Authoring Public Display Web Applications: Guidelines, Design Patterns, and Tool Support

Alessandro Bendinelli
CNR-ISTI, HIIS Laboratory
Via Moruzzi 1
56124 Pisa, Italy
alessandro.bendinelli@isti.cnr.it

Fabio Paternò
CNR-ISTI, HIIS Laboratory
Via Moruzzi 1
56124 Pisa, Italy
fabio.paterno@isti.cnr.it

ABSTRACT

While public displays are being deployed in a massive manner in various contexts, the user interfaces of their applications often still suffer from poor usability. There is thus a need for structured support for designers and developers able to highlight the main aspects to consider in these cases and suggest possible design solutions. We report on the design and development of an authoring environment for non-interactive public display Web applications that supports some guidelines that we have developed, and on which we have elicited some empirical feedback. Based on such guidelines, several design patterns have been identified, supported by the tool, and applied to some example applications.

CCS Concepts

• **Human-centered computing~User interface design** • **Human-centered computing~Systems and tools for interaction design** • Human-centered computing~Interaction devices • Human-centered computing~Displays and imagers

Keywords

Public Displays; Guidelines and Design Patterns; Authoring Environments.

1. INTRODUCTION

Public displays are being adopted in a pervasive manner. However, the design of the user interfaces of their applications is often left to the developers' personal intuition and creativity, with mixed results. Often such applications are designed and developed by people with limited knowledge of the relevant usability and user experience concepts.

Designing user interfaces and content for public displays is different from developing desktop Web sites or applications, and consequently needs specific tools. Indeed, the desktop is mainly a personal display accessed when users are sitting somewhere.

Thus, it is possible to assume that users have sufficient time to access information, navigate through it, and fill in any forms. On the other hand, a public display is oriented to a potentially numerous audience passing by in common areas, and thus the access time is rather limited. For this reason, authoring environments for responsive design [3] or proposals to adapt Web applications to large screens, but still in the perspective of personal access are not sufficient to improve the user experience through public display applications.

There is thus a need for structured support in the authoring process of public display Web applications. In order to present a contribution to address such issues, in this paper we report on some empirical feedback on guidelines for designing non-interactive public display applications, which has been useful for further refining them, and a related authoring environment also able to support a set of design patterns based on such guidelines in order to facilitate the development of usable applications for such displays. At this point the guidelines do not explicitly address interactions on the part of the final users (viewers) because they aim to provide a general framework for selecting and presenting the content, and the interactive part, when possible (most public displays are still non-interactive), depends heavily on the modality and devices considered (smartphone, Kinect, smartwatch, …).

2. THE GUIDELINES

Based on our experience and discussions with target users and domain experts, as well as the analysis of previous work in the area of public displays, we have identified nine aspects that are relevant when designing user interfaces for non-interactive public displays. The purpose of such guidelines is to highlight the key aspects to consider when designing public display user interfaces (in this work we mainly address the most common used type of public displays, those with screen size between 40 and 70 inches). They can be grouped according to three main dimensions:

- the *Context of use* in which the public display is deployed and accessed, it is based on the *Position* of the installation and the *Time* properties of the application;

- how to *select and organise the Content* to provide through it, in which we distinguished the Type of the information shown, the *Number of information areas* in the public display and the *Text* that refers to the textual styles to adopt;

- how to *Present the content* in such a way as to allow effective and efficient access, in which we distinguished

the *Layout* of the visual and graphical structure of the user interface, *Colour* to use in each information area, *Font* for the textual content in this type of display and the *Dynamicity* and how the content presentations change over time.

In order to identify issues or inconsistencies included in the first version of the guidelines [1], we carried out an online validation test. Specifically, the test was based on a questionnaire divided into three sections: the first requested some personal information, the second proposed, for each guideline, an assessment of a random selection of images / videos from various example public displays on a scale of 1 to 5, and the third and final section posed a series of general and specific questions related to each guideline aspect. The questionnaire was filled in remotely and anonymously by 70 participants (43 males and 27 females). They use technological devices extensively. The aim was to have concrete feedback from a set of potential end users representative of the general public.

Regarding position, the public display should be accessible, visible, in a heavily trafficked place, at eye level or above. It can be indoors or outdoors (e.g. streets, train stations, …). Some typical indoor locations are entrances, waiting rooms, information counters, but also hallways, shop windows, … Regarding typical public displays in the range of 40 – 70 inches, the optimal distance was indicated as between 2 and 5 meters. Users discouraged the use of some locations, such as corridors or shelves.

The type of content should be well suited to the time of its display in order to highlight information useful for the immediate future. Such information can be general or specific to the context in which the public display is located. The most appropriate content is multimedia and real-time updated information, by integrating various types of texts with images, videos, maps, … but it should also be simple to interpret. The sources of the contents can be heterogeneous, some of them can be static and others dynamic, provided by external sources. Local information was preferred over general content. Amongst the information types the preferred ones were internal communication, weather forecast, news channels, and events promotions. The least preferred information types were extensive content from social networks such as Twitter, stock market reports, music video channels, advertisements, and discount and promotions offers.

The number of information items to provide depends on the display's purpose, user interface structure, and location. If the purpose of the display is informative, then a greater amount of information is expected. The location is relevant since it determines how long people can look at the screen, and consequently the number of topics viewable. Waiting rooms or public offices imply the possibility of standing for longer time than entrances and corridors where people have to move. Each topic is associated with an area in the public display, usually ranging from 3 to 6 informative panels. Such numbers were confirmed in the user test.

Regarding the text, usually it should be composed of short clear expressions, in very few lines, left or center aligned, sometimes using bulleted lists. Secondary information can be structured in longer and more discursive paragraphs with the goal of providing additional information and stimulating reading. The user test confirmed the usefulness of using a limited number of words for the headings with a limited number of text rows (4-5) for the

content. The layout should be organized in such a way to capture the users' attention and drive their visual scan. It should be composed of three to five areas associated with the main information topics whose spacing depends on their importance. The resulting structure should be regular and easy to interpret. Symmetric layouts where two or more main areas have similar size do not seem to provide a useful hierarchy for driving the user view. In terms of layout, we proposed six examples and the most preferred was one structured into three areas, with the main area asymmetrically located on the left side, a secondary smaller area on the right, and a bottom horizontal footer area.

Public displays should grab attention and communicate a message quickly and effectively. When too many colours are used, our eyes do not know where to look first. Thus, the 7 ± 2 colours guideline used in graphic design can be applied. By simplifying the colour number, it will be possible to more effectively guide viewers. Contrast and area borders are the key elements in colour choice in order to make sure that the message is easily readable. The font should be simple and readable in order to better support the communication. It is better to avoid the use of fanciful or small fonts in support of simple fonts, with clear graphical features. The titles should have a font size larger than texts with a ratio that can go from 1 : 1.5 up to 1 : 2, for example, titles with 40 pts and text body with 24 pts or titles with 72 pts and body text with 36 pts. Users also found it useful to limit the number of fonts in one application (maximum 3) and discouraged the use of long texts with capital letters or italics.

There are two types of dynamic behaviours in public displays: one is related to animated content and one aims to provide pleasant effects during the transitions amongst different contents. Usually the interaction between the user and the display is short and casual (the user's full attention is usually limited to 2-3 seconds and then, if the users decide to read carefully, the content is usually looked at for 10-15 seconds). The overall average observation time depends on the purpose of the display and its location and generally it can be 2-3 minutes in an entrance or hallway, or 7-8 minutes in a waiting room. In the case of various pieces of information that are shown in a cyclic way then the average time for each presentation should be around 3-5 minutes. Such dynamic aspects were rated important for public displays.

3. DESIGN PATTERNS

Based on the guidelines introduced and our analysis of how public displays can be used, we have identified a set of design patterns for non-interactive public display applications. They have a dual purpose: on the one hand, they capture recurring situations and provide indications about how to address them by applying the guidelines; on the other, they aim to be a starting point in the process of developing a public display application, using the authoring tool presented in the next section. Starting with our studies, we have identified four main types of design patterns based on some charactering aspects:

- *Content type*, in which the focus is on the type of content and information that can be shown; we distinguish real-time and static content;

- *Dynamicity*, which considers how much the content in the interface of the public display changes over time; there are three levels (high, medium, and low);

- *Purpose and goals*, which vary according to the context, as a starting point we consider informative, entertaining, relaxing;

- *Position*, which is based on the location of the public display and the viewing time by the passers-by; we consider for example transit, short wait, long wait.

Table 1. Design Patterns based on Purpose

Guideline	Transit	Short Wait	Long Wait
Position	By an entrance or an elevator or in a corridor	By a desk	In waiting rooms, e.g. hospital or public stations
Time	Change every hour	Change every 2/3 hours	Change according to day period (morning, afternoon, ...)
Information type	General info or communication	Events, touristic information, video	News channel, nearby services, general info
Information areas	At most 3 areas	4-5 areas	5-6 areas
Texts	Short and brief texts	Short texts with structured paragraphs	Longest texts
Layout	Simple with a central main area	With header or footer for additional content	Regular with balanced areas
Colours	Bright colours	With clear contrast	Subdued and light colours
Fonts	1 or 2 simple fonts	2 fonts	About 3 fonts
Dynamicity	Some effect to attract users' attention	Multiple effects to highlight information updates	No particular dynamic effect

For example, Table 1 shows the design patterns based on purpose and goals (informative, entertaining and relaxing) obtained by the application of the guidelines. In particular, the aim of an "informative" display application is to provide contents with a high degree of informativeness, such as news channels and promotional events, while in an "entertaining" application we should find videos and other content to entertain and amuse passers-by. Finally, a "relaxing" display should present all information in a simple and calming way, for example, by using words with a conversational style and soft colours.

Other examples of design patterns are shown in Table 2. These patterns are based on the position of the public display and are associated with three main positions: transit, that is useful for areas with very short waiting times such a corridor; short wait, that is characterized by a medium waiting time; and finally the

long wait, where users may spend a lot of time in front of the display.

Table 2. Design Patterns based on Position

Guideline	Informative	Entertaining	Relaxing
Position	By a desk or a waiting room	Areas with long waiting time	In stations or in hospital contexts
Time	Change every hour	Change according to day period (morning, afternoon, ...)	Change every 2/3 hours
Information type	News, events, communication	Videos, point of interest, tweets	Weather, touristic info, general info
Information areas	5-6 areas	4-5 areas	3-4 areas
Texts	Clearly structured	Short texts	Conversational Style
Layout	With header and footer	With a central main area	Regular
Colours	With clear contrast	Bright colours	Subdued colours
Fonts	About 3 simple fonts	3-4 fonts more elaborated	A couple of simple fonts
Dynamicity	Highlight information update	Effects for stimulating user involvement	No particular dynamic effect

4. THE AUTHORING ENVIRONMENT

We decided to design and develop an authoring environment able to support the application of the guidelines and associated design patterns in such a way as to facilitate the work of designers and developers. There are various paradigms which can be used to develop an authoring environment [2], and our intent was to facilitate the development and management of public display applications by highlighting the most important aspects that compose the structure of such applications, while providing the possibility of controlling their temporal evolution.

Within the functionalities accessible from the homepage there are the creation of a new public display application, the selection of an existing application for further editing, and the final step of publishing it. Other tools in the homepage allows users to efficiently edit the main parts that constitute a public display application: contents, scheduling times, and look and feel, in relation to the application selected.

In the authoring environment, an application represents an installation for a real public display. It stores internally all the information necessary for its correct publication, including the graphic layout, information content chosen by the author, the temporal organization of data and so on. Using the tool, designers can create multiple applications for different types of screens so they can manage them based on various factors such as the purpose of communication, the location of a public display, the types of information presented, the complexity of the interface.

The Design Patterns section contains a list of patterns that the author may exploit in the development process: in fact, a design pattern is associated with an initial configuration that includes the basic information needed to generate a new application based on its specific characteristics. It is possible to select a design pattern and use it as the initial version of an application, which can then be further edited and customized for publishing. There is also an editor to support the creation/modification of the design patterns, in relation to the guidelines defined in the early stage.

Figure 1. Example Information Types in an application.

The Information Types section (see an example in Figure 1) shows the list of different content types created for the application under development, and allows designers to assign each specific type to an information area, and the ordering when more than one is assigned to a given area. Moreover, the designers can specify those which are to be shown publicly or temporarily suspended. Currently, the system allows authors to choose preferred content from fairly broad types, for example, textual information, image slides, tweet extracts in real time, weather forecasts, videos uploaded to YouTube, and many others. Each information type can be managed through a section with a complex input form, based on the characteristics of the type itself. In general, it contains some generic properties related to the presentation in the public display, such as display duration and the ordering in the layout area, and some specific details.

Planning the timing of the various types of information in the presentation is made through the Scheduling instrument, with which users can organize every single content within a daily grid divided into time slots. Specifically, each period is calculated based on the 24 hours composing a day and the number of slots chosen by the author.

The UI Design section is useful for the management of the overall layout and the definition of the graphics and font properties. Through an interactive tool the author can easily create the information areas and define their graphical appearance, such as dimensions (stored in percentage units to fit to the display spaces), general properties (background, edges, shadows, transition effects), fonts (for various headings and content), colours for all the elements, and text formats. Each area can contain one or more elements, created through the Information Types section, which are shown dynamically in the application once published. The playback tool is important for controlling the publication process. It shows the list of reproduction instances associated with the application.

After developing a first version of the authoring tool, we carried out a user test to evaluate its level of usability. The test involved 10 users (8 males, 2 females) remotely. They received some basic information about the tool and its goals by email, as well as a video showing its basic functionality, link to access the tool, tasks to accomplish, and a questionnaire to fill in. The users had to carry out four tasks covering the various parts of the authoring process, and then had to rate some relevant aspects, and provide free comments and suggestions. For lack of space we cannot detail the ratings. For the first task they had to select the indicated design pattern and then use it as starting point for a new application. Only one user was unable to complete the task successfully. One suggestion was to enrich the description of the design patterns with screenshots highlighting their main features. The second task required users to create and edit instances of three types of information (time-based, feed RSS, and YouTube video) and control their presentation time. All users were able to accomplish the task, they rated its complexity low and the associated user interface was considered medium in terms of effectiveness. The users provided various suggestions for small adjustments, in particular making some command labels more immediately understandable. In the third task, the users had to modify the properties of some information areas of the application obtained in the second task in order to improve the layout and the graphical presentation. In this case the complexity of the task was reported to be low and the corresponding user interface effectiveness good, some users found some difficulties due to the fact that the software they frequently use have slightly different user interfaces for performing similar tasks. The last task was dedicated to the part related to publishing a public display application. All users were able to complete it and found it easy. The associated user interface was rated well in terms of effectiveness. From the analysis of the results and users' feedback, we modified some features and interfaces to improve the usability. For example, we added some quick links to the main parts of the tool, we improved the user interfaces in some sections, in which we improved the arrangement of graphical aspects and typographical properties.

5. CONCLUSIONS
We have reported on work on developing support for designers and developers of public displays applications. It mainly consists of a set of guidelines and an authoring environment that is able to support design patterns based on such guidelines in order to facilitate their application. The guidelines and the design patterns should be interpreted as a useful starting point that then needs to be customized and extended for the specific application under consideration. Future work will be dedicated to further refining the design patterns and extending them with the possibility of considering user interactions with the public display applications, even with the support of personal devices.

REFERENCES
[1] Bendinelli A., Paternò F.: Design Criteria for Public Display User Interfaces. HCI (1) 2014, Springer Verlag LNCS 8510, pp. 623-630.

[2] Bulterman, Dick CA, and Lynda Hardman. "Structured multimedia authoring." ACM Trans. on Multimedia Computin, Communic., and Applicat., 1.1 (2005): 89-109.

[3] Marcotte E., Responsive Web Design, A Book Apart, 2011.