Overcoming Assumptions and Uncovering Practices: When Does the Public Really Look at Public Displays?

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Abstract. This work reports on the findings of a field study examining the current use practices of large ambient information displays in public settings. Such displays are often assumed to be inherently eye-catching and appealing to people nearby, but our research shows that glancing and attention at large displays is complex and dependent on many factors. By understanding how such displays are being used in current, public, non-research settings and the factors that impact usage, we offer concrete, ecologically valid knowledge and design implications about these technologies to researchers and designers who are employing large ambient displays in their work.

Keywords: Large displays, ambient displays, public settings, qualitative studies.

1 Introduction

Large displays have been a topic of research and platform for design and study since the emergence of pervasive computing as a field. Research and design using large displays has been extensive, spanning from private use [6, 10], to semi-public use in locations such as classrooms or workplaces [7, 8, 11, 15], to public use in places such as train stations and cafes [4, 5, 17, 18, 19]. In this latter category, there is a growing body of work that seeks to take advantage of large displays for the purpose of displaying awareness and other types of non-critical information to individuals in public areas. Research prototypes such as the Hello.wall ambient information system [14], and interactive public ambient displays [16] are built upon the idea that passersby will engage in explicit interactions with large display applications after first being drawn to them as ambient displays in the environment. Brignull and Rogers created the Opinionizer prototype that allowed party guests to post opinions to a large display from a nearby laptop [2].

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The decision to make use of a large display in designing systems and applications, particularly those intended for public or semi-public use, embodies a certain set of assumptions; it is generally assumed that such displays will tend to attract and hold the attention of passersby and that people in the area will be drawn to read or view content shown on them. It is often also assumed that a large display surface will facilitate and encourage use or viewing by groups or multiple individuals simultaneously. Despite extensive work in creating and evaluating individual research systems within the field of pervasive computing, even some in naturalistic deployments [3, 9, 12], a basic understanding of the effectiveness of using such displays to draw viewers and how people respond to them is still lacking. Systems are designed in part with the goal of attracting viewers and users, but evaluations focus largely only on the actions and responses of people who use them, with less attention to the population that fails to be drawn to the displays or whose interest the system does not capture. Additionally, evaluations tend to focus on individual systems or prototypes, and consequently it has been difficult to draw a comprehensive picture of the general appeal and success of large public displays. Therefore, it is still largely unknown whether large displays hold the appeal and power of attraction that they are often assumed to. To what extent do assumptions about the value of using a large display hold true? Do people look at large displays in public situations, and if so when and under what circumstances? What aspects of the displays and the environment affect attention?

Much of the work of evaluating such displays has been conducted using research prototypes either in a research setting, or limited public deployment. In this work we seek to understand how people use and react to large displays in public settings by examining *current and public* (non-research, non-prototype) large ambient information displays showing non-critical information in a variety of settings. We report on the findings of field observations of 46 large displays located in three mid- to large-sized cities in Western Europe. The aim of this work is to offer researchers and designers concrete, ecologically valid knowledge about the use of large ambient displays in public settings based on actual practices that can be used to ground and inform the design and deployment of future large display information systems.

2 Scope of the Research

In this study, we looked primarily at displays intended to provide ambient or non-urgent content for a variety of purposes, including informational, advertising, artistic, or entertainment purposes in a variety of public settings. This work examines the sorts of large displays and display content readily available for viewing in three fairly "typical" mid- to large- sized cities in Western Europe, comprising of mostly commercial LCD and plasma flat panel displays, some front and rear projected displays, and one large electronic billboard. It should therefore be noted that our research did not include settings similar to New York's Times Square or Tokyo, in which there is a dense population of extremely large electronic signage or for which the displays in the environment are a primary source of attraction for the area. The displays we examined were ubiquitous and integrated into their settings, but are of the type readily found in

most cities. We therefore cannot generalize how our findings might apply to more extraordinary display settings, such as Times Square.

This work does not consider "reference displays" that provide critical information, such as airport and train schedule and status displays. Although we did conduct observations in sites that contained such displays, we did not conduct formal observations of them specifically outside of the context of other displays in the environment. Additionally, we did not observe displays that were being used to show conventional television programming such as broadcast news or sporting events. We chose to exclude these displays from our analysis for several reasons. In addition to excluding them for the purposes of maintaining a tractable scope for this work, we also felt that these two classes of displays are novel primarily only in form factor, now using flat panel LCDs or plasma screens rather than conventional monitors or analog signs. However, the content itself and its placement in the environment is not new; this content and information has previously been available in mostly the same style and presentation but on other form factors. The types of ambient information displays on which we focused either added new content to an environment, or presented it in ways that differed significantly from previous incarnations, eg. advertisements with video, animation, or sound as compared to conventional signage.

We observed only "naturally occurring" displays, meaning we did not deploy any displays for the purposes of observations. We were therefore limited to the types and forms of content and environments that were available in these cities. The vast majority of the large displays we observed were non-interactive, with only two exceptions, and our reported findings therefore pertain almost entirely to non-interactive displays. When we refer to interaction with displays, we are therefore not referring to human manipulation of interactive elements of a display, but human action with regards to the display, including glancing at a display while walking by without changing direction or speed, slowing down or stopping to look at a display while walking by, pointing or gesturing toward the display, discussing content of the display with others, or other activity involving the display.

3 Method and Challenges

We performed field observation in 24 sites in three cities in central Europe. Many of these sites contained multiple instances of large displays or different types of large displays. In total we conducted observations of 46 large displays across the sites. We conducted observations in a wide variety of contexts, including train stations, bookstores, a travel agency, a library, main buildings of public universities, a cafeteria, a museum, groceries, banks, and a department store. Each site visit lasted at least 60 minutes, and as long as 180 minutes. Although there were several sites that we were only able to visit a single time, we conducted multiple observation sessions when possible, varying the days or the week or time of day during which we observed.

Because of the public nature of the sites, we did not use video recording, opting instead for field notes and still photographs with a camera phone or small digital camera when appropriate. Although all of the data in the study was collected by two researchers, in all cases except for one, observation sessions were conducted by a single researcher working

alone. The exception to this was a single observation session conducted by both researchers to ensure that the observation and note-taking methods were being conducted consistently.

We generally focused attention on a single display within a site throughout an entire observation session, except in cases where displays were in such close proximity that it did not make sense to or was not possible to observe them separately. We attempted to be as inconspicuous as possible, positioning ourselves close enough to the displays to see nearby interactions but far enough so as to not draw attention to the display. In most cases, such as retail locations, the number of people within viewing range of the displays was small (eight or fewer people in the immediate vicinity), or people were merely passing by, allowing us to observe all potential viewers at once for glances at or interaction with a large display.

In particularly crowded locations in which people tended to linger rather than pass through, such as a busy cafeteria during a lunch hour, we found that it was not possible to observe the population as a whole. In these situations, we created a "micro-shadowing" technique that entailed observing an individual or small group of individuals (such as a party sitting at a café table) for 5-10 minutes at a time before moving onto another individual or small group. The vast majority of situations that we observed were sufficiently sparsely populated that we did not need to employ micro-shadowing; it was employed at only four sites. Micro-shadowing made it possible for us to systematically conduct focused observations of behaviors within densely populated sites, but we recognized its limitations for our purposes as well. The more populated a site, the less likely it would be for us to "catch" relevant interactions, such as glancing at, pointing at, or discussing content; we realized that it would be possible using this method to miss important interactions. This method was therefore intended as a way of sampling, rather than a way of gathering comprehensive data about behaviors at a site.

In order to refine our observation method and determine the extent to which it was feasible to gather information in this fashion, we conducted some trial observations. Conducting observations in this fashion proved to be effective in catching glances and interactions, but presented several challenges and had limitations as well. We found that it was generally easy for us to determine when someone turned to look at a display or when someone was reading content. Additionally we were able to observe very brief glances by people who did not turn their heads or otherwise change body position to look at the displays It is, however, very likely that we were not able to catch all such instances of these momentary glances. Additionally, we were aware that the micro-shadowing technique had limitations as well; this method of observation offered insight about how people looked and responded to large displays but could not be used to catch all instances of glancing and interaction in a site.

Our data collection was qualitative in nature, looking for glances, gestures, and other responses to displays as well as details of the content, environment, and nature of the audience. However, whenever possible we did try to count to see roughly how long activities lasted. Additionally, in situations where it was possible we counted how many people looked at a display and how many did not. This was only possible under certain limited circumstances, for example when we were observing a display in a shop window and watching passersby on the sidewalk. It was less possible in places like cafes, department stores, and museums where people moved around in a space and it was not always clear when and how often they were within viewing distance or how many people were in the

space. These limitations in our ability to observe and record comprehensively and the variations in traffic and behaviors across sites also make it difficult for us to accurately aggregate or average data across sites. We therefore cannot present any totals for phenomena witnessed across the study, or meaningful averages per site or display. Instead, when possible, we present some of these numbers in reference to single sites or displays; these figures should not be assumed to be hard statistical evidence of general practices, but as illustrative examples to give ideas about frequency of activities and the amount of traffic in an environment and serve to ground the more general conclusions drawn across the 46 sites.

4 Comparative Case Study

Before presenting the general findings of this work, we offer a comparative case study of two observation sites that serves to illustrate some of the ways in which people glance at large displays and factors affecting attention to them. We discuss the general patterns of behavior and environment apparent in this case study in greater depth after describing and comparing these two sites. These examples are revealing in that they serve to illustrate several of the common phenomena and patterns that we observed across the various sites of our study.

Travel Agency A is located within a major train station in a mid-to-large size European city. The office is enclosed in glass and customers enter through a doorway to access the office. The office has a counter before which customers queue to speak with a representative. The walls up until about eye level have racks of travel brochures and there are also freestanding racks in the middle of the space that offer postcards and brochures. On the wall next to where people queue for the counter, there is a flat panel display of approximately 40" in diagonal that displays advertisements for vacations and travel specials, placed above head-level above the racks of brochures. The advertisements consist of professional-looking graphics with supplemental text and are shown "screensaver-style"- displayed for several seconds before switching to a new ad. Some of the advertisements have animation or video, but the majority of them are still images.

Travel Agency B is situated within a large grocery store in a mid-size European city. The office is an alcove with a large opening onto the well-trafficked aisle leading in and out of the grocery store. The "doorway" to the office is almost as wide as the office itself and is completely open during the hours when the travel agency is open, and covered by a pull-down metal gate when the office is closed. At one side of the office is a flat panel display of approximately 40" that is placed on a stand slightly below eye-level and angled outwards to the grocery store. The office contains a desk where a representative sits to help customers and the walls are lined in travel brochures. A large rack of colorful flyers for travel specials stands in front of the opening to the office, and similar flyers are also hung below the display. The display shows advertised travel specials in the form of text listings of destinations and prices over a background with palm trees on it. The specials are shown several to a page in screensaver-style.

Fig. 1. Travel Agency A, a busy enclosed space featuring a large display advertising travel specials and paper travel brochures

Fig. 2. Travel Agency B, an open space off of a well-trafficked grocery story entranceway, featuring colorful photocopied flyers and a large display advertising travel specials

After hour-long observations at both sites, we found that although the displays were similar in content, domain, and intent, there were several marked differences. Because of the nature of the spaces in which they were located, the goals of people n the spaces differed. The people in the viewing area of Travel Agency A were there because they were intentionally seeking travel information; they had made a conscious decision to enter the office and the display was therefore reaching a somewhat targeted audience. In comparison, the display in Travel Agency B was broadcasting information to coincidental passersby- the grocery store customers who were walking by the travel agency on their way out of the store. In both locations, we found that people's glances at the large display were rare and lasted approximately 1-2 seconds. Glances at Travel Agency B were relatively more frequent, with 17 out of 105 people

looking towards the display, whereas only three of the approximately 50 people observed in Travel Agency A glanced at the large display. In both cases, people looked at the large display only after first browsing or glancing at brochures and flyers in the area, sometimes for several minutes. In the case of Travel Agency B, the display was angled to face people leaving the store more than to face people entering the store. All glances that we observed were by people on their way out of the store.

5 Findings

In general, we found that the technology and content being widely used was relatively simple. The set of public displays for ambient information that we found deployed throughout these cities consisted almost entirely of non-interactive vertical displays consisting of announcements for services, events, resources, "fun facts," or products, as well as more abstract artistic content. Examples include a schedule of upcoming lectures in a university, advertisements for gift certificates at a department store, announcements of book signings at a bookstore, information about financial planning outside a bank, and abstract black and white video imagery in a university building atrium. Forty of 46 of the displays were plasma or LCD screens ranging from about 40" to 50" in size, as well as a few projected displays and other forms of large screens. Most of the displays showed a cycle of several items with or without animation that played in a loop; items usually consisted of a still image, or an image with some minor animation, such as text sliding onto the screen. Occasionally items included short clips of video. We were at first surprised to find that seven of the displays showed single still images (eg. an advertisement for a newspaper at a bookstore, a picture of an animal at a museum) that did not change, animate, or update the entire duration of our observation.

Over the ten months of observation, we were able to conduct longitudinal observations of seven of the sites, visiting them as many as four times to observe them at different times of the day or week, and see how their content had changed over time. The majority of the displays showed the same types and format of content with regular updates throughout the observation period. Six of the displays that originally showed only a single still image switched to showing a cycle of still advertisements on a loop. Two displays that had originally hung near the checkout counter of a large grocery store were moved to the top and bottom of the store's escalator very shortly after our study began and their content correspondingly changed from showing advertisements for specials in the store to advertisements for small local businesses. Other than these examples, we did not notice any significant changes to the displays other than updates with more current information.

In the following sections, we present our general findings regarding practices surrounding large displays and what factors we have found affect and contribute to these activities.

5.1 Brevity of Glances

In nearly all cases, we found that users paid attention only very briefly to the displays, if at all. When people turned their heads to glance at the display, we found that they usually only looked in the direction of the display for one or two seconds. Beyond that, there were extremely few incidents of people slowing down as they passed the displays,

and only a few extremely rare occurrences of people actually stopping or changing their walking path to look at the display content. On very rare occasions people would stop to look for as long as 7 or 8 seconds, e.g., after observing 88 people walk by a large display outside a bank, we saw one instance of this occurring. Displays that showed video content tended to capture the eye somewhat longer; although passersby did not frequently stop to watch the video, many did continue to look at the display for a few more seconds as they walked past, following it with their head until they were too far past it to look at it comfortably. Previous laboratory studies suggest that glances of more than 800ms suggest that the glances are intentional on the part of the passersby [13], which is promising for these technologies from an attentional standpoint. This does, however, suggest that the design of these technologies should take this expectation into consideration. Given the general brevity of glancing, we found that there was often an incongruity between the intent of the display content and people's actual actions. Many of the displays showed a few sentences of text at a time in the form of product description, a fun fact, a description of a service and a corresponding URL, or a description of an upcoming event. Considering what we observed, it is unlikely that passersby are actually reading the content in its entirety. Based on this, it seems that upon looking a display, people make extremely rapid decisions about the value and relevance of large display content, and that content that requires more than a few brief seconds to absorb is likely to be dismissed or ignored by passersby.

Fig. 3. Large displays in positioned well above passersby's heads in a variety of location attract few glances

5.2 Positioning of Displays

Displays were generally either located at approximately eye height or positioned considerably above the head, sometimes near the ceiling (Fig. 3). Both of these positions seemed intended to draw attention, the former likely intended to catch the eye easily and the latter likely intended to more visible from a distance or from a greater range of locations within the space or by more people simultaneously.

Our observations showed that the eye-position was far more effective at attracting glances from passersby, while people rarely looked up at displays located above the head. This contrast is apparent in the travel agency case study, and held true in general across the sites that we observed. For example, in one department store, there were seven large plasma displays located throughout the building, mounted at inconsistent heights, all showing similar content about products and services available at the store. Though glances at the displays were all generally brief, lasting about 1-2 seconds, those items located at eye level received a fair number of glances, while we did not observe anyone look up at the displays mounted near the ceiling at this site. Several other sites, such as a bookstore and a university building, offered the same opportunity to observe the same type of display showing the same content at different heights, and confirmed this finding. In another case, projected displays high up in a well-trafficked atrium of a public university building that displayed information about upcoming talks and events attracted almost no glances from passersby, despite being very physically large. During a one-hour observation period, we watched over 100 passersby, and saw only four turn their heads up to look at the content. Only one person actually paused to read the content for more than 1 or 2 seconds. The finding that displays were likely to attract more attention at eye-level than high up seemed to apply regardless of whether the content was for advertising, education, artistic, or informative purposes, as well as regardless of whether it was image, text, video, or some combination thereof.

Fig. 4. A display located significantly below eye-level unsurprisingly receives almost no glances and is often obscured from sight by passersby

Incidentally, we observed only one instance of a large display positioned significantly below eye-level; this display was outside a Middle Eastern restaurant and showed video of the Middle East as well as of Middle Eastern food preparation. This display not only received no glances during our observations, it was often obscured from sight by people in the area (Fig. 4).

5.3 Content Type

The types of content we observed on display were varied, including art, educational content, advertising, fun facts, news and current events. Advertising was most common but took many forms, from ads for local businesses, products, upcoming events, or services. It should be noted that advertisement was not always in the form of attempts to sell goods and services to consumers; they also included digital ads for free movies at universities, upcoming talks and lectures, and the existence of a rooftop garden and kids' reading room for customer use in a bookstore. In general, our observations did not offer any conclusive evidence that people were more likely to pay attention to certain type of content over another. Findings regarding brevity of glances, positioning of displays, and the other factors described below applied to most of the different types of content we observed on the displays.

5.4 Content Format and Dynamics

Although we were not able to draw any concrete conclusions regarding how people's attention varied based on types of content, we did find that format of content played a role in people's responses. In general, people found video to be more attractive than text, animated text, or still images. While glances at video often proved to be brief as well, we saw more instances of people craning their heads to look at the displays to walk by or on a few occasions stopping briefly, while they rarely did so for the sake of reading text. In one example, an advertisement on a display outside of a bank showed a short movie clip of a biplane flying over a landscape. A man fixed his gaze on the display while walking by and eventually stopped for 3 or 4 seconds to watch the video. When the display content switched to showing animated text, the man walked away. We witnessed this pattern on other occasions as well; when the content of a display was a mixture of video and still or other forms of content, people tended to glance less during the moments when video was not being displayed. Moments when video content switched to other forms of content also corresponded to people turning away from the displays or ceasing to look at them. Additionally we witnessed some rare instances of long engagement with video; an electronics shop had a large display in a window that showed colorful video clips of bouncing balls, animals, and other subjects of a more artistic than informative nature. On two occasions, we witnessed people who were walking by while eating fast food stop in front of this display and watch the video until they were finished eating before continuing walking. We observed no similar activity with other forms of content on large displays.

Interestingly, given the choice of digital information in the form of still content that changed periodically or information in the form of physical artifacts such as conventional signage or brochures, people generally were more drawn to the physical signage

and spent longer looking at it, as illustrated in the travel agency comparative scenario. We witnessed a similar phenomenon in a university building, where students would spend time browsing paper ads for upcoming events on a physical bulletin board, but did not watch a nearby large display that showed a cycle of still advertisements for upcoming events. It seems that while people are drawn to spend several seconds watching video on a large display, they sooner look at still content on paper than on the digital displays. Our observations lead us to believe that this is because people prefer a *dynamic* experience while engaging with information and content in such settings. Video offers a steadily changing stream of content, and we observed that when browsing paper flyers or bulletin boards in the vicinity of large displays, people browsed at varied rates, skipping past items that were not of interested and focusing longer on others, maintaining control over what they looked at. Screensaver-style information displays that imposed a temporal aspect on browsing over which people had no control rarely caught or held the attention of people in the vicinity.

5.5 Catching the Eye

One assumption often made about large displays in the decision to employ one is that they are eye-catching and naturally attract attention. In our observations, however, we found that people were more likely to look at them if there was something else nearby that caught their attention first. For example, a bookstore window display contained a large display with advertisements, some soccer merchandise, and a poster with some photographs of soccer players on it. In all but two instances of glancing at the display, passersby first stopped to look either at the poster or the merchandise before turning their attention to the display. At another site, a long case facing outwards from a bank had a row of decorative household items, followed by a large display showing advertisements for bank services. We observed approximately 80 passersby and found that nearly all of the people who glanced at the display came from the same direction; they started by looking at the items while walking by and then glanced at the display at the end. We did not notice the reciprocal behavior in the other direction; while people walking in the other direction often looked at the household items, their attention was rarely caught first by the display. This suggests that large displays may not be as eye-catching as they are often assumed to be, and play a secondary role in attracting attention when in the vicinity of other objects.

While it appears that other items in the area of a large display draw the eye to the display, we also observed that this was dependent to some extent on the arrangement of the artifacts. Items needed to be arranged such that they were either very close to another, or along some contiguous path of sight based on the direction in which the passersby were moving, as illustrated above in the example of the bank. Furthermore, the role of height once again came into play; even when displays and objects were placed near each other, having them at differing heights did not encourage viewing. For example, in a department store, a set of mannequins were placed such that the clothing being sold was at about eye-height, but displays placed directly over them showing fashion videos and advertising services and specials at the store were not viewed by the people who looked at the clothing. In the case of Travel Agency A,

although brochures were placed directly below the display, the display itself received little attention from people looking at the brochures. In the case of Travel Agency B, people walking by looked at the flyers, and then sometimes looked at the display, which was nearby albeit a few feet away, positioned at roughly the same height, and along the direction of movement of the passersby.

5.6 The "Captive" Audience

In our study, we observed that there were some situations in which people faced a display for an extended period of time as a result of social norms and practices, held "captive" before a display. Examples of such a situation included displays that were located at the top and bottom of escalators; because it is standard practice to face the direction of the escalator's movement, they were therefore also standing and facing the display while coming towards it. In several instances, a large display was located on a back wall behind a store cashier counter, such that people waiting in line to pay for items were facing the display as a result of the accepted social practice of facing forward while queuing. We found, however, that these situations did not promote more glancing or longer glances, even though the audience was "captive." In the case of one particular bookstore, displays behind a cashier did not advertise products for sale, but rather displayed literature trivia and "fun facts" as well as information about upcoming free events and free services at the store. Although the content was colorful and attractively designed, the display received almost no glances from customers waiting in line; they instead focused their attention on other merchandise nearby, such as small toys on the counter, the items in their hands, or on watching the cashiers ring up other customers.

Interestingly, in one department store, we noticed that some displays at ends of escalators did receive occasional lingering glances. These were small black and white displays that showed the content of the security video; i.e., real-time video of that particular escalator. This speaks again to the power of video to attract attention, perhaps in conjunction with the "captive" audience, and as well to a potential interest in a display that shows the viewer back to himself. Works such as [1] have touched upon the appeal of using images of the viewer on large displays, and may warrant further investigation as a technique for drawing attention to public ambient information displays.

5.7 Small Displays vs. Large Displays

In a few locations, we had the opportunity to observe how people responded differently to the same content on different sized displays in public locations. Interestingly, we found that people seemed to linger at smaller displays for a longer period of time. In a university setting, a building entrance hall had a large display showing event information and building information on the wall. This hall also had some small ATM-type kiosks with conventional-sized screens showing this same information. The smaller screens were interactive, also giving access to a university information system. But in addition to observing people actively interacting with the kiosks, we found that people waiting in the lobby also stood at the kiosks and watched the changing content, whereas they did not do this with the corresponding large display. Similarly, in an exhibit in another university building atrium, a black and white artistic video was being displayed

on both an extremely large projected display and a standard-sized iMac computer. Both of these setups had a leather bench before them where people could sit and watch the video. With the large display, we found that passersby in the atrium would occasionally turn their heads to glance at the display, and people occasionally sat on the bench briefly, but not to look at the display. The small display did not attract many visitors either, but we found that those who did sit down generally sat for an extended period, watching for several minutes at a time (Fig. 5).

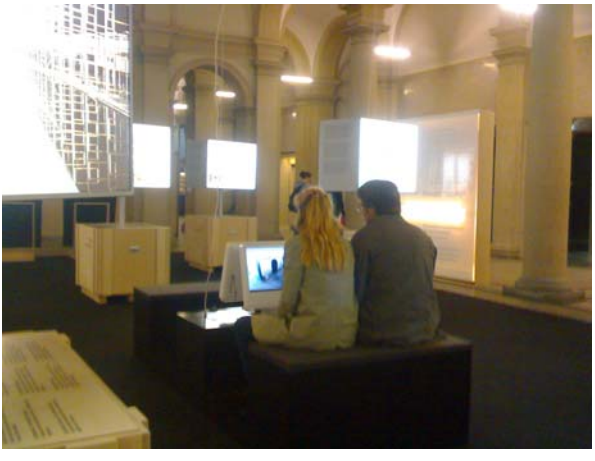

Fig. 5. People in an atrium stop to sit and watch video on a conventional monitor although the same content is available nearby on a very large projected display with similar seating

These observations suggest that small displays may encourage or invite prolonged viewing in public spaces to a greater extent than large displays, possibly because people are more used to or more comfortable with looking at small screens for a extended period of time. The use of a smaller display may also create a more private or intimate setting within the greater public setting that leads a viewer to feel less exposed and therefore encourages a longer interaction and greater comfort with displays within a public space.

6 Implications, Design Recommendations, and Conclusions

This work presents a broad picture of behaviors that occur around large displays deployed within a variety of public settings for a wide range of purposes. We have uncovered findings regarding how their use is affected by the format of their content and situation and presented suggestions for increasing the visibility of displays and improving the match between people's behavior and content. It should, however, be noted that there remains research to be done within the field of pervasive computing on how experiences with such displays should be tailored depending on the specific intent of the displays. For the purposes of brand awareness, for example, market studies have shown that brief viewing may be sufficient for increasing awareness and sales of a product [20]. Product advertisement, however, is merely one of many potential

purposes for which such displays are being designed for research and commercial deployments. For some of the more information intensive content we saw in our study, such as talk abstracts or artistic installations, the target user experience may go beyond short glances. Below we present design recommendations based on the general findings of our study; we suggest that these recommendations be taken within the context of the intended purpose of the application.

The findings we presented above generally suggest that attention to large displays in public settings is difficult to attract and hold. Despite this, our observations have revealed situations in which people are more likely to look at them and brought to attention the factors that affect attention to them. In the table below, we explicitly summarize some of the design recommendations that stem from our findings:

Table 1. Summary of recommendations for the design of large public displays

Finding	**Recommendations**
Brevity of glances	• Assume that viewers are not willing to spend more than a few seconds to determine whether a display is of interest • If the intent of the content is to be informative, present it in such a way that the most important information be determined in 2-3 seconds • Avoid using more than minimal text; even two or three brief sentences are not likely to be read
Positioning of displays	• When possible, position displays close to eye-height to encourage glances • If theft or vandalism are concerns, consider other ways to protect a display or make it inaccessible than putting it above arm's reach
Content format and dynamics	• Make content continually dynamic to keep user attention longer • Avoid abrupt changes in content to encourage continued viewing • Design to give users some degree of control over what information to view
Catching the eye	• Consider the direction of people's movement within a space when deciding where to situate displays • When choosing where to situate displays, take advantage of other objects in the environment to draw attention to displays, rather than relying on the large display to be the eye-catcher • When possible, consider ways in which the area surrounding the large display can be enhanced to maximize attention and increase the chances of glancing
Small displays vs. large displays	• Design to balance feelings of exposure and privacy within a public space by considering multiple display sizes and how they affect the viewer experience, perception, and comfort.

In addition to the implications and recommendations presented here, the more general recommendation that we can draw from this study is that in order to design content and applications that are most likely to serve their intended purpose, setting and audience should be taken into account whenever possible while creating the content, application and presentation. While this conclusion may seem to be of an obvious nature, it seems clear from our observations that the vast majority of large displays in public areas were designed with an eye towards who the target audience was and what the intent of the display was, but with less an a focus on how people would be moving within a space and how other activities within or aspects of the space might affect use of the display. The choice of specific setting within an environment appears to have been decoupled from the design process, thus yielding suboptimal situations, lower utility, and less attention.

The results of this work suggest that the ultimate position and context of the display should be taken into account during the design phase rather than after the fact. Additionally the design of the context itself can have substantial impact on how much attention the displays receive, and when possible, it should be considered how the surrounding environment can be designed or taken advantage of to draw attention to the displays, rather than assuming that the displays themselves will attract passersby. Finally, content itself should be carefully designed in such a way that does not assume that people are willing to engage for more than a few seconds before deciding whether they are interested; non-urgent, ambient information should be able to be conveyed at a glance.

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