. RFID-technology and robots replace bar-codes used in tracking books going in and out of the library and this new technology does not stay strange to children for long, but is quickly adopted as an everyday element in the environment.	The size of the digital surface in the physical room is attractive to children and they are not scared to enter the projection on the floor and do not hesitate to investigate all the functionalities. To visualize the connection between the table and the floor, the digital material chosen by the children in the projection on the floor slowly slides up the "wave" and ends up on the table.
The library has enormous databases in which there are many different kinds of information. Most of the data is used internally within the library or is just stored and the library staff does not know how to make it available to the visitors.	The installation is connected to a large database with pictures of children's book covers, categorization words, content, placing, information about e.g. "others who borrowed this book also borrowed:", and so on. The number of objects is about five thousand.

Deployment of the Four Space Model

The Four Space Model is meant to be used as a practical tool in several ways. When doing observations, the four spaces can be used as glasses or reminders of what aspects to look for and making sure no aspects are forgotten. The model presents four ways of experiencing and observing a space. When analyzing the observations, the model can be used as a discussion tool: discussions will likely appear when presenting observations from a certain perspective as others in the design team probably have a different view on some of the aspects. This may bring about very fruitful discussions in which it is possible to assess whether any of the four spaces are overweighting and to analyze why. Further on in the design process, the model can be used as an inspiration and brainstorming tool, e.g. in attempts to expand or combine the design spaces in different ways. During later stages in the design process, the model could be used partly as a design decision tool if e.g. there are certain aspects that should be enhanced with reference to goals of the project. After the design project has concluded, the model can be used as a tool to evaluate which aspects were most inspiring for the project, which aspects were most prominent at the beginning of the project, and how this has changed during the design process. This is important both when presenting the project and when evaluating the constellation of the design team and the work process for future projects.

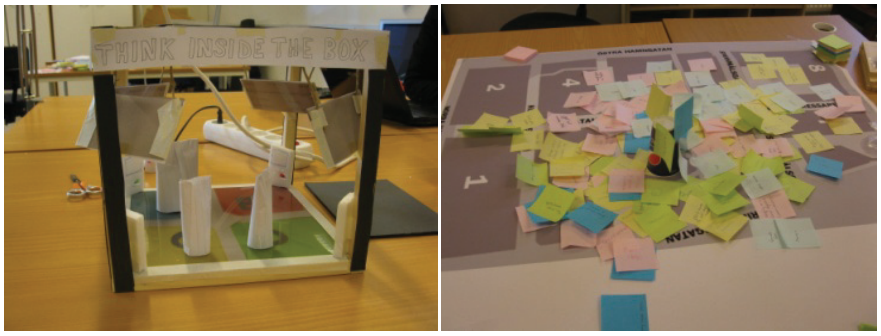


Figure 5.16. Workshop with interaction and game design students using the Four Space Model.

The model has been used in combination with other methods in different kinds of design research projects. It has also been tested in a more focused manner in two different one-day workshops, at first primarily with architect students (see Figure 5.17) and later on with students in interaction design and game design, see Figure 5.16 (Eriksson, 2011; Eriksson et al., 2006). Both workshops concerned designing for public spaces and contained elements of observation, analysis, idea generation, and prototyping. The different types of designers used the method differently: the architects easily made use of the physical and social spaces, whereas the game designers took more of an engineering approach and used the physical space to frame their creativity while experiencing difficulties using the social space when gathering data. In their design explorations, however, social space comes more into play, highly inspired by discussions with others.

The interaction design students grasped all four spaces in a very balanced way, even though there was an overweight in the digital space, at least compared to the other groups. What was really interesting to see was how interaction design students and game design students using the Four Space Model took one step away from their safe environment, where they primarily design graphical applications and stand-alone gadgets, to create more spatial designs, i.e. designs in which interaction is more spatial, and also how they included more spatial and contextual considerations in their reflections. Using the Four Space Model, the architect students took a huge step into a world previously unknown to them and, for the first time, they were actually able to use digital design materials in their concepts and design ideas (for further details, see Eriksson et al., 2006).

Figure 5.17. Testing of an early version of The Four Space Model with architect and design students.

6. Materializations

This chapter seeks to frame and guide interspace design in public libraries in line with the design program and with the use of practical process tools, examples and challenges derived from theory, experiments and interviews. The aim of the materializations is to support others who design intertwined installations and services for public libraries with information technology as a design material. The chapter will also emphasize the core idea of the design program: to have a playful approach to designing with technology, to intertwine technology with the existing public library space, to have multi-scaled design projects as informants, to emphasize the importance of a participatory approach both internally and externally, and to commit to designing and informing the remarkable design process. The chapter is divided into key condensations of insights from an interaction designer's point of view, i.e. through a toolbox for interspace design in public libraries, a design process toolbox for multi-scaled interaction design.

Toolbox for Interspace Design in Public Libraries

On the basis of the design explorations, the theory and the design program presented in this thesis, I will sum up the work in a toolbox related to the development of interspaces in public libraries. The toolbox presented here are concretizations of the challenges met when working with Multi-scale interaction in public libraries, and are labeled as follows: *To Move from Individual Design to Social Design, To Move from Closed and Regulated Systems to Extendable, Evolving and Open Systems*, and finally *To Move from Disjointed to Intertwined Systems*. In line with the Four Space Model, the challenges listed support explorations in all four design spaces, i.e. the physical, digital, social and interactional design space (Eriksson, 2011).

To Move from Individual Design to Social Design

The public library is a social place, a potential hub for new encounters. From a design perspective, a series of concerns have been identified that are relevant for designing for interaction, and these are Exploit the behaviors of people, Transfer and exchange, Design for social interaction, Think market place, Act out, Create common grounds, Encourage participation through construction and contribution, Play!, Aim for participation and study the traces, Honor Gardner, Remember the good times, Compete and Encourage random encounters. Below, these concerns will be presented in short.

Exploit the behaviors of people

When designing for interaction in public libraries, the systems should support and exploit the behaviors of the people who are there, e.g. multiple simultaneous activities in the same place. This is why there should be a democratization of interaction, where all users are potentially able to manipulate the interface simultaneously (Eriksson, Hansen, Lykke-Olesen, 2007). New applications and technologies capable of multi-user interaction on shared surfaces are constantly developed. In the beginning, the focus was on sharing existing single-user applications across a network, such as e.g. in the MMM project (Bier, 1991), and later on the notion of Single Display Groupware (SDG) was introduced (Stewart et al., 1999). Findings such as significant learning improvements (Druin et al., 1997), higher motivation (Inkpen et al., 1995), higher levels of activity, and less time off (Inkpen et al., 1999) were arguments supporting the development of technologies where several people were able to interact simultaneously on a shared surface. Other multi-user systems include capacitive surfaces or devices such as the Windows Surface (2012), which copes with input from several users simultaneously, or active ultrasonic pens such as Mimio Virtual Ink (Mimio, 2012). Even more interesting is the capability of tracking and distinguishing between actions of users, such as the Multi-Light Tracking System does, a system that allows four users in StorySurfer to interact simultaneously on a back-projected display (Nielsen & Grønbæk, 2006), or a touch screen that can tell people apart only by their fingers (Gunze, 2012). The technique is based on direct interaction with the display, but this one-to-one mapping is a difficult interaction paradigm to apply in public libraries because parameters such as e.g. scalability, sanitation and physical security may cause problems. In StorySurfer, both the camera tracking movements from the ceiling and the one in the table support several simultaneous users.

Personal mobile technologies can be used to implement simultaneous input by several users and especially to track and distinguish users, allowing the application to associate actions to a specific user, such as e.g. transfer of data or navigating. In the PhotoSwapper application, multi-user interaction is supported through the Mixis interaction technique (Eriksson et al., 2007). This technique uses people's mobile phones as interaction devices and scales to the number of users as long as they carry a mobile device. If devices already support multi-user interaction, consider what would happen if shared or individual interaction would occur (Eriksson et al., 2007). Social

interaction is a fundamental part of public life and needs to be supported, which is why multi-user interfaces may be able to facilitate new ways of living in and using public spaces.

Transfer and exchange

In systems supporting multi-user interaction, personal mobile devices can be used to implement simultaneous input and, particularly interesting, they may be used to track and distinguish users, allowing the application to associate actions to a specific user, such as e.g. transfer of data or navigating. One way is to have the mobile device control the interface (Eriksson et al., 2007), although to further explore the possibilities that comes with this technology and to further enhance user involvement, it is necessary to consider the possibility of exchange, i.e. users leaving and taking information with them through personal interaction devices (Eriksson et al., 2007). In the Q&A game iFloor, visitors of the library pose questions via SMS to the large floor-projection and the answers to the questions are sent back to their phones, allowing the game to continue when they return home (Krogh et al., 2004). Using the personal mobile device as an interaction device increases the portability and eases the physical security and sanitation of the system. When using the private device for public interaction with a shared display, it is important to have the user control which data is transferred and displayed where in order for sensitive data, such as names and phone numbers, to be kept private (Eriksson et al., 2007).

Consider issues regarding information security and privacy when using personal technology as interaction devices. Here, it should be considered which data is transmitted, if personal data may slip out, or if it is possible to identify the user? At a smaller scale, consideration must be paid to if e.g. a user can be identified in an application with multiple cursors or if interaction may take place anonymously.

Design for social interaction

Focusing only on multi-user design is not enough to build truly public, engaging, and pervasive systems for use in public library spaces. They also need to be designed for social interaction. Inspired by Ludvigsen (2005), social interaction is here viewed as an entity in itself in order not to focus on the single user experience of participation.

Think market place

Many technologies are not designed to focus on interaction between users. One approach to support social interaction by what Zagal et al. (2000) define as stimulated social interaction, as in e.g. the game Pirates! (Björk et al., 2001). In this game, players are not mandated to interact with co-players for the game to proceed, but the game encourages spontaneous social interaction to occur during gameplay. When designing for public library spaces, the applications and technology need to support spontaneous social interaction, i.e. interaction that occurs naturally between the participants (Zagal et al., 2000). Inspired by a traditional market place, the relation between the public library space and the users can be changed by using the public library surfaces to upload, discuss, view and acquire content (Eriksson et al., 2007). Then, social interaction may take place

spontaneously among the visitors of the shared market/screen, but it may also be mediated and stimulated by objects within it. In iFloor and StorySurfer, the users' focus on the shared display, where it is possible to add, change and bring information (Krogh et al., 2004; Eriksson & Lykke-Olesen, 2007).

Act out

Acting in a public space such as the library involves constantly considering social acceptability (Eriksson et al., 2007). Should interaction be discrete, embarrassing or with disturbing noise, light or gestures? Does it involve a high or low level of dexterity? Are both hands and the whole body needed for interaction or is it possible to have a hand free to hold a book, an ice-cream or a baby-stroller?

Create common grounds

Public libraries are hubs for new encounters, why the presence of a multiplicity of visitors with varying backgrounds and intentions is a further resource for design. By enabling and supporting shared interaction, their emergent behavior may contribute to the development of fruitful social practices in the library (Dalsgaard et al., 2008).

Encourage participation through construction and contribution

Knowledge stems from the transformation of an indeterminate situation into an understandable one and this process often necessitates active involvement in processes of construction and contribution. This emphasizes the potential of dialogical systems that encourages visitors to supply input which in turn may further social interactions (Dalsgaard et al., 2008).

Play!

Play can work as a facilitator for users of the library to start using more diverse kinds of media. Play is here understood as a common human practice, in which we all – children and adults alike – engage and a practice we are prepared to go through a lot of effort to perform (Eriksson & Johansen, 2013). Creating events, interiors and settings with a different set of media and where each installation points in the direction of other types of media, strengthens the link between the physical and the digital resources of the library. For instance, a Mars universe can disseminate books, music, films, sounds and computer games about space. By using play as a driving force to entice people to join in, it is possible to change a predetermined vision of a library visit into something more powerful. Play activities may not be a part of the general public perception of the library, which is why it is an important ingredient to use in order to make the library move away from the quiet place where people come only to borrow and return books (Eriksson & Johansen, 2012). Also, play makes people open up socially and may bring them together, both within families and with strangers. Results from e.g. the Families at Play in the Library project, show that innovative intertwining of play and technology engaged both children and groups of adults: parents and librarians (Eriksson & Johansen, 2013).

Aim for participation and study the traces

Participatory use of the installations through play, competition, exploration, construction and contribution are tied to the situated meanings ascribed to the libraries. Active use of the installations represents different ways of contributing to the specific places, rather than just accessing information. These contributions and traces occur both at the level of adding some sort of information, be it a review of a book or leaving traces of play in the children's department for somebody else to pick up and be inspired by, and at the level of engaging oneself in social interactions tied to the place, such as using the StorySurfer to explore books in collaboration with other visitors (Eriksson & Lykke-Olesen, 2007) or by piquing the curiosity of fellow library visitors by moving about the library while talking to books through the BibPhone (Nielsen & Lykke-Olesen, 2007) or finding props in a treasure hunt (Eriksson & Johansen, 2013).

Honor Gardner

We build knowledge through all of our senses and are capable of employing situating strategies to do so if provided the means in the situation (Dalsgaard et al., 2008). To support this, we can supplement the visual interfaces with multi-sensorial and multimodal ones and enable multimodal interaction by inviting several of the intelligences proposed by Howard Gardner (1993).

Remember the good times

Nostalgia makes people feel they are on familiar ground as they recognize things and know what to do with them. Nostalgia is a powerful source of attraction and makes people wish to involve others in their memories and knowledge (Eriksson, 2010). This became apparent when turning the library into a lumber room in the Families at Play in the Library project, where especially the Commodore 64 attracted many parents and made them devote a moment to playfulness (Eriksson & Johansen, 2013; BB, 2011). In the same project, the Time Music Machine used nostalgia to involve older generations and make the younger generations listen to their music and memories. In the U.F.O.scope, nostalgia was used to choose materials, e.g. pictures of classic cars or the sound of a modem, which the smiling parents would have to explain to their children, who had never heard that kind of sound before. In the interactive treasure hunt, this was more related to props and the pirate-themed world was chosen because it was assumed that people of all ages would be able to play along, which may not have been the case if e.g. a Manga-themed world had been chosen.

Compete

Competition is an element of play and a strong factor for engagement. It can be found in some form in all the activities of the Families at Play in the Library project, but is most obvious in the Interactive Treasure Hunt and the Time Music Machine (Eriksson & Johansen, 2013; BB, 2011). In U.F.O.scope, competition is not a part of the interaction, although it occurs when competing to find information the fastest (Eriksson, 2010).

Encourage random encounters

Decentralized systems rely heavily on the random interactions and explorations of a given space without any predefined orders (Johnson, 2002). Make room for people to meet and develop possibilities through staging interspaces for random encounters. Let time tell how things and spaces develop and how they are used. Create experiments, e.g. to see what happens when placing a sofa in a new location in the library or next to a new system. Stimulate people to meet through common interests or in communities rather than across status, age or gender.

To move from Closed and Regulated Systems to Extendable, Evolving and Open Systems

Public libraries have a history of being providers of information, but as digitalization, technology and media changes, the role of the library changes more towards guiding. In this change, the interactive systems must follow, and open up for dialog instead of pushing information. This raises some questions, namely what happens to the interaction between the physical space and the people present or between the people? Is it possible to design technology in public libraries that is more symmetric and democratic? Public users should be able to change this information push tendency, towards a situation where the public can expose, comment and edit elements of the public space. Thereby, the space is formed and shaped by people passing by. Seven concerns have been identified that can make the libraries move from closed and regulated systems to extendable, evolving and open systems. These are: Open up, Design for dialog, Come and go, Believe in self-regulation, Promote engagement through inquiry and exploration, Make it move and Bring your own device.

Open up

Most digital systems in public libraries are closed, controlled systems such as e.g. InfoGallery (Redia, 2012). Either they are not interactive at all or they merely support a few well-defined interaction sequences. Designing systems to support a public information dialog involves creating systems which are more social and less restrictive. The context-aware game "Can you see me now?" supports location-based, simultaneous interaction between multiple users (Benford et al., 2003). While playing, however, everyone is occupied with their personal device and the interaction and action all take place individually on the screen, despite the entire city being the game board. Focusing the user's attention on an individual private screen is a limitation in public places and the common denominator is missing. In e.g. StorySurfer, we tried to accomplish this openness by the shared display and the simultaneous interaction. In iFloor, the application is controlled through shared interaction, where users have to cooperate and use their entire bodies as interaction tools (Krogh et al., 2004). In PhotoSwapper and BibPhone, private material can be turned into public material and it is possible to share information with several other users (Eriksson et al., 2007; Nielsen & Lykke-Olesen, 2007).

Design for dialog

Dialogical systems encouraging visitors to supply input may also further social interactions. To foster this function is to bring in elements of construction and contribution, to transform the library from an information provider into a place for information exchange (Dalsgaard et al., 2008). To involve elements of user construction and contribution into the exploration of public libraries is to change from designing for pushing information to designing for information dialog.

Come and go

In order to support open applications that evolve through the use of people, the designer has to design for serendipitous or "come and go" interaction. The content of an application and the ongoing activities should not be affected by people joining and leaving the application and the system should support short-term interaction (Ballagas et al., 2004). However, because browsing a place is an intentional activity, joining interaction in the place requires the user to take action. Still, serendipity should be supported in the sense that the user is able to join spontaneously, without too much effort (Eriksson et al., 2007). The degree of serendipity of the system should be considered, offering the user the possibility to interact spontaneously, and serendipitous interaction could be supported by intentional interaction, where the user has to initiate and accept the application, or through unintentional interaction, where the user may even be unaware of his/her being included in the interactional system (Eriksson et al., 2007).

Believe in self-regulation

Enforcing rules is one way of controlling the use of an application, although for self-organizing systems the rules are made up as the system evolves (Eriksson et al., 2007). Within a social group, a range of local tacit urban rules exist, e.g. an unwritten rule for graffiti painters stating that a graffiti painter is not allowed to paint over a piece that he/she cannot do better himself/herself. These rules do not necessarily comply with the law and are primarily followed by the members of the sub-community defining the rule, implicitly or explicitly. Those kinds of rules are inspiring to the discussion of regulation, because in a way the graffiti world actually is self-regulated, although regulations are invisible to people outside of the community. This is not to be considered a claim that opening up for more uncontrolled interaction in public libraries does not come with any disadvantages. A controlled environment is much safer as people passing through may rest assured they will not be bothered by homeless people, racists, provoking statements or simply by people who behave in a strange manner. Control aims at making the environment pleasant, nice and secure. Interestingly, sometimes the most innovative ideas appear when something offends someone or something unexpected happens. By shielding off public libraries from uncensored, spontaneous events (while keeping a sense of accountability) the possibilities to be provoked in a positive sense also disappears.

In PhotoSwapper and BibPhone, everyone is offered an equal chance to display and control information (Eriksson et al., 2007; Nielsen & Lykke-Olesen, 2007). Of course, information offending other people will certainly be uploaded and recorded, as is the case with graffiti, but as the system is self-regulated, just as easily as it was uploaded or recorded, the offending material may be removed by the people who are offended by it.

Promote engagement through inquiry and exploration

Knowledge grows from inquisitive exploration and libraries can stimulate this process by framing intriguing situations and providing means for exploration (Dalsgaard et al., 2008).

Make it move

Physical movement is natural to children whereas it takes more effort to make adults move, at least to make them overcome the initial resistance and take the first few steps (Eriksson, 2010). Also, in making children move around, their parents will come along to see what the children are doing and, thus, they move around together. Physical movement has been explored through free play when the children's library was turned into a pirate world in the Families at Play in the Library project and is a vital part of the interaction in the U.F.O.scope installation (Eriksson & Johansen, 2013).

Every interaction is in a sense movement-based, however, by emphasizing the word "movement" in movement-based interaction, movement is no longer just the source of interaction: it becomes the central element in interaction. Movement-based interaction seems to be particularly suited for interaction taking place in a public or social context, such as public libraries, and it provides interesting alternatives to traditional interaction techniques, encouraging people to exercise (Eriksson, Hansen & Lykke-Olesen, 2006). Using movement-based interfaces may, however, be strenuous to the body and, thus, these kinds of interfaces are less suited for continuous activities, e.g. desktop work. Location-aware games (Barkhuus et al., 2005), games (Nintendo Wii, 2012), and interfaces based on accelerometer input (Patridge et al., 2002) are examples of systems based on movement-based interaction which are already available and interactions with e.g. StorySurfer and U.F.O.scope are based on this (Eriksson & Lykke-Olesen, 2007; Eriksson, 2010).

Bring your own device

Interaction devices may either be a device constrained to the site, portable personal technology, or the users' body itself. Considering sanitation, vandalism, maintenance and physical security, it is perhaps preferred to have portable interaction devices: e.g. personal technology was used as the interaction devices in PhotoSwapper (Eriksson, Hansen & Lykke-Olesen, 2007) and the human body in StorySurfer and iFloor (Eriksson & Lykke-Olesen, 2007; Krogh et al., 2004).

To Move from Disjointed to Intertwined systems

Here, the focus is on how to design with technology in order to strengthen and intertwine with the contextual aspects and values of the public library. This is opposed to designing interactive systems and installations that become superficial and insensitive to the library environment. The concerns identified are Respect the sense of place, Embody the design process, Follow the drift, Support and extend traditional functionality, Design for spatial evolvement, Intertwine, Go back to basics and Look for hidden potentials. These concerns are described in short below.

Respect the sense of place

Public libraries are established institutions which are rooted in communities and through the dual nature of their conceptual materials they embody shared socio-cultural meanings and practices. These meanings and practices, along with the existing physical structures, are resources for design (Dalsgaard et al., 2008). As argued by Audunson (2004), I agree that it is important to have the public library remain a physical place, despite the increasing level of digitalization of the collections of the library and the importance and necessity of the many web-based services, as the characteristics of the physical library cannot be found anywhere else. Although the members of the community are able to meet and share experiences on the Internet, there should still be a place for face-to-face meetings and collaborations. The library offers a place where play can take form in both the physical and the digital world, supporting both digital and physical toys and materials. The library is able to offer an inviting and playful environment where the desire to explore both materials and the space itself is primary and where co-operations and collaborations can take place across generations, genders and social status. In this environment, installations and systems should not be detached from the library but rather be intertwined with the meaning, services and traditions of the library (Eriksson & Johansen, 2013).

Embody the design process

Physical space frames most interaction and, by implication, also the consciousness of the users involved. To incorporate all aspects of the domain into the design process, except for observations, interviews and so on in line with contextual design (Beyer & Holzblatt, 1998), is to bring spatial representations into the design process. Design representations embodying spatial aspects of the interspaces designed may take various shapes throughout the design process and may encompass aesthetic and affective aspects of interspaces as well as functional aspects. Interaction designers need to understand how both the augmented spatial layout and the physical spatial layout affect the users' experience, behavior and social relations (Dalsgaard & Eriksson, 2007).

Adapting understandings of physical space into interaction design, both in the design process and in the designed artifact, may yield new ways of understanding the use of the designed artifact. Physical and digital models in architecture often serve to provide visual overviews and understandings of the entire space and can complement prototypes in interaction design, a field that traditionally focuses on functionality. Physical design representations may serve as vehicles

for communication, exploration and understanding and are able to supplement design representations such as mock-ups, storyboards, scenarios, etc. Another approach to incorporate all aspects of the spatial domain into the design process is to carry it out in situ. The advantages of performing design sessions or even the entire design process in the domain is further described in the Bthere method (Eriksson et al., 2005).

Follow the drift

People follow other people: they borrow the most popular books and are attracted by gatherings. People learn from watching others and they are inspired by each other. This should be used as means for design, e.g. when considering aspects of interaction, in user testing, and when visualizing information. In StorySurfer, this is a basic component in several ways: to present information such as "others who borrowed this also borrowed:" in order for the user to see what other people are searching for and what other people have chosen (Eriksson & Lykke-Olesen, 2007).

Support and extend traditional functionality

Explore ways of augmenting and extending the traditional functions of the library rather than introducing playful but disjointed installations. This will tie into both existing practices in the library and visitors' prior knowledge and experience of the place (Dalsgaard et al., 2008).

Design for spatial evolvement

Spatial surroundings evolve over time as crystallizations of and frames for certain types of activities and uses. Over time, cultures develop physical spaces for certain activities, as well as narratives and literacy to complement them. As means for design, it is important to consider what is already out there in the spatial surroundings and to consider these tools, habits and physical constraints to be an inspiration and parts of a foundation for systems and interactions, e.g. by using the Four Space Model (Eriksson, 2011).

One aspect of this implies consideration of how devices and applications may adapt to and/or co-evolve with changing spatial configurations. The nature of a design material is its ability to assume new forms or to relate to other materials in new ways, shifting its initial function. Although information technology may be non-physical, physical materials come into play and designers should understand how the properties of IT relate to spatial properties and boundaries as design materials (Dalsgaard & Eriksson, 2007).

Intertwine

Designers within public libraries should join digital resources and physical resources in order to create a bond and trigger curiosity for them both. This thesis suggests that designers intertwine fun technological play-ware with the physical and digital resources and services found in the physical place (Eriksson & Johansen, 2013). It is also suggested that interaction design installations may help bring people together at the library, both within families and opening up for new encounters, as an unfamiliar common ground makes people co-operate and talk across the classical social borders.

Go back to basics

To avoid systems becoming superficial and insensitive to reality, context is important in interaction design for public libraries. As a part of exploring new services in the public library, designers should use technology to support and further develop the basic functionality of the institution (Dalsgaard et al., 2008). An example of a basic functionality is e.g. searching for books in the library. Supporting a basic functionality may consist of transforming it from a desktop interface to a spatial installation, introducing new ways of interaction, as was done in e.g. StorySurfer (Eriksson & Lykke-Olesen, 2007). Exploring ways of augmenting and extending the traditional functions of the libraries, rather than introducing playful but disjointed installations, will tie into both the existing practices in the library and the user's prior knowledge and experience of the place. Examples of this are the installations Time Music Machine from the Families at Play in the Library project, which is a competition while at the same time promoting music as a resource available at the library; turning the children's department into a pirate world, promoting library resources about pirates through engagement in play; or the U.F.O.scope, in which the four different media of the library were promoted while navigating the physical library (Eriksson & Johansen, 2013).

Look for the hidden potentials

To support and further develop basic functionalities is to further investigate the hidden potentials of the place and the use of them as materials for design, such as e.g. the massive free information potential, the need of a meeting place, and the existing technologies available in the institution (Eriksson, Krogh & Lykke-Olesen, 2007).

Design Process Toolbox for Multi-Scaled Public Library Projects

This toolbox is constituted on experiences with multi-scaled design projects in public libraries and is affected by the scale, complexity and integration of this kind of projects. The information is based on experiments, experiences and interviews with key persons in the UMS project (Dalsgard & Eriksson, 2013). The tools and considerations can guide and support others who are assigned the role of interaction designers in public library development projects of varying scales. The focus of the toolbox is primarily placed on ways of aligning different paradigms of practice and inquiry and on how to capture and anchor insights from design activities.

Aligning Different Paradigms of Practice and Inquiry

Involve users

User involvement is a common approach to design within interaction design and especially in small-scale projects. However, the degree and prominence of user involvement in the large-scale UMS project was new to all parties involved. Even the UMS project management team, which was initially responsible for this framing, was by their own account venturing into unknown territory (Dalsgaard & Eriksson, 2013). The principal architects first encountered the participatory agenda during the competition phase, in which they developed the first proposal for the building and while they had encountered demands for participation and user involvement in previous projects, the complexity and scope of integration of participation in the process was unlike that of any other project (Dalsgaard & Eriksson, 2013). According to the architects, the traditional approach in architectural practice is to work with user involvement in the projecting phase and not in the programming phase, which was the case in the UMS project. To involve users in the programming phase is more demanding as it affects a larger number of aspects of the project. This is compounded by the scale, complexity, and integration into the large-scale urban transformation inherent in the UMS project. However, iterations are necessary also in large-scale design projects and there has to be room and the possibility to go back and revise earlier work. Designers, architects, library employees and users are all very different, why awareness must exist as to the fact that the cooperation is based on different paradigms of inquiry. The dichotomy between user demands and what is technically feasible may lead to conflict (Dalsgaard & Eriksson, 2013). Reciprocal partnership, good communication, and an understanding for differences of perspectives between the project partners are essential.

It is important to anchor and promote the importance of user involvement and user participation early on in the project in order for all project partners to be prepared. A committed and engaged leadership regarding user involvement is important at all levels, i.e. at the concrete project management level, at the level of the library management, and at the level of the local politicians

who, in the end, are the decision-makers for the project. Also, personal conviction among involved project members and a flexible organization are much needed (Dalsgaard & Eriksson, 2013). Plan for when to involve users and when not to, because it is difficult to engage people when the goal is too distant as it often is in a large-scale project. It is important to take on an appreciative understanding of the insights and the input of the users as it will provide a sense of ownership and responsibility among the participants. Although participatory design and user involvement activities in large projects are expensive and demand time and resources, they are worth their while (Dalsgaard & Eriksson, 2013). User involvement activities are an ongoing qualification of visions, ideas and products which provide much in the way of quality and depth, as well as political prestige.

Establish a mutual understanding

In interviews, members of the UMS project have highlighted the challenge of approaching the process from different traditions and of finding a common ground (Dalsgaard & Eriksson, 2013). While there is obviously a need for a clear division of labor, the project partners must also develop a shared language. The difference in paradigms of practice and inquiry come to light in various phases and all groups want to deliver the best possible product, although they have different conceptions of what it consitutes. The architects may focus on the building as an experience in itself, while the library as a customer sees the content and activities as the experience. Establish a shared language in the project group, in order to achieve a mutual understanding of the agenda and ideals (Dalsgaard & Eriksson, 2013). It is important to establish a mutual understanding from the very beginning and because nobody knows exactly how design activities will unfold and what the results will be, all those involved need to be open to changes. In large-scale user-centered projects, it is not only practitioners such as architects who must learn about user practices: for the project to succeed, it is also crucial for e.g. librarians to learn about architectural practice. Avoid too many compromises, as this may be a sign of a lack of overview (Dalsgaard & Eriksson, 2013). Use a design program as a guide and change the level of perspective between overview and varying levels of detail all through the process.

Just do it

The UMS project is in many ways a pioneering project and the involved partners continuously have to develop new methods and techniques to match the agenda of user involvement. Part of the challenge is to develop the competences to carry out participatory events and to establish knowledge about where user-centered input is applicable and where it is not. Arrange collaborative workshops with constructive purposes expressed in a language everyone will be able to understand and with shared tools, preferably visuals and models (Dalsgaard & Eriksson, 2013). Use many examples and practical and concrete tools, such as visuals and models, in order to avoid misunderstandings due to differences in conceptions and the use of language. This is especially important in the library context, where the written word has a strong tradition that easily clashes with the visual way in which architects communicate. The simplicity of the language and the densely interconnected systems with simple elements can foster a more sophisticated behavior

(Johnson, 2002). When e.g. designing the data gathering process or the idea generation process for public libraries, inviting different users and conducting densely planned workshops will probably not be necessary every time, as the use of much simpler methods will suffice: have lunch with the users, serve free coffee while having informal talks with the visitors, put up posters with simple questions, quick test set-ups – everything does not have to be product-like as the prototypes or set ups should be seen as methods in themselves. This may give rise to very interesting information and new ideas. It may be difficult to classify a large-scale project such as the UMS project as a user-centered design project in the traditional sense of the word, although the use of user-centered design methods and techniques such as cultural and mobile probes, mock-up sessions, and collaborative prototyping have proved to generate very concrete insights for the project (Dalsgaard & Eriksson, 2013) and are in line with multi-scaled design.

Use the masses

It is when observing the entire system at work that the global behavior becomes apparent (Johnson, 2002). In order to understand the needs and behaviors of users as well as the organization of the library, it is important to gather information at all levels and from as many perspectives as possible.

Capturing and Anchoring Insights from Design Activities

Capture and Integrate

A consensus exists among the different participants in the UMS project that there is a clear need for a better and more structured way of capturing and bringing insights from user involvement activities into the large–scale project, i.e. some best practice examples to draw upon (Dalsgaard & Eriksson, 2013). Insights are scattered across documents and exist as tacit knowledge with project members and some of what has been discovered is integrated into aspects of the process. One example of how knowledge acquired through participatory events has been integrated into the process can be seen in the way in which the seven core values developed from the initial project phase and subsequently became part of the architectural program, which in turn will be manifested in the final building. Another approach is to consider the different milestone subprojects to be condensations of insights (Dalsgaard & Eriksson, 2013).

Although the members of the UMS project have made study tours to examine other new library projects and hosted international conferences on the future of libraries, they have not uncovered any best practice models for capturing insights from participatory events and user involvement design activities. Firstly, this points to the need for the development of new process models and routines able to support the ongoing capture of insights from participatory events. Secondly, this underscores that large-scale participatory projects such as the UMS are embracing new territories of user-centered design. With this in mind, plan for how to capture insights from design activities in a structured way, perhaps by best practice examples. The results may be wasted if they are not

shared and communicated with the involved parties and also make sure it is possible to go back and re-experience the results. Due to the long timeline, people involved in the project will come and go. Establish a mutual plan for the decision structure and set up a connection between the data, analysis and decision. Open up for the possibility to make changes in the space program and establish openness to allow it to happen. Also, establish a plan for how to inform the design process and not just the project.

Go local to aim global

Local information can lead to global wisdom (Johnson, 2002). This is relevant to information gathering, but also in design. Local information may be used to build a mountain and also to help the designers understand certain behaviors or uses of designed artifacts. A clear focus on user-centered design activities is necessary, because they can both clarify and obscure. There should be a clear division of labor and a clear definition of different roles with regard to the aim of the project activities, e.g. between who is concerned with the building and who is concerned with services (Dalsgaard & Eriksson, 2013). Design events should be orchestrated by different project partners in order for rich knowledge to be absorbed at all levels of the process. Networks and knowledge sharing for inspiration is important to find best practices, gain input, receive critique, and find examples.

Program from the start

The project will always be in focus, but invest time in designing the design process in order to establish a plan for how to proceed, defining the goals, and which activities inform which part of the process. There is need for a solid program to exist from the very beginning to avoid the risk of the project slipping away when involving users and partners in the design process (Dalsgaard & Eriksson, 2013). The program in large-scale design projects may refer to the architectural program, the design program and the project program based on core values. Formulate the program in such a way that it is able to guide the process as well as the project. Deadlines and deliverables provide direction and purpose and make the design process concrete. Also, constructive milestones in a foreseeable future are important in large-scale projects with a long timeline, as they are key condensations of insights (Dalsgaard & Eriksson, 2013).

Summing up

The key condensations of insights from an interaction designer's point of view consist of a toolbox for designing interspaces for public libraries and an inspiring toolbox for designers working in multi-scaled public library development projects. This section is meant to guide fellow interaction designers and others who are interested in venturing into the domain of public libraries. The toolboxes may be used in different ways and at different stages of the design process: they may support analyses of public libraries, serve as inspiration for design concepts, guide design decisions in actual development work, or frame evaluations. The aim is to intertwine the physical space with the digital possibilities, creating interspaces.

7. Discussion

In this section, issues presented in earlier sections will be discussed more in-depth. In what follows, I will return to the research questions asked in the beginning to discuss the implications of the findings reported above. The questions are: *how to engage users and resources in the design of new public library services and buildings, how new technologies impact the role and services of the library, what methods and materials of interaction design may play a part in both small-scale and large-scale public library projects, and how small-scale design projects can be employed to inform large-scale design processes*. The discussion starts out with the main aim of this thesis, namely how an increased involvement of interaction design may contribute to the development of public libraries.

Designing for public libraries is a complex affair. My work, as evidenced by the cases, places a high emphasis on the genius loci of physical public libraries as established institutions. This is not intended to discourage or discard the idea of extending the reach of public libraries through the use of e.g. Web 2.0 technologies, but rather that such attempts should supplement rather than supplant the physical institutions. Neither do I argue that every library is in need of a BibPhone, but rather extends an invitation to see the library space and its materials as a mixture of static and dynamic resources, both digital and physical, and to find new ways to play with and intertwine the two.

Architecture as a domain is no longer static and unresponsive: it is being transformed by interaction research and new technology and the built environment are becoming increasingly dynamic and conversant. This development changes our understanding of space and even our relations. Different people have different notions of the world, why we need to create a shared frame of reference. Users of the library, here defined as visitors and staff, will be involved in concerns regarding functions, needs, flows, experiences, services, content, and the possibilities and challenges posed by technology, media and innovation. The purpose is to understand space as something more than physicality, to work out, both practically and theoretically, how an interaction design understanding of space in relation to human beings may be used to create interactive spaces as well as passive ones.

The spaces and technologies around us constitutes our experience, in that they frame and shape it, but they also change our experience in that we may employ them in processes of knowing and doing. Spaces and technologies are situated, and are products of prior practice and bear with them potentials for future events. A key quality of public libraries is that they are imbued with meaning, which is in part determined by their physical presence in a community. Some interactive technologies may contribute to make the physical presence of the libraries superfluous, as may perhaps e.g. digital services and Library 2.0. That is why it is important for interaction design to incorporate the qualities of places through their specific history of being physical places which are meaningful to the communities in which they are situated. A space, in the sense of a pure physical structure, becomes a place when it is filled and invested with meaning. Space can be both physical and digital and is formable by the designer, while a place is created by people investing memories and feelings into it. The key characteristics of the atmosphere in a traditional public library today are that 1) it is first and foremost a home for books, 2) it is a place from which information flows out to the community, and 3) it is an open and inclusive social place.

Media and technologies change rapidly, why we have to look ahead and design structures possessing a higher degree of flexibility in order for them to support users and employees of the library in the long run. The main question which designers working with public libraries will have to deal with is how to create environments that will provide users with an experience that makes it worthwhile for them to visit the library, environments that promote ownership, innovation, relaxation, openness and capacity building?

Although parts of the answer to this question can be found in many directions, in this thesis, focus has been placed on how, in particular, interaction design will be able to work with development within public libraries. Basically, an interaction designer is able to contribute by intertwining the physical aspects in a growing digital world, as interaction designers are used to design with digital materials and depend on physical materials for the functionality to take form. Interaction designers are able to design for both individual and shared experiences, using new tools as well as well-known ones. The new technology is able to support and extend traditional functionalities, as opposed to introducing disjoint installations. It is able to create engagement by e.g. intertwining Web 2.0 technologies with the physical place, by making room for engagement through sharing and inquiry, and creating participation through co-contribution. Also, the interaction designer is able to have the user activate several senses and even the whole body through design for multimodal interaction, visualizing digital materials in new ways.

By using the toolbox of the interaction designer, we can create installations as methods for investigating certain aspects, we can help to provide practical and concrete tools in a field where, traditionally, language is the most powerful tool, we may help in designing the design process for new development projects, and guide the decision on when to involve users and when not to.

Combining interaction design with physical space may yield new ways of understanding functionality and the use of designed artifacts in a larger perspective. Considering the spirit of the place and the activities mediated by the spatial configuration, as well as considering the users, resources, habits and constraints connected to it, is to take advantage of the context. Interaction designers can help to support the move from single-user systems to multi-user experiences, from individual design to social design, from closed systems to extendable and open systems, from regulated designs to evolving designs, and from systems designed merely to act as information providers to dialogical systems. An interaction designer can investigate the hidden potentials and include them in the design, intertwine elements of e.g. play, nostalgia or competition to evoke interest and create new meeting places. Furthermore, the interaction designer can help shaping a shared language to create mutual understanding in working groups with different competences and set up collaborative workshops with constructive objectives. The interaction designer is used to focus on the user and is able to work with participatory design and to design for participatory use of installations, taking on an appreciative understanding to empower the users. Finally, the interaction designer can help capture insights, evaluate activities, and provide useful networks.

Interaction Design and the Role and Services of the Library

The projects presented here have, in a way, challenged the way in which the libraries see themselves. What would happen to the library if it were to open up for playfulness with technology as a design material? Naturally, both playfulness and technology have been parts of the libraries for a long time, a natural consequence of the development and of being public institutions, but the projects differ in their promotion of technology and the way it challenges the role of the librarian. The Interactive Children's Library had an impact on the library community as it introduced new ways of interacting and new physical forms for information and services. In particular, the project Families at Play in the Library seemed to be a challenge to both visitors and library staff, as it quite explicitly pointed to some deeply rooted understandings of what a library, a librarian, and a user of the library is and ought to be. Figuratively opening the doors of the library to noise, clutter, aesthetics differing from what people are used to, and, last but not least, to seemingly pointless activities has been a challenge or even a provocation to many, but the positive effects of seeing the library in a different light seem to have proved them worthwhile. The discussion below will focus on the changing library context and the changing role of the librarian, as experienced in the projects.

Changing the role of the librarian

An obvious challenge to libraries is uncoupling themselves from the information they have such a long tradition of being repositories for and taking on the dissemination of this information through other channels, e.g. via the Internet, thus reducing or ultimately removing the need for libraries in their physical forms. However, interactive technologies are used for retrieving and sharing information and knowledge, why the materialized strategies presented above are focused on incorporating the qualities of libraries through their specific history of being physical places which are meaningful to the communities in which they are situated. With the new forms of communication and mediation, the classic roles of the library and the librarian are changing: the librarians are no longer able to control the content of the library or in what forms the user meets that content. The librarian's role is changing towards that of a guide to different types of culture, media channels, platforms, and information. The librarians are also supposed to be promoting new technologies, such as e-book readers and internet services, as well as different forms of culture, such as e.g. play culture. In relation to play and interactive experiences, librarians are to consider themselves not as teachers or pedagogues, but merely as co-players or even "co-experiencers" for visitors of the library, whether that visit is physical or virtual. In these processes, it is important to have librarians engage in open dialogs and interaction with both users and technology. It is also important for librarians to be more willing than they often are today to accept play, social activities, noise and clutter or, more at the overall level, to accept the transformation of the library space from a place of solemn silence to active, lively rooms for active, lively users. Finally, the role of the librarian may be pointed in new directions through more direct uses of technology as a communicator and provider of content, as has been seen in various experiments and projects such as the ones mentioned above.

Changing the library space

One of the arguments presented in this thesis is that, despite the increasing level of digitalization of the collections of the library and the importance and necessity of the many web-based services, it is important to have the public library remain a physical place because the characteristics of the physical library cannot be found anywhere else. Members of the community will be able to meet and share information on the Internet, but there should still be a place for face-to-face meetings and collaborations. In e.g. the children's library, where play can take place in both the physical and the digital worlds, the library should offer an inviting and playful environment, where the desire to explore materials, the space itself and games is a primary objective and where collaborations may take place across generations, genders and social status. In this environment, games and toys should not be detached from the library but rather be intertwined with the meaning, services and traditions of the library. Several efforts have been made in line with this view. For instance, StorySurfer is, on a functional level, intended to guide visitors toward books stored in the library. The strength of the installation, however, is that it acts as a conduit for social interaction, promoting and provoking interaction among visitors as they explore books. Although the

U.F.O.scope is intended to awaken curiosity for the library as a physical place and its many different types of materials, its primary strength is lies in creating co-operations across age both in the form of interaction and in the form of exploration of the unknown. In the case of the BibPhone and iFloor, the information generated by users are tied to the specific, physical books, floor or other objects housed in the library, in contrast to e.g. Library 2.0. It is from the physical objects that information flows to the visitors, who are in turn provided with very open and accessible means both for accessing and contributing comments, questions and reviews.

Physical space is the foundation of the most basic experiences upon which we create understanding and we communicate through gestures in physical space. Even the physical play of children is dependent on their access to physical places, spaces and play tools. A space can be both physical and digital and becomes a place when it is filled and invested with meaning, memories and feelings. When designing for the library, it is important to respect the sense and characteristics of place, as public libraries are rooted in communities and embody shared socio-cultural meanings and practices. These meanings and practices, along with the existing physical structures, are resources for design. The real world context is very complex, why the tendency is to focus design on simple physical or digital measures, while it appears to be more difficult to interpret e.g. the social domain. Intensive developments with Library 2.0 technologies and web-based rooms and services such as Palles Gift Shop (2012) are examples of digital interpretations of this, but should be considered as complements to the physical library. Public libraries are hubs for social encounters: the presence of visitors with varying backgrounds and intentions are great resources and enable and support shared interaction, as their emergent behavior may contribute to the development of fruitful social practices in the library. Audunson claims to actualize the role of the public library as a physical meeting-place (2004). The library can provide meeting-places that promote cross-cultural contact and communication, arenas where people from different national and social cultures are exposed to one another. It is important to create common grounds where strangers, friends or families are able to meet, explore, play and interact. By e.g. mixing media, such as when the Danish national children's TV channel Ramasjang is broadcasted live from a library, may provide a new and interesting approach to how different public service institutions may redefine themselves in a mediatized society. Also, examples based on cooperative interaction such as iFloor or artifacts such as StorySurfer or the U.F.O.scope, which trigger social interaction, point to valuable ways in which libraries can move in new directions.

Engaging Users and Resources of the Public Library

In the UMS project, a challenge has been to approach the process from different traditions and to find a common ground. While a clear division of labor is needed for obvious reasons, the project partners should also develop a shared language. The difference in paradigms of practice and inquiry comes to light in various phases of the project and brings to attention the difficulties in

communicating with partners who speak a different language and have a somewhat different agenda or a different set of ideals - all groups want to deliver the best possible product, but they have different conceptions of what that means. The architects may focus on the building in itself as experience, while the library sees the content and activities as experience. (Dalsgaard & Eriksson, 2013)

All parties stress the need for mutual understanding and that in a large-scale participatory project, not only should practitioners such as architects learn about practices of the library, it is also important for e.g. librarians to learn about architectural practice for the project to succeed. Examples of establishing a shared language is the use of collaborative sketching, discussions around models, and the use of reference images in discussions in order to address issues of the process in a concrete way.

While working with public libraries and people employed at the library in different creative processes, it has become clear that the different groups of employees require the interaction designer to adopt different approaches when deciding which methods to use. The goal is to create ownership and involvement in the different projects and also to foster ideation and creativity. The library is a complex and large organization that employs people in very different positions and from different backgrounds, ages (ranging from 18 to 70 years of age), and with varying levels of education. Even among the librarians, a group displaying relatively small differences between the level of education of its members, individuals are still very different from one another and they have very different interests. Also, working with public library employees, one always has to deal with the fear among them that the employees would lose their identities and roles as times change and materials with them, bringing about digitalization and the death of public libraries.

All groups of employees possess some form of silent knowledge which it is useful to have access to when designing for public libraries. In relation to my work, I have tried to acquire some of that silent knowledge by e.g. posting "Question of the week" notes by the shared coffee machine, trying to see to it that everyone has the possibility to contribute to the process and make sure it is not only the voice of the librarians that are heard in the process. Everyone may e.g. contribute to the knowledge concerning who is using the library and what kinds of activities are taking place in the building, as all user groups and activities are not necessarily common knowledge or even visible to every single employee. It is also important to make use of the knowledge of employees of different ages, as younger employees may come up with other types of ideas compared to those of the older employees.

One interesting group of employees is the reception staff, who performs the task of keeping everything afloat and handling anything from guest service to reservations, library cards, and payments. They meet all types of library users, in many different languages, why they are not easily surprised and also have a lot to contribute with to the project. They can be considered vital participants in new public library projects because of their unique daily hands-on experience. The

librarians are of course a primary group to involve in library development. The great challenge here is to make them daring in their ideation, as they are used to systematic thinking and order. Also, they love the spoken and written word, why it is challenging to make them move from ideation to visualization and prototyping. Working with visual examples is important and also providing them with simple creativity tools, such as e.g. Lego bricks or similar. However, it is fine to provoke them slightly in order to make their creativity begin to flow, as they are also used to playfulness and imagination in their everyday work.

In order to set up interaction design installations at the public library, it is vital to have the IT staff involved. They possess knowledge about the IT infrastructure and its uses and have an interest in technological applications. The challenge working with them is ideation; not just combining existing ideas, but coming up with something new, as it may be difficult for this group to think outside the box. It is important for an interaction designer working with this group to position himself/herself in regard to them, use references to existing technologies and show his/her experience and knowledge in using IT as a design material.

Working in constellations of library staff mixed with external partners, which took place in e.g. the Children's Interactive Library project and the UMS, increases the complexity and methods should be carefully considered. However, sometimes when involved in a project, a design problem can turn into a lucky shot. In e.g. the Interactive Children's Library project, librarians all over Denmark were set to scan 4000 book covers, due to some problems regarding copyright restrictions. We hesitated to ask the librarians for help, but in the end it turned out this made them more involved in the process and actually created ownership of the StorySurfer prototype. A substantial part of the responsibility for the success of technological prototypes rests with the librarians and the other employees at the library. Involving employees in the early design process makes them feel they are a part of the development, which is an important incentive to motivate them during the test phases, especially during periods of technical difficulties. Prototypes such as e.g. StorySurfer mediates both a new practice for visitors in their search for books and a new practice for librarians as they are supporting the visitors in their search for information. Thus, librarians need to adopt the idea of introducing alternative ways of performing library services and new social and physical situations in which the dialog between visitor and librarian may take place, as part of a new shared practice between the visitor and the library employee.

Methods and Materials of Interaction Design in the Public Library

Bringing together competences from research, industry and library in development processes at the public library has proven very fruitful. Many new ways of working have been introduced through the meeting of different methodologies and all parties have learned something from the process. The projects I have been taking part in have mostly been research driven, particularly the Interactive Children's Library project (Eriksson et al., 2007). In that project, methods developed in interaction design research were directly adopted in the project process. For instance, when doing initial observations and gathering data for the project, we involved fictional inquiries inspired by our Mission from Mars method (Dindler et al., 2005). The idea behind taking our point of departure in how children would image a library on Mars carried the ambition of creating a shared narrative in which both children and researchers were able to play with ideas outside the narrative space staged by the current library. This method for approaching children's understanding of the library through a common activity provided inspiration to the project that was both fun and valuable. Furthermore, this approach was able to (and did) bring mythical and mystical aspects into the discussion on what the children's library may be like in the future.

Also in the same project, children were asked to make short video films about the library, where they would film each other demonstrating and telling about the library, without us interrupting. The making of the video was entirely up to the children themselves and they were left alone while shooting it. These small snippets, giving us a child's perspective of the children's library, were useful not only as they focused on certain aspects, but also because many things that would seem essential to the definition of a library to a grown up were left out entirely by the children. Furthermore, the fact that the videos were shot from the eye point of a child changed the spatial perception of the physical space, as e.g. shelves constrained the space into corridors because the children are not able look over them. The design process in this project was a great inspiration to the later Families at Play in the Library project. In other workshops intended to develop ideas for the future library such as e.g. DigiForm, the purpose of which was to communicate the libraries' digital resources in the library space using the newest technology, methods such as Inspiration Card Workshops were used (Halskov & Dalsgaard, 2006). In the preparations for establishing the Transformation Lab II project, we made use of the Four Space Model to map resources and use of the library space. Other methods used were e.g. personas, questionnaires, interviews, prototyping, observations, the fly on the wall method, and other methods already in heavy use at the library.

"Personas" is an established design method in interaction design, developed to keep the user focused during the design process (Pruit & Grudin, 2003; Cooper, 1998). However, the method is used differently in the development of public libraries. Here, I will present three examples: one from Chalmers, Sweden, one from Aarhus, Denmark, and one from Queensland, Australia. At first, the personas developed by the main library in Aarhus were described in detail in a printed book published by the municipality (Aarhus Municipality, 2012). The personas were developed with both quantitative and qualitative methods within the project Unleash the users, the aim of which was to

work with different user involvement methods in order to inform the UMS process. The extensive publications from the project are available on the web (Aarhus Municipality, 2012). The project also resulted in a few pictures representing the different personas to be put up on the wall, ensuring that they would be constantly present in the daily work at the library. The personas are heavily used in workshops of different kinds, e.g. when employees and invited guests tried to come up with new service concepts. Unfortunately enough, the personas resembled one another very much and as they were published in a catalogue, they remained static and did not change. The effect of this on the design process was somewhat detrimental. First of all, when the personas were mentioned, participants reacted by saying "oh no, not them again", as many knew them inside out and were tired of them. Secondly, as they were static, it was difficult to use them for innovation, which sometimes is the purpose when using personas, as they may work to keep the design process on track. All in all, the method has been lastingly incorporated into the organization of the Aarhus public libraries, but needs to be more dynamic and perhaps also more thoughtful and provocative.

The second example is from the Queensland public library in Australia and was created in order to inform future actions and design interventions for the Edge, a digital culture center (Foth, 2012). Here, the six personas were based on ethnographic observations and visitor interviews and they are impersonal and described very briefly, as composite archetypes, together with the core motivations and attitudes of each persona. However, each description of a persona comes with suggestions for future action planning and action taking. This shows a different attitude towards the method, as the personas and the action plans were developed hand in hand and will be in need of updates as the interventions inform the action plan. This is an example where the personas were developed for a certain project and were they are not as general in scope as the previously described personas created in Aarhus. The third example is from the Chalmers University Library in Sweden (Chalmers, 2012). Here, the inspiration for the method stems from other libraries and also the Swedish Tax Agency, which has used the method in order to develop new websites from a user perspective. Although the three personas only have been given brief descriptions regarding their personalities, their needs and their ways of using information are described in great detail. As the peronas' use of information is described in such detail, they are in a sense related to the action plan used in Queensland, as one may basically read out a list of requirements on the new website directly from the descriptions of the personas.

The more personal personas in Aarhus are more open for different types of use, in both large-scale and small-scale development, while the others are more directed toward a certain aim or project. Both Aarhus and Chalmers used real faces from real people to personalize their personas, while Queensland enhanced the archetypal features of the personas with impersonal graphics. It is interesting to see how the Aarhus public library succeeded in disseminating the knowledge generated from developing the personas and in sharing them within the entire organization, making them an established part of their everyday activities. The personas method seems suitable for these types of organizations and projects. However, as the public library is open to all, it may be

a good idea to broaden the personas and also include, if not extreme personas, people who deviate more from the main stream. This is a way to foster creativity, innovation, user-centered design and design critique.

Large-scale

Although it may be of value to establish a clear definition of what constitutes a certain discipline of design in certain contexts, I find it inevitable that such definitions will be challenged or expanded when designers embrace new territories. Some may say that interaction design has nothing to do with large-scale projects such as building a new house and that it is enough to consider interaction design in relation to the building when it is completed. In this thesis, I argue for engaging interaction designers from the very start of large-sized development projects. The field of interaction design stems from human-computer interaction, in which designing computational things and systems with usability focus is only one part. More broadly, however, interaction design is about designing the way in which we use and interact with systems and products in general, which is a basic component of the design process (Buchanan, 2001). In line with the idea that interaction design is a matter of designing the acts that define the intended use of things and systems (Hallnäs 2011) or, as I claim in chapter 2, that it is about organizing (intensions for) social relations and interactions by means of spatial and digital layout, it is investigated in this thesis if interaction design has a place in large-scale projects.

The major part of the work for an interaction designer involved in a large-scale development process is to study the existing environment, involve resources, users and staff, look for inspiration in materials and methods from other domains and, most important of all, to play with technology as a design material in design interventions. In the participatory design community, some voices have been raised for the community to engage in large-scale projects, such as Shapiro (2005), although participatory design projects have a history of being small-scale and stand-alone (Oostveen & van der Besselar, 2004; Simonsen & Hertzum, 2008). In the field of architecture, Alexander requested more user involvement (Alexander, 2005) e.g. when he designed the homeless shelter in San Jose, but his approach is still far from commonplace. Traditionally, large-scale projects are most often developed top-down, with very little or no user involvement in the design process. A public library example of this is the Bibliothèque National in Paris (McCrady, 1998), which has a hierarchical system to access the different kinds of media it houses (Fierro, 2003). In the Deichmanske Main Public Library in Oslo, which is still under construction, there is some degree of participation involved in the project, however, mostly focused on services (Deichman, 2012). In this project, users, employees and external partners have been involved in coming up with new concepts for services and these concepts have been tested in small-scale prototypes for a shorter period of time. The new service concepts mainly concern ways in which to make use of the new technology and how to visualize and use all the digital material in the physical library and in the city outside the library. One of the main learnings from the process is the importance of involving employees in the project, as doing so provides more ownership and

meaning to the project. In the case of the UMS, participation has been such an important part of the agenda, both regarding services and the building, that the brief of the competition stated that the proposals will be judged on the basis of how participation is addressed in the architectural process.

From the start, the UMS project has adopted the approach that participation is a vital part of the process and the project. Interaction designers have been invited to contribute all through the project as participants, experts, workshop leaders (Eriksson et al., 2007), and designers of prototypes (e.g. Nielsen, 2006; Eriksson, 2010; Aarhus Public Libraries, 2007). In the various workshops, interaction designers have contributed with IT as a design material, with a playful approach toward technology, with inspiration and ideas, and with complementary methods. When invited as experts, it has been for workshops and meetings where certain questions are raised, e.g. way-finding or the design of certain elements in the children's library, or for giving presentations (Dalsgaard & Eriksson, 2013). When acting as a workshop leader, the role of the interaction designer is to introduce and try out new methods for data gathering or developing design concepts (Halskov & Dalsgaard, 2006), to set the research agenda (Eriksson et al. 2007, Eriksson, 2010) or maintain a neutral attitude in order to stimulate engagement, and to inspire (Dalsgaard & Eriksson, 2013). The prototypes interaction designers have been invited to design have been of different natures. Either the prototypes have been developed in co-operation with the library (e.g. Eriksson & Lykke-Olesen 2007, Eriksson, 2010) or they have been created for a certain purpose and theme, such as Voices of the city, which is an interactive system to create citizen participation in the UMS project and to gather data (Nielsen, 2006), art and technology projects (Aarhus Municipality, 2012), or a game for climate debate (Kollision, 2009).

The interaction designer can play different roles in a large-scale project. One example is to act as the missing link, e.g. to bridge the division between the building and the services. In order for a large-scale project to move forward at all levels, there is a need for a division of labor to allow the specialists of various fields to focus on their work. The interaction designer is able to move more easily between the groups of specialists and make the outcome of the work interplay and have a real effect on the overall plan. The interaction designer is able to support the project by bringing in new inspiration into the project, but also through finding new methods and techniques. The interaction designer is able to supply arguments to help make decisions and see the future possibilities in the use of designed artifacts and new materials, which other project partners may not be able to see or have no experience with. E.g. when taking decisions regarding the design of an element in the children's library, the interaction designer brought up aspects of how it would be possible to incorporate elements of IT into the construction. The experience has also been that the interaction designer has been able to take a new and critical view on common design processes, thus contributing to refreshing some details in order to achieve a better flow in the processes. Furthermore, the interaction designer has a more hands-on approach and has been able to support thinking out of the box.

In the design activities, the interaction designer plays an important role as he/she is neutral. It is important that everyone are allowed to voice their opinions, although regarding some issues this may become somewhat emotional. Coming from the outside, one may act as a kind of filter that will allow suggestions and critique to be taken further anonymously. By showing his/her interest in what participants think, the interaction designer is able to provide the participants the feeling of influence and empowerment. Also, one is able to de-mystify technology, which may be frightening to some library employees. By introducing IT as a design material and by applying a more playful approach towards it and show fun, useful and inspiring examples, the interaction designer is able to turn the negative attitude toward technology into a view of IT as a material to be used for ideas in concept workshops. When involved in large-scale projects such as the UMS project, there is a great deal of economy and prestige at play and, on top of that, the project partners have different focuses and speak different languages. Coming from interaction design and being used to close co-operations with both colleagues and users with very different backgrounds provides the interaction designer with the opportunity to help out discovering the small nuanced differences in the communication between the different partners.

Contributions have been made by the interaction designer to the UMS project at different levels. Initially, in the small-scale projects with stand-alone installations, the contributions consisted of gathering data and experiences from library users and employees, making observations, providing inspiration, organizing creative workshops and similar activities, using methods from interaction design and installations as interventions. The installations contributed to making visitors of the library open up for meetings with new technology at the library and not just the basic computer-based services. In larger-scale projects carried out during the preparations for and planning of the new Urban Mediaspace, different kinds of observations and development of prototypes were conducted in the existing library. Here, involving library employees in workshops and helping them design their own workplace was performed in the regime of the Transformation Lab II project. Also, taking part in various meetings and workshops at different levels has also been a part of the contribution. In those meetings, decisions were taken regarding elements of the building or certain services and my involvement has been that of a project partner.

The role of the interaction designer is not to be a dictator, proclaiming what should be done and how. Rather, the interaction designer should act as a moderator for creative teams and development teams, balancing everyone's interests against those of the others. This may lean up to service design, as focus moves away from the prototype or product to the system or service and from methods and frameworks to much more messy issues regarding human behavior and use. In HCI, tradition has dictated that one should analyze users and use in tasks and goals, but what may not seem relevant for one's design may actually turn out to be very important. Most human behavior is not logic, task-oriented or goal-driven and we change contexts more rapidly than ever before. Users and use are complex concepts and they are tied to meaning, culture and context.

As a final remark on the role of the interaction designer in large-scale development projects, I would like to once more refer to Jones. As modern design problems, or wicked problems, are so complex and large and the search space in which new systems can be found is too extensive to span with a rational search methods, they become too unfamiliar to those who have experiences limited from design or planning professions. Thus, Jones claims the need for "multi-professional" designers, whose intuitive leaps are informed by experience of change at all levels, from community activities to component design (Jones, 1982). As interaction design is a multi-disciplinary field by its very nature, the interaction designer can contribute in large-scale collaborations and projects.

Small-Scale Design Projects Inform the Large-Scale Design Process

Working with the large-scale UMS project and the development of the future public library involves working with visions of future results and uses. The architectural graphics and models, mixed with expectations on the possibilities of the future from the users, will have a particularly great impact on the design team and the design process. When focusing on the interaction and use of the new building and the surrounding facilities, it may be difficult to stay with both feet on the ground and avoid being swept away by the great vision, especially considering the long time-frame and the possibilities, constraints and new standards of technology of the future. Nelson and Stolterman (2003) state that a vision is not a manifestation of the whole, as the whole can never be fully described before it is composed, even with the parts at hand. As with use and users, the user is an interpretation of the designer, the design process and the design, which is why we can only design for the intended use of things. In Nelson and Stolterman's (2003) opinion, the whole is greater than the sum of its parts, but they do acknowledge that the whole is in fact made up of those parts. Consequently, it is not possible to design the whole without taking into account the selection of parts available. The relationship between the whole and its parts is inseparable, as the essence of the whole stems from the nature of the parts. "To create wholes, it is necessary to compose them from particular elements – elements that are then destined to lose their individual identity to a transcendent identity" (Nelson & Stolterman, 2003, p. 119).

Considering and talking about the whole in design is not only relevant when designing large-scale projects that may be easier to think of as wholes. Rather, it is important to consider the whole also when designing small-scale projects, processes and artifacts and it is up to the designer to judge if a design should be experienced as a whole. This is why Nelson and Stolterman claim that the notion of the whole is a foundational property of intentional design (2003). In design and wicked problems, one always has to design the whole, in opposition to e.g. in the natural sciences, where one may investigate a part of a field only. As a designer, one has to deal with the complex web that constitutes a wicked problem and it is not possible e.g. to limit the design to a shape or a function, the designer has to consider them both (Stolterman, 2008). The whole is always a part of a greater

whole, why considering the whole even when working in small-scale projects or with artifacts is important, as the small-scale projects will have an impact on another whole and will inform other processes: multi-scaled interaction design as an informant.

The experience I have gained from working practically in the public library domain and with small-scale interaction design projects have greatly impacted my role in the UMS project. Working in smaller projects, I have acquired firsthand experience with the context, materials, employees, users and the physical place, which was vital to my ability to contribute at the level of the large-scale project. The small-scale projects performed within the time-frame of the UMS have affected the overall process and project. For instance, the focus on the children's library and families probably would not have been informed to the same degree if the various design experiments had not been carried out to inform the process and to strengthen arguments.

8. Concluding Remarks

This dissertation addresses how an increased involvement of interaction design can contribute to the development of public libraries. In the dissertation overview, five years of research has been summarized and the specific research cases are described in detail in the six included publications. Participating in the development process of new public libraries is breaking new territory for the field of interaction design. This thesis discusses the part an interaction designer can play in developing public libraries and how to interplay between large-scale and small-scale projects. The work has been performed within research programs focused on the spatial qualities of the public library and work has progressed through a range of design experiments. The work has been conducted through experimental design research driven by experiments, questions and design programs, in which research is driven by interventions in concrete situations. The projects and experiments described in detail in the appended papers have been summarized, connected and theorized in the dissertation overview. The papers are contributions in their own right, each relating to established discourses and experiments.

The contribution of the dissertation is two-fold, overarching theoretical design program as well as more concrete techniques and tools for designing interspaces. The thesis defines Multi-scaled interaction, which is explored through a design program based on experiments. The suggested toolbox for interspace design in public libraries concern how to move from individual design to social design, from closed and regulated systems to extendable, evolving and open systems, and from disjointed to intertwined systems. The Four space model is developed, where four different spaces have been identified in order to focus and define interspaces. Further, a process toolbox for multi-scaled interaction design deals with how to align different paradigms of practice and inquiry and how to capture and anchor insights from design activities. The contributions made in this thesis are mainly positioned within interaction design, but are highly influenced by in particular architecture and participatory design. The contributions may be seen as extending the field to address new domains, new technologies and new methods. The work has primarily taken place in public libraries, but I find it reasonable to argue that it is applicable and useful for designers working with exploring exciting futures beyond this domain.

9. Futures

In the past, several authors have made great efforts and contributions to the field of design research, partly explored in chapter 4. These contributions concern both theoretical and practical aspects of design research. I argue that further research is needed in order for educational programs to provide their candidates with the tools needed both for reflection and action, in order for them to be able to design their own research processes. Also, the discipline of design research is in need of platforms for how to reach out to the design industry and how to inform practitioners. Traditionally, the design community has looked in the directions of other design practitioners in order to develop and exchange ideas for methods, tools and best practices, but I believe they would gain from contact with the design research community, if we could find better ways of disseminating our findings.

In the process of writing this dissertation overview, I have revisited projects, methods and inquiries and it becomes clear that there are still many questions left that have not been addressed so far. The problem, and the fun part, about design research, however, is that with every answer, a new question arises. That is why it is difficult to conclude that this is the end. Many issues have been left out in which could perhaps have made this work take another direction. Some of these are e.g. the huge development of the digital libraries and results reached in the area of library research. Initiating co-operations with library researchers rather than library practicians would perhaps produce more strategic and high-leveled results, which may have been an interesting turn to take. Also, the large issue of how to develop digital services, digital libraries, and e-resources at the library is barely just touched upon in this overview and could have been investigated more thoroughly.

The work produced in this thesis is a platform for my future work, and my next steps to further explore Multi-scaled interaction design are in the direction of how interaction design can be incorporated into large-scale architectural processes and citizen dialogues, in order to create more sustainable and attractive spaces. The user centered approach and participatory design fits well with the identified needs within practicing architects and the public institutions (Dalsgaard & Eriksson, 2013), and information technology can in many ways be used as a design material for new methods and tools in this area.

10. Summary of Appended Papers

Eva Eriksson; Peter Krogh; Andreas Lykke-Olesen (2007).
Inquiry into Libraries - A Design Approach to Children's Interactive Library In proceedings of Nordes. Stockholm, Sweden, 2007

This paper reports on a design process of pervasive computing installations for an interactive library for children. The design process involved a wide range of decisive parties of the domain and the process was designed in order for the collectively developed design concepts to suit the needs and interests of the many parties. Narratives and sketches were used for inquiries and communication and the concepts and their iterations illustrate the design process and how the physical qualities of the environment and the artifacts played a central role in the development of the concepts.

Eva Eriksson; Andreas Lykke-Olesen (2007).
StorySurfer – A Playful Book Browsing Installation for Children's Libraries. In Proceedings of IDC'07. ACM, Aalborg, Denmark, 2007.

In this paper, the authors present a large-scale interactive book browsing installation for children's libraries called StorySurfer. The StorySurfer prototype was developed within the Interactive Children's Library project, which includes interests from within design, research, the industry, and libraries. The objective of the project was to give room for and encourage the physical activities of children, while pursuing to connect these with the basic digital and analog services of the library, e.g. borrowing and handing in books, searching for information, and providing access to a rich variety of media.

Peter Dalsgård; Christian Dindler; Eva Eriksson (2008).
Designing for participation in public knowledge institutions. In Proceedings of NordiCHI 2008.

This paper addresses the challenges facing designers of interactive technologies for public knowledge institutions such as museums, libraries and science centers. It is argued that visitor participation is a key concern for these institutions and it presents a theoretical framework for understanding participation grounded in pragmatist philosophy. The authors then present design work carried out in three different settings, namely a museum, a combined aquarium and science center, and a municipal library. Based on a discussion of these design cases, six design considerations for designing for participation in public knowledge institutions are offered.

Eriksson E. (2010)
U.F.O.scope – Families at Play in the Library. In Conference Proceedings of DIS 2010, Aarhus DK. ACM press, New York.

This paper investigates how interaction design installations can support families playing together in the context of public libraries. The interactive installation U.F.O.scope is presented as a means to investigate how the library is able to support children and parents playing together. The idea of the installation is to stimulate the lust for families to explore the unknown together on unfamiliar ground, while also discovering the physical library and the different types of resources it holds. The design and evaluation of the installation are discussed and some general issues central to future design are outlined.

Eriksson, E., Liv Johansen S. (2013)
Playful Technology - Design of Children's Library Services. Accepted for publication at 10th European Academy of Design Conference: Crafting the future, Gothenburg, Sweden, April, 2013.

In this paper, the design of future services for children in public libraries is discussed. The paper explores play culture and take a stance, especially in the project "Families at Play in the Library", but also presents experiences from related projects. The paper focuses on families playing together in the library and the changing role of the librarians and the library space. We argue that intertwining traditional library services with new forms of media and engaging play is the core challenge for future design in physical public libraries, but also that it is through new media and technology that new perspectives for the future of the libraries become visible. Experiences from the project will be presented as general design considerations for the future design of services for children in the library.

Dalsgaard P., Eriksson E. (2013)
Large-Scale Participation: A Case Study of a Participatory Approach to Developing a New Public Library. Accepted for publication at ACM CHI, Paris, France, 2013.

This paper offers a case study of a participatory project that focuses on interaction in large-scale design, namely the development of a new municipal multimedia library. This project, which has been under way for ten years, embodies a series of issues that arise when approaches from participatory design are brought to bear on large-scale, IT-oriented projects. At the same time, it highlights the issues facing public knowledge institutions when interactive technologies challenge their fundamental roles and practices; by extension, the case offers examples of how these challenges can be explored and addressed through IT-based participatory initiatives. The paper present a range of such activities carried out during the past ten years and present the main lessons learned from the project on the basis of interviews with three key stakeholders. These lessons focus on how to make participation work in practice, how to align different paradigms of inquiry and practice in a project of this scale, and how to capture and anchor the insights from participatory events in order for it to inform the ongoing design process.

11. Illustrations

Cover Illustration – by Andreas Lykke-Olesen, based on photos by Eva Eriksson, Andreas Lykke-Olesen, Smith Hammer Lassen Architects and Aarhus Municipality

Chapter 3
3.1.a Missing Link – by Eva Eriksson
3.1.b Missing Link – by Andreas Lykke-Olesen

Chapter 4
4.1.a Diagram of Design Process – by Eva Eriksson

Chapter 5
5.1 Timeline – by Eva Eriksson
5.2 UMS – by Smith Hammer Lassen Architects
5.3 - 5.7b Various – by Eva Eriksson
5.7c – 5.12 Children's Interactive Library– by Andreas Lykke-Olesen
5.13- 5.17 Various - by Eva Eriksson

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