InfoGallery: Informative Art Services for Physical Library Spaces

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ABSTRACT
Much focus in digital libraries research has been devoted to new online services rather than services for the visitors in the physical library. This paper describes InfoGallery, which is a web-based infrastructure for enriching the physical library space with informative art "exhibitions" of digital library material and other relevant information, such as RSS news streams, event announcements etc. InfoGallery presents information in an aesthetically attractive manner on a variety of surfaces in the library, including cylindrical displays and floors. The infrastructure consists of a server structure, an editor application and a variety of display clients. The paper discusses the design of the infrastructure and its utilization of RSS, podcasts and manually edited news. Applications in the library domain are described and the experiences are discussed.

Categories and Subject Descriptors
H.5 [**Information Interfaces and Presentation**]. H.5.1 [**Multimedia Information Systems**] augmented reality; H5.2. User interfaces; H.5.4 [**Hypertext/Hypermedia**]

General Terms
Documentation, Design, Human Factors.

Keywords
Informative art, ambient displays, interactive spaces, digital exhibition, RSS, ubiquitous hypermedia.

1. INTRODUCTION
This work reported was conducted in the Future Hybrid Library project under the Center for Interactive Spaces, Aarhus, Denmark www.interactivespaces.net. The focus of the project was to create new types of IT-based experiences when visiting physical libraries. The work has been inspired from mainly two sources namely empirical research in arrangement of physical spaces in libraries [3] and in literature studies of calm technologies [28], ambient displays [16] and informative art [25] [12]

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The empirical research in libraries revealed a problem in creating awareness about all the digital subscriptions that the libraries spend a lot of money on. It takes a long time before library users discover new digital subscriptions and new issues of existing digital subscriptions. This is in contrast to what happens when new physical books or periodicals arrive, they are put on display in the entrance hall or on very visible shelves in relevant parts of the library building. This challenge made us look into the field of informative art. This is a new research area focusing on making digital information displays aesthetic, calm, and pleasurable.

This idea dates back to Weiser & Brown [28] who are introducing the notion of calm technology that is meant to be discrete artistic "displays" in the environment which conveys information to people in a physical room without disturbing and with a more aesthetic form than the classical look and feel of a computer display. Also MIT has worked with these ideas in their Ambient Room project [16], and finally Georgia Tech has developed a system called InfoCanvas [20] aiming at people composing an abstract picture with dynamic indicators of weather conditions, stock market prices etc. InfoCanvas is made in a screen saver variant that consists of abstract screensaver picture that convey information to the computer user without displaying hard curves and facts directly. The main term being used about this kind of technology is now informative art, and we will describe this related work in the following section.

2. INFORMATIVE ART
Researchers from the Swedish research center RE:FORM – (formerly known as PLAY) have introduced the term informative art: "Informative art is computer augmented, or amplified, works of art that not only are aesthetical objects but also information displays" [25]. They argued for new aesthetic approaches to IT-design. Their work thus focused on bringing abstract art expression into the communication of factual information like weather, stock prices, bus arrivals, or web server traffic. Thus aesthetics is used not only for pleasure but also for serving a communicative purpose. But communication of digital information is integrated in the shaping of the physical space, e.g. in a library or in an office environment with the purpose of creating mutual awareness of important information, e.g. with "pictures" on the wall as illustrated in Figure 1

As an example on the extension of an aesthetic painting with informative properties, Redström et al. [25] uses the expression of the Dutch artist Piet Mondrian's pictures. Here Mondrian's characteristic rectangles in the basic colors yellow, red and blue are used to illustrate the activity in users' mailboxes. Colors may

correspond to different people in an office layout and the sizes of rectangles indicate the number of unread mails in their inbox.

Another example described by [15] is informative art based on the British artist Bridget Riley's colorful patterns - Op-art. Here patterns change dynamically based on measures of the number of people and their activity in the room.

Figure 1: Informative art on the wall (Redström et al. [25])

A final example is InfoCanvas [21] developed at Georgia Tech as a tool to support personalized ambient displays with abstract graphics representing various kinds of information like weather and traffic information, see Figure 2. A typical application of InfoCanvas is a user who builds his/her own graphical images with the InfoCanvas tool and assign various types of information to the graphical elements of the image. Then the image slowly animates in the background to signal changes to the information sources being subscribed to.

Figure 2: InfoCanvas example (Miller & Stasko, [21])

The main differences between Redström et al's informative art and InfoCanvas are that InfoCanvas is meant to be personal and uses a specific set of graphical primitives that comes from a very different artistic genre, than informative art.

As described a number of examples of informative art applications have been presented in literature, but none of these have directly addressed the library environment. In the "Future Hybrid Library" project under Center for Interactive Spaces, we have worked with librarians in a participatory design process [5] to develop general informative art services for library spaces.

3. MOTIVATION AND CHALLENGES IN THE LIBRARY DOMAIN

In recent years more and more library services have moved out of the physical library building to services on the internet. Many library materials have become digitized and many resources such as periodicals come as digital versions only. In many libraries physical shelves are placed centrally to expose new books and new issues of periodicals. This supports serendipity, meaning the faculty of making happy and unexpected discoveries by accident. [1][7][8]. The library visitors may discover unanticipated material of interest when passing the shelves. According to the librarians this rarely happens with the digital resources. Many library visitors never find out that the library possess a lot of digital resources unless the have a targeted need and ask a librarian or perform a targeted search. When a visitor decides to sit down and use a search mechanism, this search system may support serendipity since some research in search engines has taken serendipity into account [2]. But it is creating the awareness of existence of specific resources which possess the main challenge in the physical space of the library. Another challenge is to make grabbing a piece of digital material as natural as grabbing a physical book or periodical issue.

The aim of introducing informative art applications in the physical library space is to support serendipity for digital library resources and grabbing of digital material of interest.

In the Hybrid Library project, we made a first experiment on providing informative art to support serendipity and physical grabbing of digital material. We developed an InfoColumn, which can be seen as digital version of a poster column where librarians could post announcements via a web interface. The posted announcements then appeared as animated objects in an aesthetic appealing graphic environment on the column (see Figure 3). If a visitor became interested in a piece of digital material s/he could place a Bluetooth enabled mobile phone on specific locations on the shelf surrounding the column. Selected references to library materials were then pushed to the phone via an established Bluetooth connection. For this purpose we used the adjustable range BlueTooth base stations from BlipSystems (www.blipsystems.com)

Figure 3: InfoGallery in use on a prototype column

These experiments indicated that large scale exhibition of digital library material in the physical library is a good idea. In particular many librarians who visited the library during the pilot experiment phase made requests for this kind of physical exhibition possibility for library materials. Based on the ideas put forward by informative art, and these experiments we decided to build a general infrastructure for web-based informative art. This infrastructure and its applications have been named *InfoGallery*.

Visitors at a library typically experience InfoGallery on large flat panels or projection surfaces on walls, floors, or ceilings. The display will feature an animation of a collection of InfoObjects each consisting of a snippet of text and some graphics, see Figure 4. At random an InfoObject may zoom to large scale and show up in the center of the display for a while before it again continues to be part of the animation.

If the display enables interaction, visitors may at any time click or tab on the touch-sensitive surface to explore a piece of displayed information in depth. And finally references to the information may be dragged to a Bluetooth phone or sent to an email address supplied by the visitor.

Figure 4: Example from an InfoGallery about Danish literature – www.litteratursiden.dk

In the following we will describe the InfoGallery design and architecture, general lessons learned, experiences and potentials.

4. INFOGALLERY INFRASTRUCTURE

InfoGallery is a software platform aimed at being a flexible generic infrastructure for informative art inspired exhibition of digital information and material. It is designed for libraries in the first place, but we intend to deploy it in broader contexts.

The basic architecture is inspired by context-aware hypermedia architectures [4], but it is simplified to three layers: Server layer, client layer and a sensor layer as depicted in Figure 5.

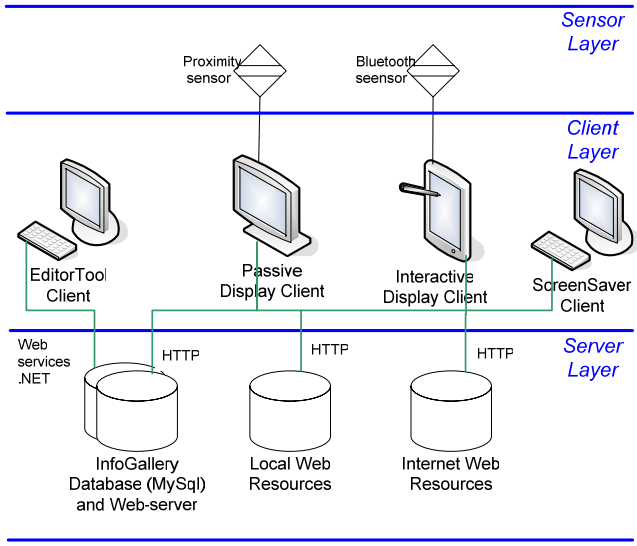

Figure 5: InfoGallery architecture

The elements of these layers will be described in the following.

4.1 The Server layer

The server layer consists of the InfoGallery database (DB) and Web-server. The database which is implemented in MySQL holds meta-data about the set of displays connected to the server, channels for distribution, the set of skins (presentation styles to choose among), categories of InfoObjects, and finally the InfoObjects that contain meta-data about the resources to put on display in the galleries. The resources referenced by InfoObjects may be RSS feeds (http://web.resource.org/rss/1.0/), specific Web-pages, calendar data, as well as announcements with all its content made and stored directly in the InfoGallery. An overview of the InfoGallery data model is shown in Figure 6

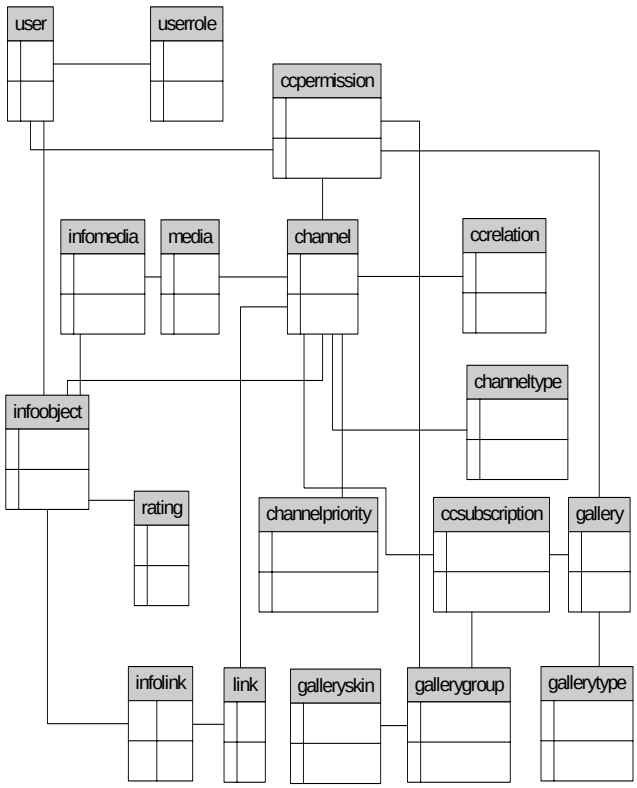

Figure 6: InfoGallery data model

The *InfoObject* is a class of objects representing meta-data about resources (e.g. a specific book, article or a "live" RSS feed) to be exhibited in InfoGalleries, they may utilize a variety of *media* types to provide attractive previews of the resources. Preview media, is accessed via the InfoGallery Web-server. Preview media may be snippets of text, preview pictures, snippets of video and sounds made and maintained by the InfoGallery for presentation purposes. InfoObjects may be assigned a specific *category* attribute, determining certain aspects of the presentation, e.g. shape or color.

Gallery is a class of objects representing physical displays connected to the given InfoGallery server. Editors may at any time remotely inspect a gallery to see what is being exhibited on it. A gallery subscribes to a number of channels supplying streams of InfoObjects to be exhibited on the gallery.

Channel is a class of objects representing information of a certain type to be distributed to galleries subscribing to that channel. In a specific library we may have channels like "Events", "General messages", "Music", "Local History" etc. A gallery in the music department may subscribe to the first two channels and the "Music" channel, whereas the "Local History" gallery may subscribe to the first two plus the "Local History" channel. Finally, there is an "Urgent" channel that every gallery has to subscribe to. This channel is used to announce information that has to be immediately displayed on every display. It is also possible to assign a high priority to individual InfoObjects in a channel ensuring that the object doesn't disappear from the display at any time.

GallerySkin is a class of objects used to specify the graphical properties and animation behavior of a gallery. This may be understood as an interchangeable graphical stylesheet. The graphical properties include background graphics, different appearances of InfoObjects in various categories. Animation behavior includes properties such as type and speed of the animation or aging animations for InfoObjecs that have an expiration time. Galleries may dynamically be assigned new skins or they may shuffle among a set of pre-specified skins.

Finally, a *user* class is used to maintain rights to manage channels and galleries.

The objects in the data model are maintained through an editor tool and the InfoObjects are displayed in gallery displays, which will be explained in the following client layer section.

4.2 The Client layer

The client layer covers both an editor application and a number of display applications. In this section we focus on the editor application and briefly describe the display application implementation aspects. The means of artistic expressions are described in a separate section.

4.2.1 Editor application

The editor application is a .NET application available for the librarians through a floating toolbar, from this toolbar new InfoObjects can be created, galleries can be inspected, and general settings can be managed. See Figure 7.

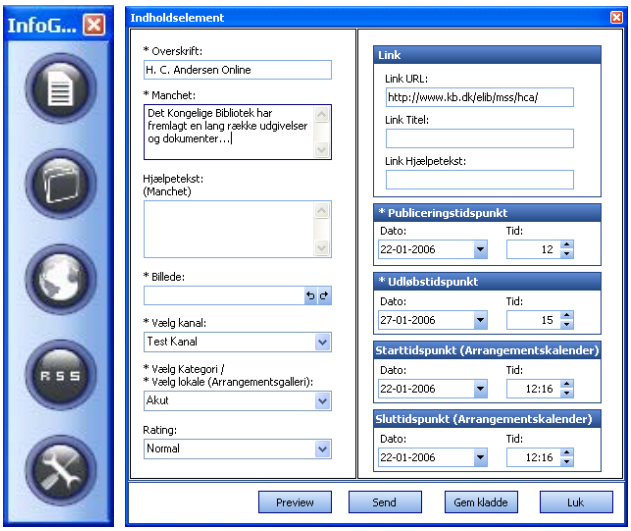

Figure 7: InfoGallery editor application. To the left, the floating toolbar. To the right, the InfoObject editor.

Currently the interface only exist in a Danish language version, thus a little explanation is needed. InfoObjects are maintained as shown in the right hand side of Figure 7. Here the attributes of the InfoObjects are edited manually. The fields in the left column of the dialog are the content descriptions, the top field of the right column is the link to the actual library resource, and the bottom fields are time of publication, time of expiration etc. This interface allows creation of InfoObjects for arbitrary types of manually maintained information. InfoObjects representing RSS feeds are treated in a special dialog, with a similar structure, but with the difference that much of the information is extracted automatically from RSS specification, and the properties includes the filtering how many items from the feed to show, and how to cycle through the items.

4.2.2 Display applications

InfoGallery currently provides three main types of display applications: a *passive*, view only application aimed large shared displays; an *interactive* application aimed at large displays with point and select capabilities; and a *screensaver* application to run when library search stations are idle.

The display applications are .NET applications communicating with the InfoGallery server through a SOAP interface or tunneled through HTTP to avoid firewall setup difficulties. The graphics and animations for these applications are made as a Flash movie (http://www.macromedia.com/software/flash/flashpro/); the Flash movies are executed in a Flash player encapsulated in the .NET application. This architecture allows us at the same time to take advantage of a standard graphics/animation package and to provide the advanced types of interaction we wish to achieve through integration of various kinds of sensors registering visitor behavior in the proximity of the displays. The .NET application also monitors activity, e.g. when a user leaves the display inside a browser at the Level 3 (see section 5.1); the display automatically shifts back to Level 1 after some idle time.

Another advantage of the .NET encapsulation is that we can seamlessly integrate relevant parts of the Internet Explorer Web browser in the display application. In the InfoGallery context, we wish to restrict user navigation and activity to exploration of the exhibited resources, thus the address bar and other navigation facilities that allow the user to jump out of the gallery context, are disabled and hidden.

Further details on display application appearance are discussed in Section 5.

4.3 The Sensor layer

The sensor layer encapsulates the variety of sensor technologies that is relevant in order to support both implicit and explicit interaction with the display clients. An example of explicit interaction was supported in the original InfoColumn installation. The adjustable Bluetooth base station could be restricted to sense only phones put in specific spots on the column enabling grabbing of references from the InfoColumn. This functionality has been integrated in the generic InfoGallery architecture. An example of implicit interaction is movement and proximity sensors that may detect activity in the proximity of an InfoGallery display and scale the size of text and graphics to a proper size for the expected reading distance. If there is no activity in the immediate proximity of the display the text and graphics may scale up in order to be readable at a distance, and the display may even issue sounds to draw attention. A final example of a type of sensor may be a Web-cam allowing either tracking of body shapes/shadows like in the iFloor interactive floor application [17] or coarse gestures like the widespread EyeToy Play games for Playstation (http://www.us.playstation.com/EyeToy.aspx). This kind of sensor may be used to let users select and interact with InfoObjects on large displays at a distance either on walls or floors.

5. INFOGALLERY ARTISTIC EXPRESSION

A central element of informative art is to provide an artistic or aesthetically appealing interface to information. We attempt to

make the interface remarkable rather than transparent to the library visitor [23]. Thus the visual expression and other means to draw attention to the information is a central aspect of providing an informative art service. It is also important that an institution who wishes to provide information with an informative art has the possibility to tailor the visual expression to their needs and sense of aesthetics. InfoGallery provides this tailorability by means of the GallerySkin concept. Graphic designers and artists can be involved in the design of a GallerySkin, and a new skin can be installed on-the-fly from an editor application making either a specific Gallery change its skin or all galleries in a building to change skins at the same time. Below we will illustrate how GallerySkins work.

5.1 Visual expression

We have made full-scale applications for the Royal Danish Library (Danish acronym: KB) and the Municipal Libraries in Aarhus (Danish acronym: ÅKB), Denmark. Below we show how the GallerySkin concept can be used to tailor InfoGallery to these two different institutions with a minimum of development effort. We show how two radical different visual expression and animation schemes work on the same set of InfoObjects, from a set of H.C Andersen resources. In the shown version, there are 4 different levels of view.

Figure 8: Level 1 view – animation of the set of InfoObjects

In the Level 1 view (Figure 8) the entire set of registered InfoObjects for all channels are animated. At the top, the KB GallerySkin with a tile layout is shown. Here the animation appears much like a memory game, where tiles shuffle, show and hide in a slow animation. At the bottom, the same set of InfoObjects is shown in the ÅKB skin, which is a slow bouncing ball like an animation with a slightly higher speed.

Figure 9: Level 2 view - a single InfoObject has been selected in an interactive InfoGallery

The level 2 view appears in two different situations: at random as part of the animation or when a user click or tap with his/her finger on an InfoObject in an interactive InfoGallery. Here all the detailed meta-data for a resource is presented, and it is possible to follow links to the actual library resource.

The level 3 view appears when a user has followed a link on an InfoObject to the actual resource being exhibited. The resource is presented in an embedded Web browser with its navigation being restricted to only follow links inside the InfoGallery context, since we do not wish the gallery to become a work station for web mail or the like.

Figure 10: Level 3 view - embedded browsing of library resource for an InfoObject

Users are meant to explore information and to pick up references to information found in the serendipitous “search” among objects being exhibited. Picking up references to resources may be supported in several ways, such as Bluetooth pick up, SMS or e-mail.

Figure 11: Level 4 view - emailing a reference

In the two versions delivered to KB and ÅKB we have chosen a low tech solution for picking up references. During the first test of the InfoColumn we found out, that the number of users with active use of BlueTooth enabled cell phones is still quite small. Instead of pushing information from the InfoGallery to a mobile phone via a Bluetooth Connection we have chosen to make a low tech email interface. This interface enables a user to bring up an address field and in the case of a touch monitor also an on-screen keyboard allowing the user to type in his/her email and receive the reference this way. This interaction does not in the same way

as the Bluetooth pick up described earlier give an experience similar to picking up physical material, but it does provide the user with a means to save the reference for later use. An alternative to email may be a SMS text message sent to the user's mobile phone. This pick up can be invoked in two different ways either by typing the user's phone number with the on-screen keyboard or by sending an SMS to an InfoGallery number, triggering the return of an SMS text message to the mobile phone containing the reference.

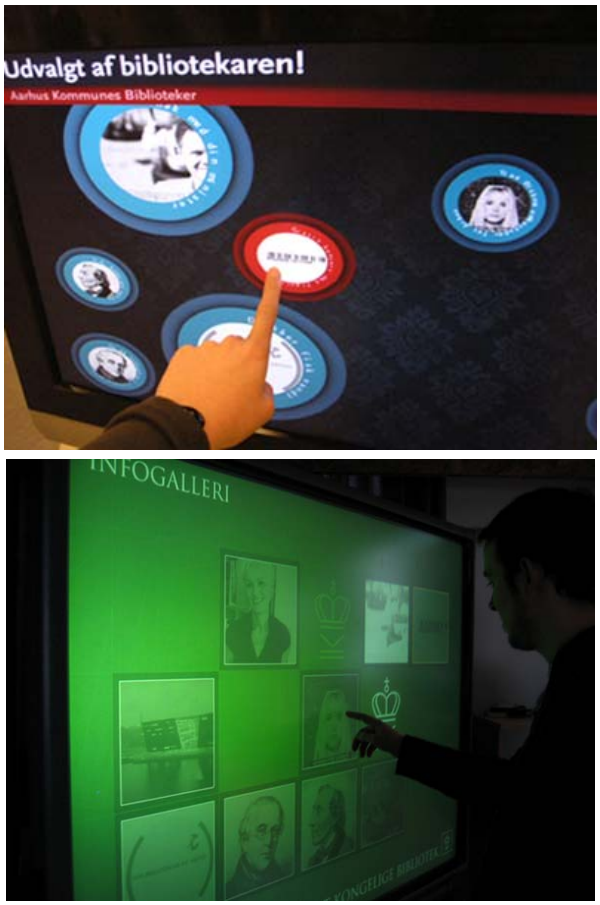

Figure 12: Users interacting with InfoGallery

5.2 Animations

The visual expression is an important part of the interface, but the dynamic behavior is an equally important aspect of making informative art appealing. Redström et al [25] denotes informative art as "slow technology" expressing that the animations should be calm and fluid, i.e. informative art displays could be viewed as a slowly changing painting on the wall. InfoGallery is not attempting to look like a painting but it is important that display surfaces are not becoming disturbing billboard like commercials in library space. We have thus chosen fairly slow going animations that move fluidly, allowing people to read texts easily even when they are moving on the display. The speed of animations can be specified in the editor application with ranges that prevent the display for becoming disturbingly dynamic. In the Level 1 view of the ÅKB InfoGallery – the bouncing ball skin – the user may impact the animation by pushing to the (slowly) bouncing ball InfoObjects. This may stimulate a playful interaction [9] with the display.

5.3 Sound

We have deliberately not integrated sound in the current version of InfoGallery since it is aimed at being placed in library spaces, where sound often is considered disturbing noise. But we have made the InfoGallery open to later deployment of sounds. Sound may be mandatory for some library applications, e.g. media libraries where the library resources may be audio or video recordings, and then it would be natural to allow sounds from the media preview snippets. This is possible in the current InfoGallery if we insert Media-RSS feeds, and allow the sound to be on, when we play podcast snippets.

Sound may also be used to amplify the artistic expression of the display itself e.g. aiming at drawing attention to specific InfoObjects by means of sound effects. This is not yet supported by InfoGallery, and is thus considered future work together with an analysis of what are acceptable sound effects in certain library spaces.

6. PHYSICAL APPEARANCE OF INFOGALLERIES

The overall goal of informative art and the InfoGallery system is to make people discover useful information or inspirational material. This discovery may happen "by accident" when passing or experiencing the exhibition on an InfoGallery. To make this discovery happen an InfoGallery needs to draw and maintain the attention of potential users via its placement, shape and aesthetic expression [24]. In the previous section we discussed the aesthetic expression in the software, in this section we will focus on the role of the physical appearance.

6.1 Placement of InfoGalleries in the Library space

An important part of creating attention is to choose a proper placement of InfoGallery displays. In the library projects several types of placements have been identified so far. We will briefly discuss a few:

- Refreshment areas. In [15] coffee rooms and printer rooms are optimal for placing informative art in an office space. This experience may apply to libraries as well: a relaxing moment or waiting for a copy or print will allow time for watching or exploring InfoGallery information.
- Queues and lines. Similar to above InfoGalleries may be placed where people tend be in line, e.g. when delivering back books at a counter. This will make people use otherwise idle time to serendipitous exploration of material exhibited.
- Entrances and hallways. InfoGalleries may be placed in places where many people pass by, but it is important that users who stop to explore the InfoGallery do not block traffic, and create negative attention.
- Section squares of a library, like the music section, newspaper section, or children's section. Here targeted InfoGalleries with skins and information relevant for the section will draw attention.
- The city. Both our collaborating libraries ÅKB and KB consider bringing digital library awareness out in the public spaces in the city. InfoGalleries may thus be integrated in city surfaces similar to SloganBenches [11] and Texting glances [27].

Careful consideration of the placement in the physical library space is one of the success criteria for InfoGalleries and the communication of digital library resources in the physical library. But the physical appearance of the display itself may also play a role in getting attention.

6.2 Creating attention with new types of display surfaces

In addition to the placement, the size and form factor of the display may play an important role in getting and maintaining user attention. In the Future Hybrid Library project as well as in the follow up developments for ÅKB and KB, we have made several proposals for new physical design forms. The first version of the InfoGallery was running on an "InfoColumn" a large cylindrical display with a radius of 65 cm (see Figure 3). The display picture was made by multiple projectors from the inside and the shelf surrounding the column was a large wheel enabling users to turn the display. This column prototype worked very well in drawing attention to the exhibited information, since intuitive interpretation of the column as a digital poster column worked. However, the artistic quality was not optimal, since the projections on the cylindrical surface got very small and distorted due to the use standard projectors. Since the first experiment we have found a series of NEC projectors (e.g. 1075 and GT6000) that features a unique 3D-reform software tool running on the projector and controlled via a USB interface. This type of projectors is able to provide distortion free curved displays. Figure 13: Distortion free large scale curved display with NEC projectors. Picture taken from the opening session just before the red ribbon is cut. Figure 13 shows a 3 * 2 meter curved front projected display running InfoGallery, as part of the design of a large scale elliptic InfoColumn measuring 3.8* 4.8 meters planned for our new IT-library at the University of Aarhus.

Figure 13: Distortion free large scale curved display with NEC projectors. Picture taken from the opening session just before the red ribbon is cut.

The large elliptic column will be placed in front of the main entrance to the IT-library, and it will consist of a partial physical exhibition with shelves and a partial InfoGallery based exhibition with a 6*2 meter interactive curved display. This InfoGallery installation will be exhibiting new issues of digital periodical subscriptions, RSS feeds from selected IT news sites, published papers from local authors, events and other news from the library. Based on the initial InfoColumn prototype from the Municipal Library in Århus, we believe this will become an informative combined physical and digital portal to the new physical IT-library.

In the Future Hybrid Library project we also developed another physical display and interaction technique called iFloor [17] for knowledge sharing in the physical library space (see Figure 14).

In addition to displaying information on the floor, iFloor provides an interaction technique based on camera tracking of its users shadows from the ceiling. The iFloor interaction was based on collective dragging of a single cursor to stimulate social interaction and knowledge exchange around the floor display. This interaction technique created a lot of attention and interaction around the floor in the library during the pilot test period. It also created attention outside the library domain, and it was given the Danish Design Award in 2004 for a visionary interface integrated in the physical space. The iFloor camera tracking can easily be integrated in the InfoGallery infrastructure via the sensor layer, and provide each user with a cursor to make the selections in InfoGallery which are made by finger or pointing devices in the wall-based displays.

Figure 14: iFloor in use in the lobby of the Main library in Århus, Denmark.

The InfoGallery infrastructure is thus prepared to be deployed on a rich variety of display surfaces affording different kinds of experiences and interaction techniques

7. EXPERIENCES AND REFLECTIONS

The first version of InfoGallery was tested on the InfoColumn in a three week period in the lobby of the main library in Århus, Denmark. The use was studied qualitatively based on video recording and open ended interviews by Bech-Petersen & Rohde [3]. Based on the studies they identify a number issues involved in introducing this kind of digital exhibitions in public spaces.

Based on the InfoColumn experiment and the reported experiences the Municipal Library in Århus decided to fund the development of specific InfoGallery applications to create awareness about a portal for Danish literature called litteratursiden.dk in the libraries subscribing to the portal.

The InfoGallery for litteratursiden.dk has been in use for months now. First it was running for a period on only five ordinary workstations in the main library, but now it has been distributed to a larger number of displays in other libraries. We are now able to start measuring quantitatively how many users are attracted by the galleries, how long they maintain interaction with the galleries, and how many actually leaves with a recorded reference to resources found in the gallery.

The InfoGalleries for ÅKB and KB shown in section 5.1 were put into use late January 2006, and they provide us with experiences on differentiated distribution of InfoObjects based on the channel concept as well as the effect of different kinds of skins.

So far we have noticed that also the hardware ought to show that InfoGallery is an interactive media. We have experienced that the users more frequently interact with the InfoGalleries installed on larger touch screens than on the workstation based installations. This is due to the unusual appearance and the simple touch interaction.

7.1 Lessons learned

The first lesson was learned during the user studies at the Main Library in Århus. We found out that it is a challenge to attract the users' attention in a library. To learn how to attract the users' attention and make them interact with an installation we divide the area around the installation into four interaction spheres: 1: the explicit interaction, 2: the implicit interaction, 3: the first attention and 4: the remote attention.

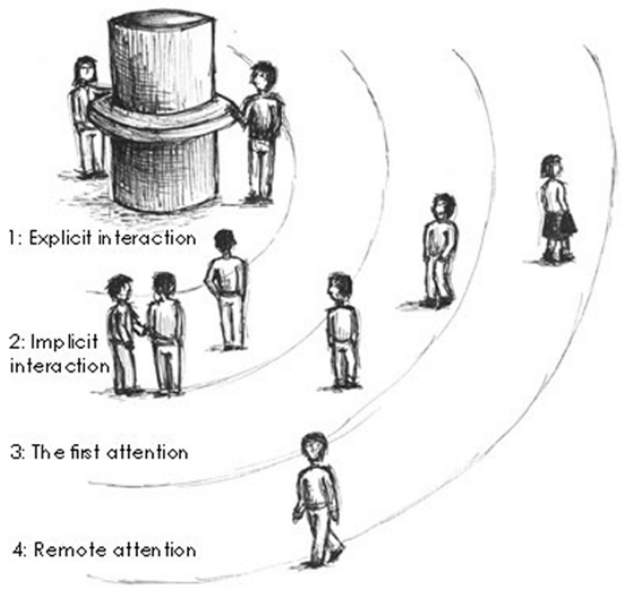

Figure 15: The area around the installation can be divided into four interaction spheres.

In each of the interaction spheres you should use different strategies to motivate and engage users. Bech-Petersen & Rohde [3] summarizes the lessons learned about this in 15 design patterns among which we will briefly discuss four here.

1: *The surrounding should not be disturbed*: In the sphere of the remote attention, the InfoGallery is supposed to create peripheral awareness but at the same time it is important that it does not make too much disturbance at the library as described in section 5.2. Thus dramatic visual effects and the use of sounds needs to be carefully designed taking the use context into account. In a shop dramatic effects may be acceptable whereas some parts of libraries definitely have to be quiet and calm.

2: *Attract attention*: public spaces are filled with information and something special must be done to get the user's attention. A lesson in this interaction sphere supports Spool's [26] idea of using *Seducible moments*, i.e. trying to catch the users' attention at times when they are willing to receive information. Spool's examples are from web site dialogs where seducible moments occur while closing a dialog e.g. in a web shop after having pushed the confirm button. But in the physical context there are many potential seducible moments in queue situations, where people ate spending idle time, with otherwise no engagement, thus having a lot of time to watch or even interact with InfoGalleries. To find the seducible moments you have to know more about the users' activities and movements in the library.

Another lesson in this sphere is that playful and visible interaction helps creating awareness of an installation. Experiences from our own iFloor [17] and from installations like TextRain (http://www.camilleutterback.com/textrain.html) show that "unusual" interaction behavior by some users attracts other users' attention.

A final lesson concerning attention supports Gaver et al's [11] observation that *ambiguity* of context and physical design may intrigue the user and engage him/her in the use of the InfoGallery. InfoGallery signals that it is an IT-system, but it is different from what most library users are used to since it runs on large and sometimes rather unusual surfaces. They thus need to stop and reflect while watching or interacting. This reflection is observed to lead to engagement in many situations.

3: *Use implicit interaction*: After the first attention is created it is important that the installation registers the user and gives feedback to show that the user is in an interactive space. This can be done by giving feedback on implicit interaction. The iFloor showed us, that implicit interaction achieved by using movement based interaction taking advantage of the users' motor skills, quickly makes the user feel as a part of the installation [17]. As described in Section 4.3, we may use sensors to detect when the user is getting into the second interaction sphere. Hereby the user will become aware that s/he is able to affect the installation, and it might invite to further interaction in sphere number one: the explicit interaction.

4: *Affordance as temptation*: After attracting the user's attention you have to attract him/her further to engage in interaction with the InfoGallery in sphere number one. One strategy could be that you tempt the user so much, that s/he can't resist interacting with it and this supports the work of [6]. In one of the GallerySkins, the InfoObjects are shown as bouncing balls. In the middle of the balls there is a peephole to a picture that tells more – but not the whole story - about the content. This is a simple way to tempt the user to find out what is behind the ball.

In general when designing for non-working domain applications, we see a trend in moving away from transparent easy to learn and efficient to use interfaces to more aesthetic and remarkable interfaces [23][24] that attempt to surprise and engage the user in different ways. The InfoGallery experiences contribute to an understanding of where and how to make interfaces remarkable.

8. RELATED WORK

As described in the introduction the RE:FORM group [15][25] has taken the arts aspect very literal and used the artist

Mondrian's pictures directly in the interface to provide very abstract visualizations of mainly quantitative data, which can be conveyed by changing sizes or colors. In contrast Georgia Techs InfoCanvas makes special purpose clip art like objects that can be combined to a personalized collage of pictograms with houses, animals, cars, the sun etc. where all the objects are tied to some mainly quantitative data sources such as traffic on the street or on a web server. The InfoCanvas is similar in approach and infrastructure to the RE:FORM work, but it can hardly be perceived as an art piece.

Ishii's [16] ambient displays are utilizing pinwheels, changing wall papers and water ripples also to display typically quantitative information such as web server activities and number of people in meetings rooms.

InfoGallery is different from the above systems in that it presents more qualitative pieces of information, i.e. meta-data for library resources, rather than the types of information displayed by Ambient Displays, InfoCanvas and RE:FORM's informative art which in many situations could have been shown with a set of gauges. But InfoGallery is similar in the sense that it provides slow artistic and ambient animations of information objects in order to draw the users' attention to exhibited information.

InfoGallery may be seen as an artistic animation of spatial hypermedia structures as provides e.g. in Viki [19] or in Apple's HotSauce Meta Content Framework (MCF) http://www.xspace.net/hotsauce/. Both of these systems provide tools to handle meta-data objects either in a 2D or 2.5D interface allowing grouping into composites. Channels play a similar role as the composites in spatial hypermedia, namely to group similar InfoObjects for similar presentation purposes.

The emerging notion of InStore TV [14] also shares similarities with InfoGallery, in that it provides infrastructures to distribute commercials for products typically to flat panels in large shops. However, most InStore TV solutions are aimed at scheduling a playback of a single high quality commercial film or animation at a certain time on a certain display. This is quite different from InfoGallery, which present collages of information which is dynamically added by a group of editors.

InfoGallery is to our knowledge the only system that provides an informative art approach to exhibition of digital library meta-data in the physical space supporting serendipitous discovery of digital library resources meeting some of the requirements by LaRue [18]. We see many prospects in continuing this development and a few ideas are outlined in the following section.

9. FUTURE WORK

Having developed the first full-scale InfoGalleries for real use in library settings, we still have a long list of potential extensions to the concept and follow up studies.

We plan to include more types of sensors in the sensor layer to make more advanced interaction with the galleries. In particular, we wish to provide multi-user interaction with the large scale displays on columns, walls and floors. For floors we will integrate the multiple user tracking from iFloor and for walls and columns we will integrate the MultiLightTracker [22] technique that utilize multiple colored light diodes to provide multi-user interaction on semi-transparent surfaces.

We will explore the use of sound effects to draw and maintain attention to InfoGalleries. Sound may e.g. appear in an InfoGallery as part of a podcast integrated by means of Media-RSS.

We will also make experiments on partnering with artists to develop skins, and to develop the skin concept further to allow more artistic expressions than supported currently.

Finally, we will initiate further studies of user behavior to evaluate and improve on the InfoGallery concept.

10. CONCLUSION

In this paper we have discussed how to create attention about digital library resources in the physical library space and support serendipitous experiences of digital resources for visitors in the physical library. This kind of serendipity is provided by means of informative art services. We have described the InfoGallery, which is a Web-based infrastructure for enriching the physical library space with informative art "exhibitions" of digital library material and other relevant information, such as RSS news streams, event announcements etc. InfoGallery presents information in an aesthetically attractive manner on a variety of surfaces in the library, including cylindrical displays and floors. The infrastructure consists of a structure server, an editor application and a variety of display clients. The design of the infrastructure and its utilization of RSS, podcasts, and manually edited news were discussed. Applications in the library domain have been discussed.

The InfoGallery system has recently been transformed from a research prototype to a full scale product, which has been installed at the main Library in Aarhus, Denmark and the Royal Library of Denmark. At least three other Danish libraries are currently in the process of getting InfoGalleries.

Finally, we see many prospects in using the InfoGallery for other application domains than libraries. We may support as diverse things as commercials in stores improving state of the art in InStore TV [14] and the sharing of knowledge in a corporate building by allowing people to distribute InfoObjects on specific channels to InfoGalleries.

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