Designing for Large Public Displays

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INTRODUCTION

While large displays have a long history, e. g. Billboards or large scale paintings like in churches, *interactive* displays are only used in the last couple of years. Their main use today is in collaborative and group based activities, for example like in the Stanford iRoom. They function as a shared resource for a variety of community-based activities, by helping to catch up and coordinate with others; furthermore they have a positive impact on the social climate.

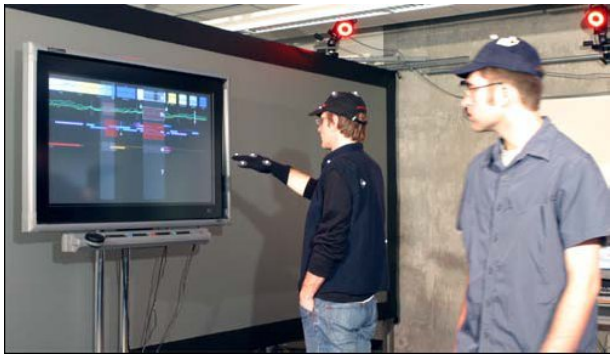
But apart from the positive aspects large public displays have, designer have to overcome some challenges. Some important ones are firstly that the displays have to be ubiquitous—they have to present information without overloading users' senses—so there are technologies needed to notify and communicate with users. Secondly the desktop metaphor is not sufficient anymore, therefore novel input techniques have to be developed. Similarly multiple-user interaction requires further research. Lastly privacy an important issue, as non-toy interactive use mostly covers private information, e. g. consider a simple bus route planner, which needs your desired destination as input. D. Tan and M. Czerwinski have shown in [6], that large displays are considered more public and afford reading.

EXISTING APPLICATIONS

In the following section we will present applications which already use large public displays. We introduce the work of three reasearch groups and describe the systems they build. At the end we briefly present four other systems which use large public displays.

Gesture/Posture prototype

The first application was developed by a research group around Daniel Vogel and Ravin Balakrishnan at the University of Toronto. They built the prototyp to explore the challenges which arrise in the interaction with large public displays. In the line of their research they identified a set of design principles, which they regarded as important for the design of large public displays. For the test setup a 50-inch plasma display, a SMART Technologies touch sensitv overlay, and additionally a Vicon motion tracking system with passiv markers was used. In the system a single ambient display served the dual role as public ambient and personal focused display. When the user approaches the ambient display he is able to interact with public information via postures and gestures and as soon as he steps closer to the display he can directly interact with personal information via touch interaction. The challenge for the researcher was to design a fluid transition from implicit interaction with public information to explicit interaction with personal information.



Gesture/Posture prototype

Design Principles

While the development of the prototyp the team identified the following design principles:

- *Calm Aesthetics*: Because the ambient display is permanently placed in the environment it is important, that the display is not to overreactive – hence distracting – but also it should not be to calm and static – so that it seems unresponsive to the user.
- *Comprehension*: The information shown on the display should be understandable to the user, even if it is abstract. Step by step he discover the meaning of each presented information through subtle interaction.
- *Notification*: The user should be notified about the existence of the display in a socially acceptable manner based on the users level of attention.
- *Short Durration Fluid Interaction*: To ensure that the ambient nature of the display is maintained the interaction with the display should be as short as possible. The user is only supposed to use the display for short queries.
- *Immediate Useability*: Upon walking up to the display the user should be able to immediately use the

display without prior training. The system guide the user through the interaction phases and demonstrate difficult to discover interaction techniques.

- *Shared Use*: To take advantage of the large display users could share the display either to work alone on individual tasks—but on the same display— or collobaratively work on a big task.
- *Combining Public and Personal Information*: Rather than showing only public information the system should integrate also harmless personal information.
- *Privacy*: Because large public displays seem to encourage people to look at the information presented, the system should offer means to prevent eavesdropping of sensitiv personal information.

Interaction Phases

In additon to the design principles the team developed an interaction framework, which covers the range from distant implicit public interaction to up-close explicit personal interaction. This transition between these to states is described in four different phases:

- *Ambient Display Phase*: This is the neutral state of the system. It shows many information categories simultaneously and allows the user to get overall information with quick glance. The display should attract the user, so that he engage in an interaction with it.
- *Implicit Interaction Phase*: The system shifts in this phase, when a user passes by. With the help of the user's body postion and orientation the system should determine the user's openness to receive information. It should notify the user about urgent personal or public information in a subtle manner.
- *Subtle Interaction Phase*: When the user steps closer to the display and provides an exlplicit cue, such as pausing for a moment, the system should enter the subtle interaction phase. During this phase, the system offers more detailed descriptions of the notifications and it augment the public information with personal information
- *Personal Interaction Phase*: Upon steping up-close to the display the systems goes in the last phase. Now the user can directly interact with personal and public information via direct touch interaction. To ensure the privacy of personal information, the body helps to occlude the view on them.

Prototyp description

Conventional public information sources—such as bulletin boards—are very common in office buildings. These displays are suiteable to present public information, but they are not capable to show more personal informations or react to the users in the vicinity. The prototyp system the research team developed extended such systems, but they also paid attention, that the system was not only suitable for offices, but also applicable beyond this environment. The design principles as well as the four interaction phases were realized in the prototyp. The team focused on the fluid transition between the interaction phases, multiple user support, subtle notification privacy controls, and self revealing help.

The ambient display represented four information categories as horizontal stripes, which spanned the width of the screen. When a user approaches the display and step into the tracking area around it, the body location and orientation were translated into an abstract representation of the user and associated information were shown in a vertical bar. On the intersections of the vertical bars and the horizontal strips a notification flag is shown. Transparency, color, and dynamics of the notification flag is influenced by the current level of importance. The user can obtain additional information for each notification flag if he faces the display and wait for a moment. The public information catatgories are augmented with personal information of this user. With the help of simple hand gestures the user can select each information category and make further queries. Hand gestures and body movement allow the user to query the entire ambient display space. If he steps very close to the display personal information are shown and the user is able to interact directly with the information using touch interaction. The display allows multiple user to work with the system even if some of the user are in deeper interaction phases. To ensure privacy hand gestures are accessible to hide the notification and querying display elements.

Plasma Poster

The next system was developed by Elizabeth F. Churchill, Les Nelson, Laurent Denoue, Jonathan Helfman, and Paul Murphy at FX Palo Alto Laboratory. The system consists of a network of interactiv posterboards, which were scattered in an office building. The main idea behind this system was to encourage social interaction. Plasma Poster allowed content sharing within teams, groups, communities etc. This way the users of the system were getting aware of others' interests and favored information sources. The user could also easily share multimeadia content in an socially acceptable manner. For example, if one want to prevent that an mulitmedia file, which he regarded as worth noticing for others, is deleted, because the recipients do not know the sender, he could use Plasma Poster and share the file with others. Existing content sharing tools like email, Usenet groups or online communities should be complemented, but not replaced. To further underscore that the system is a community resource the team encouraged the user to sign up as a member of the Plasma Poster Community at FXPAL. If a user want to sign up he has to supply a photo, with the option of creating a personal profile and a screen name. Every post is supplemented with the name and the photo of the user, thus making it easy to respond to a post. Most of the content was generated by the people who use Plasma Poster, but some

was also generated by the intranet at FX Palo Alto. To post content the user can either use a Web Interface or email. In case of email-postings the user can attach a file to the mail and write text or an URL in the body of the email.

Plasma Poster

Interface Principles

While designing the Plasma Poster the research team paid attention to several interface principles:

- *peripheral noticing*: The Plasma Poster should be appealing from the distance and attract users to work with the system. To achieve this the content changes regulary. The system cycles through all posts and every 30 seconds a new post is shown.
- *active reading*: The user can directly interact with the displayed content. It can be scrolled, paused, and printed. If the user touched the display the 30 second timer is reinitated and the user can scroll the conent up and down, if he moves his fingers on the display up and down.
- *navigating and browsing through posted content*: The content can be browsed item by item and the system offers overviews searchable by date and author.
- *social connections*: Plasma Poster emphasize the social dimension of posted information. Below each post the photo and name of the person who provided the content is displayed. Users who read the content can write a message to the person who posted it, but he can also forward the content to friends or colleagues.

Dynamo

The last system is similar to the Plasma Poster, but while Plasma Poster emphasize social connections, Dynamo is only a tool to easily share multimedia content. Dynamo was developed by Harry Brignull, Shahram Izadi, Geraldine Fitzpatrick, Yvonne Rogers, and Tom Rodden. The system is a public interactive surface, which is used to share, exchange, show, and interact with digital media. Multiple users have the opportunity to share content with each other. The test system was deployed in the common room of a high school and consists of two 50-inch plasma screens, three wireless keyboard and mice, which served as interaction points, and various mobile devices like USB pen drives or digital cameras, which are brought in by the users. The research team developed an interaction model through user-centered design and a DIA-cycle-like development process.

Dynamo screenshot

Interaction Techniques

To work with the Dynamo the research team developed four interaction methods. These methodes can be accessed via the interaction points, which are represented through colored telepointers on the screen.

- *Palettes*: Palettes are used to move content onto the surface. They function as sinks and sources for files. In a palette a iconified representation of a storage device is displayed, from which one can move data on the surface or drag data onto the storage device.

Dynamo Palette

- *Carves*: Carves are regions on the surface for individual or mediated shared use. The creator of a carve can restrict the access to it, so that only certain interaction points can interact with the carve. A small bubble around a telepointer indicate, that the interaction point is not allowed to interact with the carve.

Dynamo Carve

- *Parcels*: Parcels are used for asynchronous mediated media sharing. A file is kept in iconified form on the surface—even for longer time periods—and only the people appointed from the creator of the parcel can access its contents.

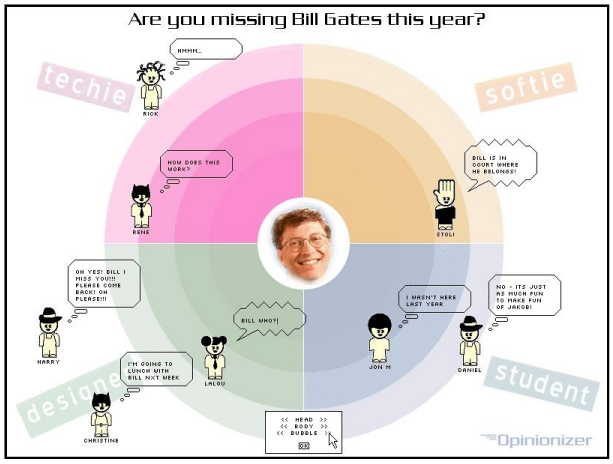
Dynamo Parcel, expanded and iconified

- *Notes*: With the help of notes the user can share information asynchronously. They allow asynchronous discussions.

Other Systems

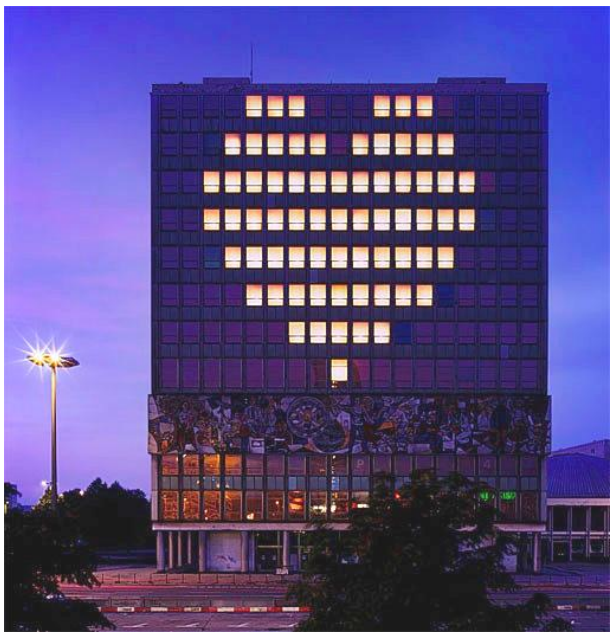
Besides the systems we presented so far, we now briefly describe three other systems which use large public interactive displays, but which are not so sophisticated compared to the other systems.

The first system—the *Opinionizer*—allows you to post an opinion about a certain topic on a large public display; thus use it to host a discussion about this topic.



Opinionizer Screenshot

The second system—*Blinken Lights*—was developed by the Chaos Computer Club. They posted 144 lamps behind the front of a large building and created a 12x12 pixel matrix this way, which they used to display animated pictures. The user can use his phone to request, that a animation, which was previously sent to the system, is shown.



Blinkenlights

The last system—*Nike iD Advertisement*—is a huge advertisement screen, which offer the user the possibility to personalize his own shoe—similar to the Nike iD internet site. With the help of his mobile phone the user can call a specific number and change the shoe on the fly, while he sees the changes on the screen.

Nike iD advertisement

INPUT METHODS

Traditional Methods

The traditional input methods show some deficiencies when used in conjunction with a large display. Generally they are not intended for multiple users. Mouse and keyboard pose the question where they would be located. Furthermore the mouse shows unsuitable for large areas, and keyboard-input needs some kind of input focus. On the other hand a touchscreen type interaction force you to be very close to the display, which is something you not always want. It is also not sufficient to control the whole display; you are more or less limited to what you can reach with your arms.

Posture/Gesture System

This system aims at interaction without additional devices. To interact with the prototype we described above, the reseachers used also an interesting interaction technique based on motion tracking and the possibility to use the display as touchscreen. Their system uses gestures and takes also the body position into account (posture). And while the currently available technology does need tracking markers, it is just a matter of time until that restriction will fall. Using simple gestures, a self-revealing help system and immediate feedback considerably contributes the ease of use. One of their ideas addressing the privacy issues was to introduce the personal interaction phase, where mainly touch interaction takes place. Also a smaller font was used and the body took the role to quite naturally occlude the corresponding part of the display. While the reseachers focused mainly on content navigation tasks, the underlying interaction technique has great potential to establish as a common interaction technique for large displays.

Audience Participation

A completely different idea is to use the whole audience in a room to generate input events. This was first presented at SIGGRAPH 1991, where red and green paddles in the audience were used to control a pong game. Inspired from that D. Maynes-Aminzade, R. Pausch and S. Seitz developed and evaluated in [5] three more techniques:

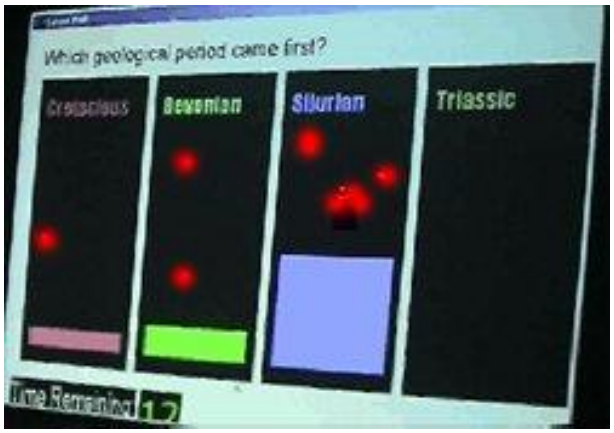
- *Audience Movement Tracking:* Here a camera is used to capture the audience. Then a template based tracking algorithmus recognizes the gestures and reacts accordingly. Multiple different gestures can be trained in a setup phase and without additional devices be recognized. As the template is generated for a specific audience, this does not adapt well to changing audiences, however the operator can trigger an on-the-fly capture that will not interrupt the gameplay.


Audience Movement

- *Beach Ball (shadow) Tracking:* A beach ball is thrown up in the air by the audience and causes a shadow in a front projected screen. This shadow is then extracted by an algorithmen and determines the actual input for an application or game. This makes more precise input possible, as single users have full control for short period of time. But there are also shortcomings, for example a high contrast is needed and other users might try to fool the system with other thrown items. One may track the ball directly (e. g. by radar) and calculate the shadow afterwards, but then a good calibration of the system is required. This technique has also some upper bound on the number of participants that will get involved into the game.

Beachball Tracking

- *Laser Pointer Tracking:* The audience has laser pointers with them and uses them to point at the large screen, for example in a cinema. By measuring the distribution of points on the screen a program can be controlled, so e. g. a poll can be easily done. However not everyone has a laser pointer with him, and it has shown that is is difficult to distinguish the own point from others, especially when a large number of pointers is involved.



Laser Pointer Tracking

Overall the three presented techniques provide true multi-user input, and single user action is not intended and mostly not possible. They approach in the multiple user problem in a completely different way than all the other techniques that we will look at, or that are widely used.

Bring Your Own Device

Another idea to replace the mouse is to take the users camera-equipped cell phone with a special software, as shown in [2]. Either visual codes (2D-Barcodes) in the Point & Shoot technique or a flow motion tracking algorithm in the Sweep technique are captured and processed by the cell phone and the results are then transmitted via Bluetooth to the large display. Additionally the Keypad and Joystick of the phone can be used for input purposes. These techniques can furthermore detect rotations of the phone, and so act as a rotary controller. The term "'Bring Your Own Device"(BYOD) covers also PDAs users might have with them; text input is one application for them. By the way this opens one possible way to deal with privacy issues: Use your PDA for private interaction, and the display's other input methods for more public interaction. This brings back the ubiquitous computing idea of having pads (the PDAs), tabs and boards (the large public displays). Although BYOD uses devices that most people carry around, still not everyone has an adequate mobile phone. The needed Java applet has also to be provided somehow. However the Bluetooth configuration is already possible in Point & Shoot by scanning a special visual code.

Point & Shoot with displayed 2D-Barcode

CONCLUSION

In this paper we described how large public interactive displays are allready used in existing systems to enhance the way how people interact with information or each other. Large public displays offer the means to show a wide range of information—like in the *Posture/Gesture Prototyp* or *Plasma Poster*—, support multiple users, encourage social interaction—especially in the *Plasma Poster*—, and provide access to personal data.
Furthermore we have shown how some of the design issues, like privacy and the inadequate desktop methaphor, are solved by various research groups. Here the novel posture/gesture input method was especially interesting to us.
At the end it is left to say, that the research conducted so far is probably not the end and we surely will see more exciting applications for large public interactive displays. Hopefully they will become as normal in our daily life as mobile devices or computer.

REFERENCES

1. Rafael Ballagas, Michael Rohs, and Jennifer G. Sheridan. Sweep and point & shoot: Phonecam-based interactions for large public displays. *CHI*, 2005.

2. Rafael Ballagas, Michael Rohs, Jennifer G. Sheridan, and Jan Borchers. Byod: Bring your own device.

3. Harry Brignull, Shahram Izadi, Geraldine Fitzpatrick, Yvonne Rogers, and Tom Rodden. The

introduction of a shared interactive surface into a communal space. *CSCW*, 2004.

4. Elizabeth F. Churchill, Laurent Denoue Les Nelson, Jonathan Helfman, and Paul Murphy. Sharing multimedia content with interactive public displays: A case study. *DIS*, 2004.

5. Dan Maynes-Aminzade, Randy Pausch, and Steve Seitz. Techniques for interactive audience participation.

6. Desney S. Tan and Mary Czerwinski. Information voyeurism: Social impact of physically large displays on information privacy. *CHI*, 2003.

7. Daniel Vogel and Ravin Balakrishnan. Interactive public ambient displays: Transitioning from implicit to explicit, public to personal, interaction with multiple users. *UIST*, 2004.