StorySurfer – A Playful Book Browsing Installation for Children's Libraries

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

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Interaction design, children's library, pervasive computing..

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION
The physical library has a central cultural and social role in society, democratically accessible to all free of charge and being based on the combination of sociality and collection of information material. Generally the library as an institution is challenged in many ways these years, among others by the extensive Internet-based services provided by libraries enable people to do searches, read reviews, and make reservations of physical materials from their home computer. Though many of these services are desirable from an ease of use point of view, they also contribute to the depopulation of the physical library.

Focusing on the children's library, it is typically seen as a library within the library, a service on its own rights. Though being an institution on its own rights it is very faithful to the fact that it is grown out of the "adult" library with regard to search facilities and the display of materials. In a strive to change this, the library has introduced both PC's equipped with children appropriate games and console games, to both facilitate children in just being there for the entertainment as well as settings for parents playing and aiding their children. Some libraries have in addition to this also established facilities for teenagers. Typically the computers as well as the facilities for the teenagers are separated into rooms and niches in association with the children's library as these activities are still regarded to be side-activities to the traditional functions of the library: borrowing materials and reading books. But there is an increasing awareness and acceptance that noisy elements such as game playing and hanging out, are important elements in what a children's library should offer its users, and that the children's library should build upon values appreciated by children and not just a miniature version of the adults' library comprised of children targeted materials. The many web-based services e.g. chat forums, reviewing and recommending, contributes to make children aware of the services and many facets of the library.

The vast research in children's social and search behaviours in a physical library as well as in digital libraries reveal an interesting area [1]. However, little has been done in trying to combine the two, making the physical space and artefacts in the library the interface for digital material, and shifting the desktop computer to pervasive computing systems, to emphasize the social qualities of being co-located.

There is extensive research in various digital services for libraries e.g. library web sites, library search engines, sociable web based chat rooms connected to the library web site and digital comments on books; services and developments supporting future visions of the children's library as digital, virtual and distributed [6, 7, 12]. On the other hand, research reveals that children desire for physical spaces in the libraries meant for them; spaces supporting them in living out their social life among friends and peers [9], and that they wish to hold on to the libraries [10]. An indication of the importance of the physical environment

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can be found in [5] where 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 towards the overall advantages for physical environments over desktop environments.

In this paper, we will present experiences and findings from a project titled The Interactive Children's Library, dealing with pervasive computing installations, and especially the concept StorySurfer, an interactive physical installation for book browsing within children's libraries.

THE DESIGN PROCESS

Project group and ambitions

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 of the libraries, the need of a meeting place, and the existing technologies in the library. With this project, we aim to investigate the hidden potential in seeing such factors as material for design, and to join them in design proposals. In addition to this, our central material for design is information technology, and to explore the possibilities of the children's library domain, we also include spatial architectural perspectives to enrich the interaction design.

To meet the challenges experienced in the children's library domain, a research consortium was established, comprising competences from the research centre; architecture, interaction design, engineering, and computer science, combined with a set of industrial partners having various interests: pedagogues, a cabinetmaker, a web bureau, a company developing library databases and an architectural office. To facilitate quality and diversity of input from the library domain, representatives from five major regional children's libraries were part of the project setup.

The design criteria for the installations was to go beyond existing interaction modalities for computer appliances, and on the basis of these challenges the local library services and key researchers formulated a set of ambitions and facilities to be met in a future interactive children's library:

- The children should be able to engage several senses and even the whole body when experiencing and dealing with information
- Noisy activities are accepted on equal basis with more silent ones as e.g. reading
- Regain the importance of being co-located in a physical room emphasizing and staging the social qualities this do enable – the library as a social arena
- Work positively with the fact that children see IT services as being a natural and attractive part of a learning environment.
- The target group of children should be those who just started reading (approximately 7 – 8 years) but not exclude older nor younger children

In order to ensure the relevance of the project; user studies, time line and structure of the project is designed to facilitate several experimental periods involving children in sparking design ideas, providing valuable input for the iterations of the prototypes and also being test drivers of the installations.

Initial field studies

We performed field studies early in the design process, to get insight into the children's library. Apart from observing the physical space and organization of different books and materials, we had informal talks, interviews and sketch sessions with children visiting the library.

In total, three different public libraries were visited for field studies; one for observational studies only and two where we engaged the children in activities that would help us understand their perceptions of the current library and what they would like to see happen in the near future. There were four steps in the user studies in the two libraries. Firstly we placed ourselves in the children's library department, and started to unpack things that we had brought. The children were curious about us, and approached us to ask what we were doing. We asked them to tell us about the library, what they were doing there, why they were there and what people they would meet there. We asked the children to make short video films about the library, where they would film each other demonstrating and telling about the library, without us interrupting. How they would make the film was all up to them and they were left alone while shooting the film. These small snippets into the children's library were useful not just as they focused on certain aspects, but also because things that would seem important for a grown up for defining the library were left out. Further, the fact that the films were shot from the eye point of a child changed the spatial perception of the physical space, e.g. as shelves constrained the space into corridors because the children could not look over these.

Secondly in the middle of the room we had a table which we filled with crayons and papers, and we asked the children coming up or passing by to draw from one of two themes, either how the library will look like in 100 years, or to explain how the library is on the planet Mars. The idea of taking departure in how the library might be on Mars was inspired by [3] carrying the ambition of creating a shared narrative in which both the children and the researchers could play with ideas that are outside the narrative space staged by the current library. This method for approaching the children's understanding of the library through a common activity, gave both fun and valuable inspiration to the project. Furthermore this approach could (and did) bring mythical and mystical aspects into the discussion on what the children's library might be like in the future. (Figure 1B.)

Figure 1. A member of the research team A) studying children playing a computer game, and B) sketching with a child.

Thirdly we placed out questionnaires in different places in the children's department of the libraries, where the children freely could give criticism to the library and suggest changes. Fourthly and last we did unstructured interviews with interested children while they were demonstrating for instance how a computer game was played or how one returns borrowed books. (Figure 1A).

Findings from field studies

Our findings from the user studies can be divided into three categories; Social and spatial, Cognitive and emotional, and Technological and digital.

Social and spatial findings are for instance that many children have a hard time finding a physical location to hang out. In two of the children's libraries we visited one part was dedicated to infants and pre-school children, and one part to teenagers. Many children do not see themselves as belonging to any of these groups. Experiences from one of the visited libraries show that nuanced and graded divisions of the space based on the spatial layout of information facilitate children in finding "their space". Perceivably this can be achieved when the materials are ordered in terms of the age group they appeal to; as expressed by one of the children: "we meet where I find books that interest me".

With regard to the cognitive and emotional aspects, shelves are not the preferred ordering and display of books seen from a child's perspective. The amount of books placed together makes the titles hard to separate, leaving children with little chance of estimating which book might be of interest to them. Librarians know that the children do perceive it as if the all the books turn their back to them. In response to this librarians pick out books for display on special stands so that the cover becomes visible. As soon as the cover is turned towards the children, the number of borrowers of the book will increase dramatically. As candidly noted by a librarian: "this way we can almost decide which books the children should read!" This is of course not fully true, but the covers of course help the child to visualize if the book might be of their interest along with the note on the back-cover, and furthermore the children expressed interest in having more info on the story in helping them to decide.

Many libraries are adopting digital technologies for library purposes, for instance RFID-technology and robots replace the praxis of bar-code use for tracking in and out going books. In our studies we found that these technologies do not stay strange to children for long, but are quickly adopted as an everyday element in the environment. Rather than being hesitative, the children put their curiosity at work and quickly understand the use and purpose of the technology. On the other hand, we found that children do not use computers to search for books. The interface of search engines and browsers available today are perceivably more suitable for adults, the children do not use them.

THE STORYSURFER PROTOTYPE

Turning findings into design

The findings from the field studies, the focus on the library as a physical space that make a bridge between users and digital material, as well as valuable information from the librarians within the project team, served as a basis for developing concepts in several workshop sessions with all project partners.

The initial concept of StorySurfer was called cubeSearch, and consisted of a range of cubes that on each of their six sides contained a keyword that could be used to search for books within the library e.g. "love", "horror", or "horses", see Figure 2A. The idea was that the cubes together with a floor and a large wall projection made up an alternative physical search machine. By sliding the cubes on the floor, more or less of a certain keyword would be influencing the book results presented on the wall display. Using multiple cubes would function as a Boolean search, presenting books relating to *this* and *that* keyword.

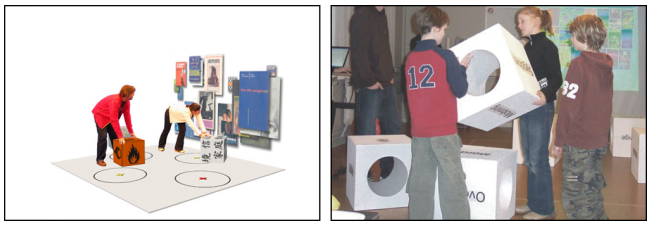

Figure 2. A) A concept sketch of cubeSearch, B) Children testing cubeSearch in a Wizard of Oz setup.

Before developing the entire system, we made a "Wizard of Oz" workshop [8] with children; to test the feasibility regarding children browsing books with cubes representing keywords, see Figure 2B. This showed that the children had difficulties coupling the cube activities on the floor with the books presented on the wall display. Thus the concept was iterated, redesigned, and later developed into StorySurfer.

StorySurfer evolved through numerous iterations by sketching ideas out and discussing these with the core group involved in StorySurfer. To put focus on the physical aspects of the library, and inspired by technologies supporting a potential social or collaborative interaction, we focused on the floor and the table as two surfaces that relate to the body in different ways. The floor relates to the entire body, whereas the table relates to hands and gestures. By making this distinction we divided the search of books into

two activities: roughly browsing pools of books with your body on the floor; and investigating interesting books from the floor more deeply on the shared table. The interaction on the floor and on the table both support multiple simultaneous users interacting trough their own cursor. (Figure 3).

Figure 3. The StorySurfer prototype installed at the library.

Setup

The StorySurfer prototype is giving new physical form to two standard desktop computers. (Figure 4). Hereby, the setup is seeking to shift the focus from the well known desktop computer boxes to a large scale spatial installation with dynamic properties that expand the physical realm. By hiding and covering the desktop computers the setup also seeks to imply ways for engaging and interacting with technology that are not based on the regular desktop interaction paradigm.

Physical setup - the division between floor and table

The physical setup is designed as a 4x6 meters one plane folded into a waveform creating a continuous surface between a floor and a table, see Figure 3. The construction consists of multiple components made of MDF boards that are assembled into one installation. The waveform is thought to express the division and connection between the floor component and the table component. This division is an important aspect of StorySurfer in regards to expressing the different activities offered on the floor and at the table and the corresponding division of digital functionality in the application. In the rim of three sides of the floor 19 buttons are distributed and available for stepping on to configure the application. The table surface is made up by a translucent glass material suitable for projecting on from beneath.

The digital setup

The digital setup consists of two desktop computers, two web-cams, a reconstructed keyboard, four LED pens, and three projectors. Respectively, the two computers are respectively running an application for the floor component and the table component as well as a visual tracking application detecting inputs from the web-cams and providing these to the floor and table applications. Both computers are accessing the same database of books stored on the one running the table application. The database is in direct contact with the database of the library, so that the books that are not present in the library at the moment will not appear in either of the projections. The content of the database is based on the same content as the database of the library, only with two changes. The major change is that images of book covers have been added to each of the over 4000 chosen children's books. In order to do this, due to copyright restrictions, we had librarians manually scan each physical book. The second change in the database is clustering of keywords, so that for instance both "romance" and "love" was indexed under "love". This is due to the limit of 19 buttons on the rim of the floor, meaning just 19 keywords instead of the several hundreds that the library database originally has.

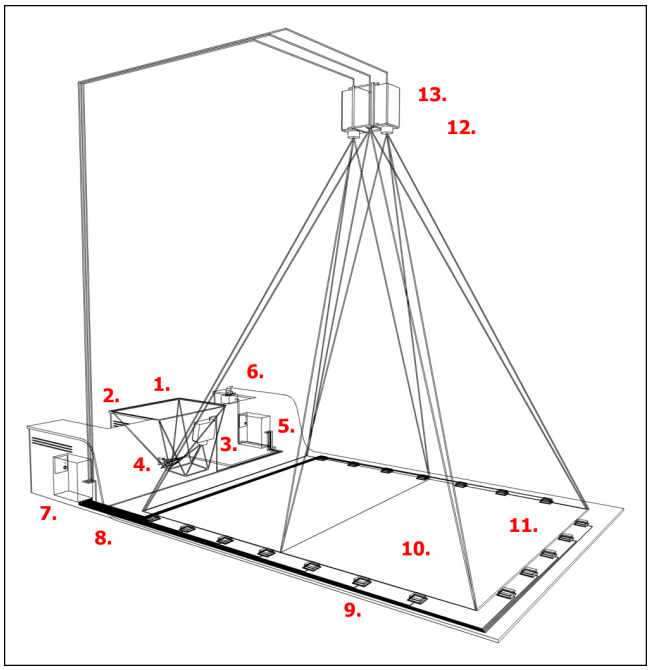

Figure 4. Diagram of StorySurfer 1) Table projection, 2) Table tracking area, 3) Table projector, 4) Table web-cam, 5) Table application computer, 6) Printer, 7) Database and floor application computer, 8) Reconstructed keyboard, 9) Buttons triggering keystrokes, 10) Floor projection, 11) Floor tracking area, 12) Floor web-cam, and 13) Floor projectors.

For the buttons, a keyboard is torn apart and different keys are placed within each of the 19 buttons around the floor component. Two projectors together with a web-cam are mounted in the ceiling, creating one unbroken projection on the floor of 1536*1024 pixels (approximately 4*3 meters). The third projector is placed underneath the table surface along with a web-cam creating a back projection on the translucent table surface.

Interaction and interface

The interaction in StorySurfer happens through two different graphical user interfaces and on two different levels; a rough book cover search on the floor and a more detailed inspection of book objects on the table. There is no specific order for interacting but the initial idea is that users make a rough search on the floor, pick some book titles by sending them to the table and inspect these further there.

On the floor, the projected interface, made in Flash, is presenting various book covers according to the configuration of search criteria. The interface is capable of displaying up to three colored blobs, each representing a set of book covers that match a specific keyword. Books matching both or all three keywords are displayed in the areas where the blobs overlap, as in a Venn diagram. Hereby, children can get introduced into Boolean search techniques in a visual manner. The keywords related to the blobs are configured by stepping on the buttons on the rim of the floor. In front of each button a keyword is projected such as "love", "horror" and "fantasy". (Figure 5A). Stepping on a button will expand a new blob and display a new set of book covers. If all three blobs are in use, the blob with the oldest keyword will contract and be replaced by the newly chosen one.

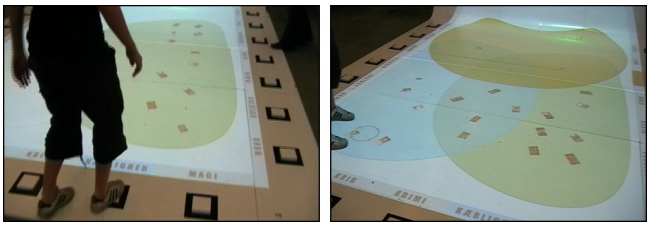

Figure 5. Using the floor A) Stepping on keyword buttons, B) The magnifying lens.

Entering the floor surface, the user's body position is tracked by the ceiling mounted web-cam and analyzed by Retina [13]. This provides the user with a magnifying lens that is projected in front of her, always turning towards the center of the floor to avoid user shadows occluding the projected lens, and that follows her around while inspecting the floor. (Figure 5B). Multiple users can be tracked simultaneously and can interact individually through their projected magnifying lenses. When a lens rolls over a book cover, the image expands to give a better visual impression of the book. (Figure 6A). After keeping the lens over the book for a short while, a graphical timer will appear around the lens to count down before executing a selection command. (Figure 6B). If the user moves away from the book before time out, the cover image will contract and the selection timer disappears. Otherwise the selection command will be executed, which means that the book is sent from the floor to the table visualized as an animation of the book cover literally sliding up the waveform to the table.

Figure 6. Using the floor A) Expanding a book cover, B) Invoking the selection timer.

On the table, the interface, made in Flash, is projected from beneath through the translucent surface. The interface is displaying book objects that have been selected by users when browsing the floor interface. When book objects arrive on the table they reveal new properties that are not visible on the floor, as the rough bodily interaction technique is not suitable for browsing content within each book object. The configuration of book objects on the table is governed by the users, however, two constraints have been applied to avoid extreme cluttering of the interface. The table can display a maximum of 15 book objects at a time. When new books arrive from the floor, the book objects that have been on the table for the longest period of time, without being inspected by users, are exchanged.

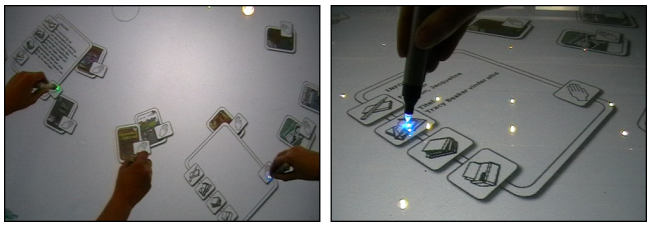

Figure 7. Using the table A) Multiple pens dragging book objects, B) Expanded book object.

The other constraint is related to the interaction technique that is based on the MultiLightTracker pen-based interaction technique [11]. This technique uses the web-cam mounted underneath the table surface using EyesWeb [4] to detect and track colored LED lights and provide these as inputs to the table application. By pressing a pen on the "hand" icon of a book object on the table, and hereby activating the LED, it can be dragged around on the surface. (Figure 7A). When releasing the pen, and hereby deactivating the LED, the book object expands to double size and uncovers ways of investigating the book object. See Figure 7B. Apart from the cover image, book objects on the table contain buttons to information on author, summary, related books, and access to a printer. (Figure 8A). In the StorySurfer prototype four pens with different LED colors are used simultaneously, however, each pen can only have one book object expanded at a time. When choosing a new book object, the book object currently in focus by the according pen color contracts. Again this is to avoid cluttering the interface.

If a user finds a book interesting and wants to locate the physical book in the library, it is possible to print a slip of paper that contains directions to the shelf, the related meta-

information, and the cover image, as StorySurfer contains a thermal printer placed inside one of the side tables. (Figure 8B).

Figure 8. Using the table A) Printing information, B) Collecting the print-out.

DISCUSSION

In the following we will present a number of observations and findings from our test periods with StorySurfer and discuss these against our initial ambitions towards the future interactive children's library as presented in the introduction of this paper.

Findings, Observations and explorations

Through two periods of approximately 3 weeks each, StorySurfer was exhibited and tested in the main municipality library of Aarhus, Denmark, where we were able to study it in actual use by children in different ages and gender. (Figure 9AB). Due to multiple initial problems related to the very large setup, it was decided that trying it out once was not sufficient. So when installing it for the second time in the library, StorySurfer had undergone a number of design iterations to correct the problems from the first test. StorySurfer did not function properly as intended in either of the two test sessions, even though it was much better the second time. Nevertheless, there have been many valid observations and interviews with children, made by librarians, researchers and pedagogues during the test periods, and some of them will be presented and discussed here.

StorySurfer became a compliment to existing traditional search methods at the library, as well as it became a playground for children of all ages to, in a playful and experimental way, explore the functionality of the installation as well as their own knowledge. StorySurfer had a central position in the library, and the children were often in contact with the librarians when using it. StorySurfer became a new tool of communication between the librarians and the children, as well as a new meeting place for children of varying ages.

On unfamiliar ground

StorySurfer appeared to be an installation where people do something together. Both individual children, children in groups and children together with parents explore the prototype. As it is an unknown setup to all, it is a meeting place for doing investigations together. No parent can be the instructor, meaning the child and the parent rather meet in a common unfamiliar ground. The smaller children use the installation too, they investigate books they will read later through play. Most new visitors, no matter age, are hesitating at start and are very careful. But after a while, when nothing dangerous seems to happen, they start running and jumping on buttons and floor. There appears to be a fear of breaking something in the start, but when they see that nothing strange happens, they become more relaxed and confident.

Figure 9. StorySufer A) Browsing for books on the floor, B) Inspecting books on the table.

Social interaction

There is a lot of social talking taking place around the installation, comments on the covers and exclamations when someone recognises a book they have read. There is not a particularly high level of noise around the installation though. At start there is a lot of communication about how to use the installation, and then visitors pass that knowledge further to others. There is also cooperation between parent and child, where the child surf the floor for interesting books that the parent reads about on the table, and when they have decided upon some books, the parent goes out to find the books,

Though the potential for social interaction is high given that multiple users can interact simultaneously in the same system, there is not much physical contact. As the cursors (magnifying lenses) on the floor are individual, users tend to avoid going to close to each other to interfere with the other users' search and cursor. By designing StorySurfer we had the ambition to exploit the physical library space for supporting social interactions, however, the prototype acknowledges that users might want to be left alone while browsing books and that the social engagement must evolve from the participants in action. Browsing books within certain categories in public might feel embarrassing for some children. In the prototype, searching books on your own while serendipitously being able to follow what "the others" find interesting holds social aspects on a lower implicit level than direct social and physical contact. It is worth noticing that this kind of looking over the shoulder is much harder in the traditional library layout, with book shelves and only book backs visible.

Picking up the functionality

Most children get an idea quite quickly of how to use the system, even though technical restrictions did not make everything work out the way it was meant. At the floor, the interaction is based on pushing buttons and dragging a cursor. Some misunderstanding came across the fact that

you can not step on a book to choose it, and that there is no double-click. On the table the hand icon was misguiding, as you were supposed to use the pen to drag book objects around and not your hand.

An interesting observation is that an understanding for how the installation functions come quicker if the children tried all the functions of the installation first, instead of asking for help before trying it out. So the understanding for how it works turned out to be more dependant on the child's carefulness versus the lust to explore, and less on the actual level of difficulty for understanding.

The influence of age

Age was the most important factor for differences in use of StorySurfer. There was a great difference in the younger and the older children's use of the installation. The youngest children, about one to four years old, used the floor for different games, which were only indirectly connected to the interface, e.g. trying to catch each other with the cursors. They ran a lot over the floor and pushed the buttons. The young children about five to eight years old searched for books in the way they could, but ran a lot back and forth between the floor and the table to be sure that the books they had chosen really had reached the table. The older children, between nine to fifteen years old, also had a playful attitude towards the interface, but in contrast to the younger children, after just a short while they used the installation for what it was meant for, to find books and print covers. The older children, especially the girls, were eager to fulfil the activity, to find a book or several to bring home. The older children walked around more calmly on the floor discussing the covers of the books with each other, spontaneously exclaiming, "Oh see, I've read that one!"

Perceiving StorySurfer

An interesting discussion is how children perceived the installation. It was our intention that by embedding the technology in the physical installation and thus hiding the desktop computer, we could exploit new interaction paradigms. Nevertheless some children started out by the table, as they believed it to be the "keyboard" for controlling what they saw as the "screen" on the floor. Here it is interesting to see how some children perceived the technology and tended to decode it as a large scale desktop computer as discussed by Buxton [2].

The overall reactions are mostly joy and laughter, and verbal expressions of how cool and fun it is. There are a few unfortunate disappointments too, mostly because of that the technology was not optimal at some times. There are some differences in the use of StorySurfer when they have tried it for a while. Some just find it fun and amusing, while others see the use of it and return several times to search for books. This addresses another of our initial ambitions to regain the importance of the library as a physical space. StorySurfer afforded activity and functionality that went beyond the console games and browsing books on the internet that does not differentiate the library from most children's homes. That some children returned several times shows that the prototype had an impact in adding focus to the physical space.

The process of changing practice

For a prototype like StorySurfer to be successful a large part of the responsibility lies on the librarians. Having the librarians involved in the early design process as well as in scanning books made them feel a part of the development of the prototype, which was important for their motivation during the test phases, especially during the times of technical difficulties. StorySurfer mediates a new practice for children searching books as well as a new practice for the librarians in providing support for children in their search for information. Thus the librarians need to adopt the idea of alternative ways towards finding books and also new social and physical situations in which the dialogue between child and librarian can take place. Through StorySurfer, movement, stepping on buttons, pointing towards book covers on the floor as well as dissecting book objects on the table becomes part of a new shared practice between child and librarian.

StorySurfer points towards a future children's library as a cultural meeting place rather than an institution for promoting culture; a meeting place where the users can meet several physical and virtual materials that open up for multimodal learning processes. The interaction with StorySurfer became to a large extent a social activity. To use it as a search tool was something the children did with their parents or friends, rarely alone. It was also a very physical activity, meaning that the children moved around and explored the digital interface by using different tools and body movements. StorySurfer was appealing to all ages, and the installation became a new social and interactive meeting place for both young and older children, teenagers and adults. Instead of dividing the library into different sections for different age groups and activities, StorySurfer creates a non-divided space, a common ground.

FUTURE WORK

Though StorySurfer has been tested for two periods so far, it would be interesting to observe it in use for a longer period of time, to see if and how the use of it might change over time. It could also be of interest to add other materials to the content of the database, such as movies, web-links, music CD's and more, and not just focus on the books of the library, but on all of their resources.

In other design concepts and prototypes under development and in test phases, we are working further on evaluating the ambitions of the project, and also looking for further research directions within the children's library domain.

CONCLUSION

An empirical analysis of the interactive large-scale installation StorySurfer presented in this paper lead to a more general discussions of interactive use of space and

mediation of information in the future children's library. StorySurfer can raise the awareness of new routines around for instance searching for information by bringing the user in the center and make searching for information another form of (often social) activity.

Today, children are used to computers, but instead of placing the children by a table in front of a screen and keyboard, in StorySurfer the children have to go out on the floor and use their entire body in their search for information. StorySurfer represents a new way to use technology. At the floor, the children can stand on one leg and move their foot over to a virtual book cover to activate it; at the table they can use the pens to drag and inspect books for more information about them. The children are challenged motor functionally in different ways.

Our analysis of the children's use of StorySurfer supports the projects ambition that pervasive computing can give new forms of (interactive) use of space and new forms for cultural experiences and learning processes. Also, StorySurfer creates attention around searching for information and the existing practice, and the installation points out the importance of bringing children into a process which traditionally only exists behind the librarians table.

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